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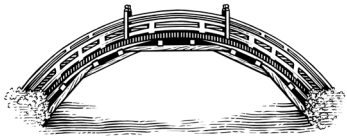
ROUNDTABLE

Asia's Space Ambitions: Driving the Next Chapter in Global Space Competition



Greg Autry

R. Lincoln Hines

Saadia M. Pekkanen

Rajeswari Pillai Rajagopalan

Sangwoo Shin

Brian Gallant and Jordan Miller

Cassandra Steer

Hema Nadarajah

with an introduction by

Vina Nadjibulla and *Charles Labrecque*

One Union Square, Suite 1012, 600 University Street, Seattle, Washington 98101 USA

Introduction

The use of space assets has become an integral part of life on Earth, impacting humanity in unprecedented ways. From the smartphones in our pockets to the weather forecasts vital for agriculture, space technology plays a crucial role in communication, navigation, safety, and security. Today, many of our daily activities rely on the thousands of operational satellites orbiting the planet that make up the global network underpinning modern communication. Beyond international prestige, deep space exploration has led to numerous scientific and technological advancements in areas such as health, information technology, and industrial productivity.

More than ever, space is recognized as a critical operational domain for national security alongside air, land, sea, and cyberspace. Space is essential for military operations globally, with militaries increasingly dependent on space assets for power projection and national defense. According to a recent Space Foundation report, global military space budgets surged 18% to $57 billion in 2023, making up nearly half of total government spending on space.[1] Strategic competition between states, especially the competition between the United States and China, extends into space, heightening the risk of increasing militarization and even weaponization of this new domain.

At the same time, the space domain has expanded, involving a diverse array of actors and activities, with the private sector playing a growing and indispensable role, further complicating interactions in space. While governments still drive the majority of space activities, key components and missions are now contracted out to private firms. This new era, often called "Space 4.0," is defined by dynamic partnerships between governments, the private sector, and society.[2] According to a 2024 report by the World Economic Forum and McKinsey & Company, the space economy, valued at $630 billion, is projected to triple and reach $1.8 trillion by 2035, creating even more opportunities for private actors in the coming years.[3]

Today, nearly 80 countries have space programs, compared with 40 in 2000. Asia, as highlighted by Saadia Pekkanen in this roundtable, boasts

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1 Space Foundation, "Space Foundation Announces $570B Space Economy in 2023, Driven by Steady Private and Public Sector Growth," July 18, 2024 ~ https://www.spacefoundation.org/2024/07/18/the-space-report-2024-q2.

2 "What Is Space 4.0?" European Space Agency ~ https://www.esa.int/About_Us/Ministerial_Council_2016/What_is_space_4.0.

3 "Space: The $1.8 Trillion Opportunity for Global Economic Growth," World Economic Forum and McKinsey & Company, April 8, 2024 ~ https://www.weforum.org/publications/space-the-1-8-trillion-opportunity-for-global-economic-growth.

the "world's greatest concentration of countries with independent space capabilities," which positions the region at the forefront of a modern space race. As nations increasingly recognize the domain's strategic and economic importance, they are rushing to invest in and develop pivotal space capabilities and competing to explore and exploit outer space. While the Outer Space Treaty has facilitated the governance of space since its adoption in 1967, this new space race has triggered a debate over the need for a new legal framework to help manage intensified competition and increased congestion.

Four years after a 2020 roundtable in *Asia Policy* entitled "Asia in Space: The Race to the Final Frontier," this issue offers a reassessment of the region's four major space powers: the United States, China, Japan, and India, and a review of four middle powers: South Korea, Canada, Australia, and Singapore. Each essay analyzes recent initiatives and developments in these countries' space programs and commercial space sectors, as well as their implications.

The roundtable begins with an essay by Greg Autry on U.S. space programs. He argues that the United States maintains its dominant role in global space activities, which enjoy rare bipartisan support. He describes the breadth of U.S. space efforts as "extending across multiple government agencies and includ[ing] thousands of commercial firms and dozens of nonprofits." He explains that the centerpiece of the U.S. space policy is now the Artemis Accords, which seek to solidify and document support for the American interpretation of the 1967 Outer Space Treaty. Of the eight countries examined in this roundtable, only China is not a part of this U.S.-led set of arrangements.

In the second essay, R. Lincoln Hines describes China's growing space ambitions, especially as it narrows the capabilities gap with the long-dominant United States. He highlights China's recent advancements in military counterspace capabilities, which pose a challenge to U.S. space dominance and freedom of action. However, Hines cautions against "exaggerating China's advantages," at least for now. He notes that what China lacks is "an alternative to the U.S.-led Artemis Accords" and the "political capital to translate such a vision into reality."

In her essay on Japan, Saadia Pekkanen examines the country's recent space-related developments and the driving factors behind its decision-making, which she describes as motivated by threat perceptions and a changing external environment. She explains that Japan is advancing its space capabilities through a coordinated approach that integrates military,

economic, and diplomatic dimensions, with a focus on both commercial and security interests. Pekkanen also describes Japan's international collaborations, which extend well beyond its alliance with the United States, remarking that Japan engages on "economic and defense issues with a range of other actors."

Rajeswari Pillai Rajagopalan, in her essay, details the significant advancements India has made in its space capabilities, despite operating with a relatively small budget. She explains that while India's space program continues to prioritize its space capacities for social and economic progress, it "now appears to be expanding…to include military and security dimensions in a more determined manner." This shift reflects an "intensifying space competition in [its] neighborhood, especially China's growing counterspace capabilities."

Sangwoo Shin provides an overview of South Korea's new space policy, which he argues is shifting from "a catching-up strategy to taking a leading role in space innovation." Guided by the establishment of the Korea AeroSpace Administration in May 2024, Shin explains that South Korea seeks to become "one of the world's top-five aerospace powers as well as establishing aerospace as a key national industry."

The authors of the essay on Canada's space activities, Brian Gallant and Jordan Miller, describe the country's current objectives as "focused on space exploration and national defense programs." They emphasize Canada's potential to expand its commercial space industry and strengthen its position in the global space economy but critique the lack of a comprehensive strategic vision and argue for better integrating the private sector into Canada's national space policy.

Regarding Australia, Cassandra Steer explains that although the country has its own (albeit small) space agency, it lacks a cohesive "space narrative" and a clear national space policy, unlike other middle powers such as Canada and South Korea. She argues that Australia is missing a "strong, coordinated national approach" to space, and that despite being the third country to conduct its own launch from its own territory, its identity as a space nation remains nascent.

In the final essay, Hema Nadarajah describes Singapore's space activities as representing "both an opportunity and a necessity." She explains that, though small and possessing very few natural resources, Singapore is strategically positioning itself in the global space industry by advancing its space capabilities, fostering a commercial space sector, and engaging in international collaborations. The country sees space as essential for its

economic competitiveness, technological leadership, and national security, especially in the context of intense U.S.-China competition.

Once the exclusive domain of a few nations, space has now become the next frontier for an increasing number of Indo-Pacific countries. While this roundtable focuses on the space activities of eight key nations, many others in the region are also making rapid advancements. Asia's remarkable economic and technological growth over the past two decades has not only propelled the region to the forefront of the modern space race but also positioned it as a key driver in shaping the future of global space competition. ◈

Vina Nadjibulla, Vice President, Research & Strategy
Asia Pacific Foundation of Canada

Charles Labrecque, Director, Research
Asia Pacific Foundation of Canada

The United States in Space: Strategies, Capabilities, and Vision

Greg Autry

In this journal in April 2020, John Logsdon wrote that "by almost every measure, the United States is the most space active country in the world."[1] This statement remains true today, even though the mix of U.S. space activities is shifting and the international context in which they occur is rapidly evolving. Big ambitions, both governmental and commercial, abound. NASA is returning to the Moon in a major way by building a coalition of international and commercial partners, and it has its eyes on Mars. The still new U.S. Space Force is redefining its mission to include protection of space activities and is increasingly focusing on projecting capabilities beyond low-earth orbit (LEO). Commercial operators are not just fulfilling NASA and Department of Defense orders but finding a very real market for commercial launches and human spaceflight. They are even launching ambitious, privately funded missions of science and exploration.

However, all these efforts are exposing the constraints of economic realities: governmental budgets and private investment in space may have reached apogees far below the dreams of policymakers and entrepreneurs. A fresh look at the current state of the U.S. space domain and its future vector is called for. This essay will provide a broad survey of the United States' governmental and commercial space activities and programs, actors, and policies toward outer space.

Current U.S. Space Activities and Programs

U.S. engagement in space is both broad and deep. It extends across multiple government agencies and includes thousands of commercial firms and dozens of nonprofits. The United States is the undisputed world leader in many categories of space exploration, science, and development. These include space launch (rockets), human spaceflight, planetary missions, astrophysics (space telescopes), earth observation, communications, defense applications, and satellite construction. While overall U.S. leadership in

GREG AUTRY is the Associate Provost for Space Commercialization and Strategy at the University of Central Florida (United States) and a Visiting Professor in the Institute for Security Science and Technology at Imperial College London (United Kingdom). He can be reached at <greg.autry@ucf.edu>.

[1] John M. Logsdon, "Asia in Space: The Race to the Final Frontier," *Asia Policy* 15, no. 2 (2020): 5 ⇝ https://www.nbr.org/publication/asia-in-space-the-race-to-the-final-frontier.

space has been a given since the late 1960s, individual domains have often been quite dynamic. For instance, the United States ceded leadership in commercial space launch in the 1990s and lost human spaceflight capability following the shuttle program's retirement in 2012. For many years, U.S. satellite construction was waning as well. Dominance in all these areas has been regained during the commercial space boom of the last decade.

During this period, the United States' traditional space rival, Russia, has fallen behind. Roscosmos has been in a state of notable decline, and Vladimir Putin's regime has chosen not to embrace the commercial trend.[2] China has clearly ascended into the position of the world's second space power, while other Asian states, notably India, Japan, and South Korea, have demonstrated serious ambitions and capabilities in recent years.

The Moon redux. The most visible portion of the United States' governmental space effort has always been the National Aeronautics and Space Administration, or NASA as it is more commonly known. Established during the Eisenhower administration, NASA enjoyed the notable support of President John F. Kennedy, who established a clear objective for the agency of "landing a man on the moon and returning him safely to the earth."[3] Having accomplished this audacious goal in 1969, NASA received global accolades, and the agency has accomplished a number of notable feats in space in the decades since, despite a persistent decline in appropriations. The NASA budget, when measured as a percentage of federal spending, has declined by more than an order of magnitude since the heydays of the 1960s. Even with recent nominal increases, it has largely stagnated (when adjusted for inflation), accounting for 0.4% to 1.0% of government spending since the 1970s. The agency's current budget is around $25 billion.[4] NASA's planetary missions to Mars and the outer solar system have been unparalleled in their quantity and success. Although human spaceflight remained constrained to LEO, the shuttle program pioneered the use of reusable spacecraft, and the scale of the International Space Station (ISS) is notable.

In 2017 the Trump administration committed to returning Americans to the Moon and eventually beyond. The administration's first space policy directive departed from the Apollo program's "flags and footprints" model

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2 Ramin Skibba, "Russia's Space Program Is in Big Trouble," *Wired*, March 28, 2023 ~ https://www.wired.com/story/russias-space-program-is-in-big-trouble.

3 John F. Kennedy (address to the joint session of Congress, Washington, D.C., May 25, 1961), available at https://www.jfklibrary.org/learn/about-jfk/historic-speeches/address-to-joint-session-of-congress-may-25-1961.

4 "Your Guide to NASA's Budget," Planetary Society ~ https://www.planetary.org/space-policy/nasa-budget.

by replacing Obama administration text that began "Set far-reaching exploration milestones" with the following:

> Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.[5]

This was a significant departure. Human settlement and sustainable, long-term exploration and development were previously considered politically untenable policy objectives. Presidential candidate Newt Gingrich was widely mocked, for example, for proposing a U.S. lunar base during the 2012 Republican primary debate.[6] It is notable that the Biden administration has kept and built on the Trump administration's space policy in a rare demonstration of policy continuity between the two contentious administrations.

The centerpiece of this policy is manifested in Artemis, NASA's multifaceted human-focused program to return American astronauts to lunar space, make surface landings, and construct an orbital lunar outpost called Gateway. The program's architecture is complex, utilizing system elements from several commercial vendors and international partners. Notably, more of the design choices have been left to vendors than was the case with the Apollo program, the shuttle fleet, or the ISS. The selection of a variant of SpaceX's revolutionary Starship as the initial human landing system was particularly unusual.

The original Artemis timeline called for completion of the Gateway and landings by the end of 2024. Several of the program's major components include a new mobile launcher for Boeing's space launch system rocket, the re-entry system for Lockheed Martin's *Orion* capsule, SpaceX's lunar lander (based on its Starship), and the initial modules for the Gateway produced by Maxar and Northrop Grumman. NASA currently projects that the Artemis III mission, which was supposed to include a human lunar landing, will not fly until September 2026, although the Government Accountability

5 "Presidential Memorandum on Reinvigorating America's Human Space Exploration Program," White House, December 11, 2017 ~ https://trumpwhitehouse.archives.gov/presidential-actions/presidential-memorandum-reinvigorating-americas-human-space-exploration-program.

6 Tom Toles, "End to the Lunacy," *Washington Post*, February 6, 2012 ~ https://www.washingtonpost.com/blogs/tom-toles/post/end-to-the-lunacy/2012/02/03/gIQAhXl8mQ_blog.html.

Office suggests that 2027 is more likely.[7] Even NASA administrator and former senator Bill Nelson has recently worried that China could beat the United States to a crewed Moon landing.[8] Credible reports suggest that NASA might divert the Artemis III mission to a non-landing profile.[9]

Science. For the first time since the 1960s, NASA's Science Mission Directorate has been tightly aligned with the agency's human exploration objectives. The Commercial Lunar Payload Services (CLPS) program provides funding to several commercial firms building robotic lunar landers capable of delivering NASA, international, and commercial payloads to the surface of the Moon under fixed-price contacts. Two CLPS missions were launched in early 2024, with one suffering a fatal propulsion problem and the other toppling over after landing.[10] Several more CLPS missions are scheduled over the next few years.[11]

Despite these failures, the United States continues to dominate space science. NASA has had a string of successful missions with increasingly complex Mars rovers, and today two large, nuclear-powered rovers are operating on the red planet's surface.[12] NASA continues significant robotic exploration of the solar system, particularly asteroids. In 2023 the OSIRIS-REx mission returned samples from the asteroid Bennu to Earth. In September 2022 the Double Asteroid Redirect Test (DART) successfully demonstrated the ability of a spacecraft to nudge the orbit of a small asteroid.[13] The probe Psyche was launched to a metal asteroid of the same name in 2023.

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7 William Russell, "NASA Artemis Programs: Lunar Landing Plans are Progressing but Challenges Remain," Government Accountability Office, testimony before the Subcommittee on Space and Aeronautics, Committee on Science, Space, and Technology, House of Representatives, January 17, 2024 ~ https://www.gao.gov/assets/d24107249.pdf.

8 Scott Detrow, Linah Mohammad, and Adam Raney, "NASA's Chief Is Worried about China Getting Back to the Moon First. Here's Why," NPR, May 6, 2024 ~ https://www.npr.org/2024/05/06/1249249941/nasa-bill-nelson-moon-artemis-china-starliner.

9 Eric Berger, "NASA May Alter Artemis III to Have Starship and Orion Dock in Low-Earth Orbit," Ars Technica, April 19, 2024 ~ https://arstechnica.com/space/2024/04/nasa-may-alter-artemis-iii-to-have-starship-and-orion-dock-in-low-earth-orbit.

10 Aria Alamalhodaei, "One Busted Valve Led to the Failure of Astrobotic's $108M Peregrine Lunar Lander Mission," TechCrunch, August 27, 2024 ~ https://techcrunch.com/2024/08/27/one-busted-valve-led-to-the-failure-of-astrobotics-108m-peregrine-lunar-lander-mission; and Jeff Foust, "IM-1 Lunar Lander Tipped Over on Its Side," SpaceNews, February 2024 ~ https://spacenews.com/im-1-lunar-lander-tipped-over-on-its-side.

11 "CLPS: NASA's Commercial Moon Landing Missions," Planetary Society ~ https://www.planetary.org/space-missions/clps.

12 Nola Taylor Tillman and Mike Wall, "Perseverance Rover: Everything You Need to Know," Space.com, July 24, 2024 ~ https://www.space.com/perseverance-rover-mars-2020-mission.

13 Daisy Dobrijevic, "NASA's DART Asteroid-Smashing Mission: The Ultimate Guide," Space.com, October 14, 2022 ~ https://www.space.com/dart-asteroid-mission.

Major new missions are under development to explore the icy moons of the outer solar system. Europa Clipper, an orbiter, was launched toward Jupiter in October 2024.[14] The Dragonfly mission will send a nuclear-powered helicopter to Saturn's moon Titan in 2028.[15]

NASA also leads in space-based astronomy, astrophysics, and heliophysics, operating a fleet of space-based observatories covering the spectrum from infrared to X-ray. The flagship James Webb Space Telescope notably strained NASA budgets for years, coming in at about $10 billion, well above its original proposed cost of $1.0 billion to $3.5 billion.[16] The agency's Parker Solar Probe became the fastest-moving human object ever launched, traveling at 500,000 kilometers per hour, and the first to reach the atmosphere of the sun. The Deep Space Climate Observatory (DSCOVR) satellite, operated with the National Oceanic and Atmospheric Administration (NOAA) and stationed at the Earth-Sun Lagrange point 1, provides constant analysis of Earth-bound space weather events.[17]

However, cost overruns accompanying delays in the Artemis lunar program have put significant pressure on NASA's budget during a time when Congress has been trying to rein in spending. Congress and the White House have also failed to agree on a budget, resulting in months of governmental operations under continuing resolutions that simply extend the previous year's budgets regardless of actual agency need. That has put pressure on NASA's science budget and negatively affected several missions.[18] In February 2024, Jet Propulsion Laboratory (JPL) laid off 8% of its work force due to "budget uncertainty."[19] The proposed Mars Sample

14 Stephen Clark, "NASA Will Proceed with Final Preps to Launch Europa Clipper Next Month," Ars Technica, September 9, 2024 ~ https://arstechnica.com/space/2024/09/nasa-will-proceed-with-final-preps-to-launch-europa-clipper-next-month.

15 "NASA's Dragonfly Rotorcraft Mission to Saturn's Moon Titan Confirmed," NASA, April 16, 2024 ~ https://science.nasa.gov/missions/dragonfly/nasas-dragonfly-rotorcraft-mission-to-saturns-moon-titan-confirmed.

16 Nell Greenfieldboyce, "Why Some Astronomers Once Feared NASA's James Webb Space Telescope Would Never Launch," NPR, December 22, 2021 ~ https://www.npr.org/2021/12/22/1066377182/why-some-astronomers-once-feared-nasas-james-webb-space-telescope-would-never-la.

17 "DSCOVR: Deep Space Climate Observatory," NOAA ~ https://www.nesdis.noaa.gov/current-satellite-missions/currently-flying/dscovr-deep-space-climate-observatory.

18 Greg Autry, "Pennywise, Future Foolish: Congress Moves to Cut NASA Science Budget," *Forbes*, July 27, 2023 ~ https://www.forbes.com/sites/gregautry/2023/07/27/pennywise-future-foolish-congress-moves-to-cut-nasa-science-budget.

19 Marcia Smith, "JPL Lays Off Eight Percent of Workforce amid Budget Uncertainty," SpacePolicyOnline.com, February 6, 2024 ~ https://spacepolicyonline.com/news/jpl-lays-off-eight-percent-of-workforce-amid-budget-uncertainty.

Return mission was deemed fiscally unsustainable, and the agency sent out a new solicitation for different approaches.[20]

International cooperation. Launched by the U.S., Russian, Canadian, Japanese, and European space agencies in 1998, the U.S.-led ISS has long provided an example of sustained international cooperation in space. The station has provided American astronauts with a destination to live and work in space, supported microgravity science, and been a major tool of diplomatic soft power. Most notably, U.S. cooperation with Russia on the ISS has continued despite the immense tensions associated with the war in Ukraine.

Looking to continue that success, NASA has included international partners in the development of its Artemis architecture. The service module for the *Orion* spacecraft is produced by the European Space Agency (ESA). Modules and components of the lunar Gateway space station will be provided by the ESA, Japan, and Canada.[21] NASA reports that two-thirds of its international agreements pertain to science missions.[22]

NASA and the Department of State drafted the Artemis Accords. The accords are an international agreement on norms of behavior for lunar exploration and development. Grounded in the 1967 Outer Space Treaty, they reinforce commitments to the Registration Convention and the Rescue and Return Agreement. They also fulfill a major U.S. objective of solidifying and documenting support for the American interpretation of the Outer Space Treaty's rules on the commercial development of lunar resources. Section 10.2 includes a statement that signatories "affirm that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty."[23] This language supports the U.S. position (from the 2015 Commercial Space Launch Competitiveness Act), that national and commercial actors can extract, process, and resell lunar material. As of this writing, the accords had been signed by 45 nations.

Commercial activities. NASA's use of commercial vendors under fixed-price contracts has been particularly active in LEO, a domain that U.S. space policy has recognized as one that commercial vendors are best suited to manage. The Commercial Orbital Transportation Services (COTS) program and its follow-on, Commercial Resupply Services, have been

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20 Brett Tingley, "NASA Wants New Ideas for Its Troubled Mars Sample Return Mission," Space.com, June 7, 2024 ~ https://www.space.com/nasa-mars-sample-return-alternative-methods.

21 Theresa Cross, "The Global Alliance Pioneering NASA's Lunar Gateway," Space Explored, March 16, 2024 ~ https://spaceexplored.com/2024/03/16/the-global-alliance-pioneering-nasas-lunar-gateway.

22 Peyton Blackstock "International Cooperation at NASA," NASA, August 18, 2023 ~ https://explorers.larc.nasa.gov/2023APPROBE/pdf_files/08_APEX_PPC-Blackstock-International_Cooperation.pdf.

23 "The Artemis Accords," NASA, October 13, 2020, section 10.2 ~ https://www.nasa.gov/artemis-accords.

widely recognized as extremely successful in both serving NASA's needs and bringing new solutions to the commercial marketplace. SpaceX and Northrup Grumman have sent dozens of resupply missions to the ISS. SpaceX's Falcon 9, in particular, was developed with COTS funding and, since its first launch in 2010, has become the world's most popular launch vehicle. Other government space agencies, including China's and the ESA, are emulating the COTS program.[24]

NASA leveraged the COTS model to develop crew transportation to the ISS in the post–space shuttle period. Under the Commercial Crew Development Program, SpaceX delivered a crew version of its Dragon capsule and has developed a commercial follow-on business for both space tourism and the flights of foreign astronauts to the ISS and for LEO missions. In September 2024, SpaceX's Polaris Dawn mission carried four private astronauts beyond LEO to an apogee of 1,400 kilometers and performed a brief extravehicular activity. Boeing has conducted crewed and uncrewed tests of its Starliner commercial capsule, but technical glitches have, as of this writing, prevented the vehicle from entering routine service. Starliner's launch vehicle, the United Launch Alliance's Atlas V, is also slated to be discontinued due to its dependence on Russian-built RD-180 rocket engines.[25]

The ISS is scheduled to be decommissioned in 2030. The United States has been looking for commercial alternatives, and NASA's Commercial LEO Destination Program is designed to address that need.[26] Although several vendors are developing potential commercial space stations, there is growing concern about the ability of any of them to deliver before the ISS deadline, risking an "LEO gap" for U.S. microgravity research.[27]

U.S. Government Space Actors

The Department of Defense. As a newly formed branch in 2019 of the U.S. military, the U.S. Space Force has been a high-profile part of the United States' growing commitment to space. Despite media concerns

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24 Eric Berger, "Nearly Two Decades after NASA, China and Europe Eye Commercial Cargo Plans," Ars Technica, June 6, 2023 ~ https://arstechnica.com/space/2023/06/china-and-europe-both-seek-to-emulate-nasas-success-with-commercial-cargo.

25 Joey Roulette, "ULA Stops Selling Its Centerpiece Atlas V, Setting Path for the Rocket's Retirement," Verge, August 26, 2021 ~ https://www.theverge.com/2021/8/26/22641048/ula-boeing-lockheed-end-sales-atlas-v-rocket-russia-rd180.

26 "Commercial LEO Development Program," NASA ~ https://www.nasa.gov/wp-content/uploads/2023/10/nac-oct-2022-commercial-leo-development-program-final-reva.pdf.

27 Jeff Foust, "NASA Acknowledges Possibility of Short-Term Post-ISS Gap," SpaceNews, November 22, 2023 ~ https://spacenews.com/nasa-acknowledges-possibility-of-short-term-post-iss-gap.

over "militarizing" space, it is important to note that the United States' space program, like those of Russia and China, has its roots in military development. U.S. space efforts started with military suborbital launches in the 1940s, and the first U.S. satellites were built by the army (Explorer) and the navy (Vanguard). The first U.S. astronauts were all military members and were launched into space on modified intercontinental ballistic missiles.

Although all branches of the U.S. military have had space-related functions, the air force has led the launch and management of most satellites. The initial role of the space force was to take over those activities within an organization fully devoted to space. In September 2023 the force adopted a new mission statement—"Secure our Nation's interests in, from, and to space"—suggesting a clear role in defending U.S. governmental and commercial space activities.[28] The space force has been increasingly focused on cislunar space as exploration and commercial development head for the Moon.[29]

The Air Force Research Laboratory, which is the science and technology research organization for the U.S. Air Force, is also tasked with supporting the space force. The Space Vehicles Directorate works with the space force to develop, test, and deploy state of the art experimental components and satellite systems. Other laboratory directorates, including the Propulsion Directorate, provide support as well.

The Space Development Agency was established in 2019 and joined the U.S. Space Force in 2022 to apply disruptive innovation and commercial technologies to military space applications. The agency has specifically focused on the use of large constellations of low-cost commercial satellites to enhance missile tracking.[30] The space portfolio within the Department of Defense's Defense Innovation Unit addresses immediate defense needs while fostering long-term industry growth. It has engaged with the space force's efforts to secure "responsive launch," which is the ability to deploy space assets on extremely short notice.[31] In 2023 the U.S. Space Force successfully conducted a pre-staged effort to integrate and launch a commercial satellite

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28 "Space Force 101," U.S. Space Force ~ https://www.spaceforce.mil/About-Us/About-Space-Force.

29 Sandra Erwin, "U.S. Space Force Sees Future Demand for Surveillance Beyond Earth Orbit," SpaceNews, May 16, 2022 ~ https://spacenews.com/u-s-space-force-sees-future-demand-for-surveillance-beyond-earth-orbit.

30 Sandra Erwin, "Space Development Agency Marks Five-Year Milestone," SpaceNews, March 13, 2024 ~ https://spacenews.com/space-development-agency-marks-five-year-milestone.

31 Sandra Erwin, "Defense Innovation Unit to Sponsor a Rapid Response Space Mission," SpaceNews, August 25, 2023 ~ https://spacenews.com/defense-innovation-unit-to-sponsor-a-rapid-response-space-mission.

on a commercial rocket within 24 hours.[32] This is a capability no other nation currently possess.

The Department of Defense's National Reconnaissance Office builds, launches, and operates governmental satellites that perform orbital reconnaissance. This office provides data to defense and intelligence agencies, including the National Geospatial-Intelligence Agency, which collects, analyzes, and distributes data collected from space for military branches and intelligence agencies. Both agencies are embracing smaller, commercial constellations as part of their overall operation.[33] The Department of Defense has also embraced nimble, LEO constellations for communications and is specifically deploying a military-grade version of SpaceX's Starlink constellation after viewing that system's value in the Russia-Ukraine conflict.[34]

Other U.S. space offices. The Federal Aviation Administration (FAA) and NOAA have space offices tasked with overseeing and promoting U.S. commercial space ventures. The FAA's Office of Commercial Space Transportation regulates the launch and re-entry of commercial spacecraft. Under a 2018 space policy directive from the White House, NOAA's Office of Space Commerce has been tasked with space situational awareness duties that were formerly only handled by the military, including sending conjunction warnings. While it is assumed that Russia and China have similar tracking efforts, their databases are opaque. Most U.S. space tracking data is publicly available, and a warning service is provided at no charge to governments and commercial operators around the world. The Office of Space Commerce is developing a traffic coordination system for space that is supposed to eventually integrate launch and re-entry activities. There is an ongoing dispute within the U.S. political system over the allocation of the regulatory roles between the Office of Commercial Space Transportation and the Office of Space Commerce. Some experts have suggested that this dispute has slowed progress on the increasingly important task of managing active satellites and tracking space debris.[35]

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32 Sandra Erwin, "Pentagon's Innovation Unit Steps Up Role in Space Force's Responsive Launch Program," SpaceNews, March 19, 2024 ~ https://spacenews.com/pentagons-innovation-unit-steps-up-role-in-space-forces-responsive-launch-program.

33 Sandra Erwin, "National Reconnaissance Office Embracing Mix of Big and Small Satellites," SpaceNews, March 18, 2024 ~ https://spacenews.com/national-reconnaissance-office-embracing-mix-of-big-and-small-satellites.

34 Sandra Erwin, "Pentagon Embracing SpaceX's Starshield for Future Military Satcom," SpaceNews, June 11, 2024 ~ https://spacenews.com/pentagon-embracing-spacexs-starshield-for-future-military-satcom.

35 John Kelvy, "Mastering Space Traffic Management," Aerospace America, November 2023 ~ https://aerospaceamerica.aiaa.org/features/mastering-space-traffic-management.

The Commercial and Nonprofit Sectors

The commercial space sector is integral to U.S. dominance in civil and military space activities and is an important force all its own. This sector is composed of both major "prime" legacy firms with deep supplier networks and an increasingly successful group of independent start-ups. The U.S. Bureau of Economic Analysis reports that in 2022 U.S. space economic activities accounted for 0.5% of U.S. GDP, or $131.8 billion, and supported 347,000 jobs. Inflation adjusted, this number grew at 2.3%, which is faster than the overall economy (1.9%). A significant portion of this growth was driven by governmental defense spending on the space force and NASA's Artemis program.[36]

U.S. commercial launch companies, led by SpaceX, now conduct the majority of global launches. In 2023, there were 223 orbital space launches (212 successful), of which 116 were American and all were by commercial firms.[37] SpaceX rockets accounted for 98 launches, U.S.-based Rocket Lab for 10 (7 of which were from New Zealand), and United Launch Alliance for 3. Europe, by comparison, conducted only 3 launches in 2023.[38]

The vast majority of active orbital satellites are built and operated by U.S. commercial firms, again led by SpaceX. In 2023, there were 2,664 satellites launched into orbit, and 2,166 of these were American. To put this into perspective, twenty years earlier in 2003, only 88 satellites were launched globally. SpaceX's Starlink constellation makes up most of these new satellites. As of August 2024, there were 6,350 Starlink satellites in orbit as part of a plan to eventually launch 42,000.[39] Amazon's Project Kuiper is targeting over 3,000 satellites for its network.[40] U.S. remote-sensing operators have also launched hundreds of satellites to observe the Earth in a variety of spectrums, including infrared, visible light, and with active radar. The Department of Commerce's Office of Space Commerce has

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36 Tina Highfill, Patrick Georgi, and Chris Surfield, "New and Revised Statistics for the U.S. Space Economy, 2017–2022," *Journal of the U.S. Bureau of Economic Analysis* (2024) ~ https://apps.bea.gov/scb/issues/2024/06-june/0624-space-economy.htm.

37 "The Space Report 2023 Q4," Space Foundation, January 23, 2024 ~ https://www.spacefoundation.org/2024/01/23/the-space-report-2023-q4.

38 Jack Kuhr, "2023 Orbital Launches by Country," Payload, January 4, 2024 ~ https://payloadspace.com/2023-orbital-launches-by-country.

39 Tereza Pultarova and Elizabeth Howell, "Starlink Satellites: Facts, Tracking and Impact on Astronomy," Space.com, August 29, 2024 ~ https://www.space.com/spacex-starlink-satellites.html.

40 "Everything You Need to Know about Project Kuiper, Amazon's Satellite Broadband Network," Amazon ~ https://www.aboutamazon.com/what-we-do/devices-services/project-kuiper.

reduced NOAA regulatory restrictions on imaging systems to increase U.S. competitiveness in this field.[41]

U.S. governmental and commercial space actors and activities are supported by a robust network of nonprofit organizations. The National Space Society, founded in 1987 through a merger of the National Space Institute and the L-5 Society, advocates for human spaceflight and settlement of the solar system. It is also active in pushing for the development of space solar power satellites. Students for the Exploration and Development of Space is a college organization founded on similar principals. The Planetary Society, founded by Carl Sagan, is dedicated to the scientific exploration of the solar system, mostly focused on robotic probes, landers, and rovers. The Space Foundation is a highly influential, well-funded organization that hosts an annual major conference, the Space Symposium. Other nonprofits include the Space Frontier Foundation, the Mars Society, the Earthlight Foundation, Club for the Future, and the Beyond Earth Institute. Together these organizations, among others, represent hundreds of thousands of members. They all engage in lobbying and advocacy to support governmental and commercial space missions. Major industry organizations include the Commercial Spaceflight Federation, the Coalition for Deep Space Exploration, and the American Institute of Aeronautics and Astronautics. These organizations represent dozens of companies and many thousands of space professionals. No other nation has such a robust citizen and industry advocate network.

U.S. Policy, Strategy, and Vision in Space

U.S. space policy is usually led by the White House, with the vice president serving as the president's primary adviser and as chair of the National Space Council. The council is a body composed of cabinet officials and top administration figures, including the secretary of state, the secretary of defense, the national security advisor, the chairman of the Joint Chiefs of Staff, and other officials with space interests. In some cases, broad space policy objectives are established by the efforts of the presidential transition team, specifically the NASA and Department of Defense review teams.

Members of the House and Senate, particularly those seated on the House Science and Technology Committee and the Senate Committee on Commerce, Science, and Transportation, often influence and set agendas

41 "NOAA Eliminates Restrictive Operating Conditions from Commercial Remote Sensing Satellite Licenses," U.S. Office of Space Commerce, August 7, 2023 ~ https://www.space.commerce.gov/noaa-eliminates-restrictive-operating-conditions-from-commercial-remote-sensing-satellite-licenses.

that shape the specifics of space policy. The grandest space visions of presidents often perish in these committees. The Office of Management and Budget (OMB) also plays a critical role in overseeing the expenditure of public funds on space projects. Since these ambitious efforts have a history of running years behind schedule and significantly over budget, the OMB tends to be very aggressive with its space portfolio.

The Trump administration issued six space policy directives and conducted eight meetings of the National Space Council in what was widely regarded as the most significant reform of U.S. space policy in decades.[42] Trump administration space policy recreated the National Space Council, supported the commercial sector, committed to returning sustainably to the Moon as a step toward a human mission to Mars, and addressed important issues in the space sector including cybersecurity and space traffic management. These initiatives received broad bipartisan support, and the Biden White House has kept and built on them.

In December 2021, ahead of its first National Space Council meeting, the Biden administration released a framework document for its space priorities.[43] This document identified space activities as "essential to our way of life" and emphasized the importance of space to U.S. technological innovation. The framework also noted the importance of space in understanding weather and climate challenges, acknowledged space's role in defense and national security and as a domain of international cooperation, and referenced the importance of avoiding conflict in space. The framework called for "clarity and certainty" in supervision of nongovernmental (i.e., commercial) space activities, showing an understanding that a cooperative regulatory environment is critical for maintaining U.S. leadership in space.

In April 2022 the United States unilaterally committed to not conducting any destructive direct-ascent anti-satellite (ASAT) tests.[44] This was a belated response to Chinese and Russian ASAT tests, which had generated dangerous debris clouds. In December 2023, concurrent with its third space council meeting, the White House released a fact sheet entitled "Strengthening U.S. International Space Partnerships" that reinforced the government's commitment to expanding the

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42 "Space Policy Directives," Space Foundation ~ https://www.spacefoundation.org/space_brief/space-policy-directives.

43 White House, "Space Priorities Framework," December 2021 ~ https://www.whitehouse.gov/wp-content/uploads/2021/12/United-States-Space-Priorities-Framework-_-December-1-2021.pdf.

44 "Vice President Harris Advances National Security Norms in Space," White House, Fact Sheet, April 18, 2022 ~ https://www.whitehouse.gov/briefing-room/statements-releases/2022/04/18/fact-sheet-vice-president-harris-advances-national-security-norms-in-space.

Artemis Accords and called for academic and military cooperation with international partners in space.[45]

Conclusion

With the launch of the Artemis campaign, creation of the U.S. Space Force, and promotion of public-private partnerships between NASA and commercial actors, the United States has reinvigorated its space activities and policy. It has the most clearly defined public space policy of any country: a well-defined objective of returning to the Moon in a sustainable manner and taking people on to Mars. For the first time ever, expanding the human presence into the solar system and developing space resources for the benefit of humanity are clearly articulated goals. As well, this policy framework has been consistent across administrations and enjoys rare bipartisan support. U.S. space policy is highly regarded globally and has attracted a significant number of countries to participate in U.S.-led space efforts. No other nation has been as successful in space policy; it can even be argued that no other policy domain has been as successful for the United States. ◈

45 "Strengthening U.S. International Space Partnerships," White House, December 20, 2023 ⇝ https://www.whitehouse.gov/briefing-room/statements-releases/2023/12/20/fact-sheet-strengthening-u-s-international-space-partnerships.

China's Space Activities: Drivers, Trends, and Progress

R. Lincoln Hines

China's growing space ambitions and capabilities represent one of the most important trends in contemporary world politics. Considering the United States' long-standing preeminence in the space domain and how extensively modern militaries, the global economy, and daily life depend on space assets, China's continued rise as a space power may portend significant consequences for international relations. In recent years, the country has made important strides in its space activities, narrowing the capabilities gap with (and in some cases even surpassing) the United States. Militarily, China's continued progress strengthens its anti-access/area-denial (A2/AD) capabilities, while diplomatically Beijing increasingly has a number of carrots for pursuing its interests.

Yet, despite the important progress China has made in its space activities, this essay cautions against exaggerating China's advantages. The proliferation of megaconstellations such as Starlink poses new challenges to the assumptions undergirding China's counterspace strategy. Moreover, organizational dysfunction—epitomized by the recent disbanding of the People's Liberation Army (PLA) Strategic Support Force (SSF)—suggests important barriers to China's ability to leverage space capabilities for joint operations. Diplomatically, Beijing, as of now, does not appear to have a coherent vision of an alternative to the U.S.-led Artemis Accords, nor does it have political capital to translate such a vision into reality. Within this context, this essay analyzes recent trends in China's space activities, their potential security and political implications, and the limits of Chinese space advantages.

Background

China's space ambitions are driven by a mixture of motives, including economic, security, and prestige. Official Chinese documents link outer space to China's broader goals of the "great rejuvenation of the Chinese nation" (*zhonghua minzu weida fuxing*) and the "China dream"

R. LINCOLN HINES is an Assistant Professor in the Sam Nunn School of International Affairs at the Georgia Institute of Technology (United States). He was previously an assistant professor for the West Space Seminar at the U.S. Air War College. He can be reached at <lincoln.hines@gatech.edu>.

(*zhongguo meng*).[1] More broadly, China seeks to "become a strong space power in all respects" (*quanmian jiancheng hangtian qiangguo*) by 2049.[2]

While its space ambitions date back to the late 1950s, China has made notable strides in the past two decades. In 2003 it became the third country to send a human into outer space using its own rocket.[3] In 2007, China became one of three countries at the time to successfully test a ground-to-space kinetic kill vehicle (KKV) in outer space.[4] Beyond KKVs, China is comprehensively developing its counterspace capabilities, including lasers, co-orbital capabilities, and electromagnetic interference capabilities.[5] In addition, in 2020, it completed the global BeiDou Navigation Satellite System, China's position, navigation, and timing analog to the United States' Global Positioning System (GPS), Europe's Galileo system, and Russia's Glonass.[6] China has similarly achieved notable milestones in space exploration, becoming the first country to land on the "far side" of the Moon in 2019 (the side facing away from Earth) and the second country to conduct a soft landing on Mars in 2021.[7] In 2022 it completed the construction of a three-decade-long project for a space station in low-earth orbit, coinciding with U.S. plans to de-orbit the International Space Station by 2030.[8] China, moreover, has

1 "Feitian yuanmeng: Weida shiye dou shiyu mengxiang Xi Jinping zheyang yinling hangtian qiangguo meng" [Flying to Realize Our Dreams: Greatness Begins with Dreams: Xi Jinping on Leading the Dream of a Strong Aerospace Country], *People's Daily*, October 31, 2022 ~ http://cpc.people.com.cn/n1/2022/1031/c164113-32555442.html.

2 State Council Information Office of the People's Republic of China (PRC), "Full Text of White Paper on China's Space Activities in 2016," December 28, 2016 ~ http://english.gov.cn/archive/white_paper/2016/12/28/content_281475527159496.htm.

3 "China Successfully Completes First Manned Space Flight," Space Daily, October 16, 2003 ~ https://www.spacedaily.com/news/china-03zo.html.

4 Carin Zissis, "China's Anti-Satellite Test," Council on Foreign Relations, February 22, 2007 ~ https://www.cfr.org/backgrounder/chinas-anti-satellite-test.

5 Matthew Mowthorpe and Markos Trichas, "A Review of Chinese Counterspace Activities," Space Review, August 1, 2022 ~ https://www.thespacereview.com/article/4431/1.

6 "China Completes First Self-Developed Beidou Industrial System," State Council Information Office (PRC), April 9, 2022 ~ https://english.www.gov.cn/news/videos/202204/09/content_WS62515f14c6d02e5335328f64.html.

7 "China's Chang'e-4 Probe Makes Historic Landing on Moon's Far Side," China National Space Administration, January 3, 2019 ~ https://www.cnsa.gov.cn/english/n6465652/n6465653/c6805049/content.html; and "Tianwen-1: China Successfully Launches Probe in First Mars Mission," China National Space Administration, July 23, 2020 ~ https://www.cnsa.gov.cn/english/n6465652/n6465653/c6809882/content.html.

8 Ling Xin, "China Astronauts Say Hello from Completed Tiangong Space Station," *South China Morning Post*, November 3, 2022 ~ https://www.scmp.com/news/china/science/article/3198266/china-astronauts-say-hello-completed-tiangong-space-station; and Jeff Foust, "NASA Planning to Spend Up to $1 Billion on Space Station Deorbit Module," SpaceNews, March 13, 2023 ~ https://spacenews.com/nasa-planning-to-spend-up-to-1-billion-on-space-station-deorbit-module.

announced plans to build the International Lunar Research Station with Russia by 2035.[9]

Military Space Activities and Progress

During the Gulf War in 1990–91, often dubbed the "first space war," Chinese analysts concluded that China needed the ability to win "informationized wars" under local conditions.[10] In 1995–96, during the Taiwan Strait crisis, Chinese military officials alleged that the United States cut off Chinese access to GPS. This alleged incident is said to be the reason for China's development of the BeiDou Navigation Satellite System.[11] Likewise, following the United States' accidental bombing of the Chinese embassy in Belgrade (an incident that was viewed as intentional by many in China), Chinese leaders increased support for China's anti-satellite program.[12] Under Jiang Zemin's leadership, China sought to develop "assassin's mace" (*shashoujian*) weapons—capabilities that would allow it to fight a militarily superior adversary.[13] This approach to space meant exploiting the United States' reliance on space capabilities—what PLA analysts referred to as the "soft ribs" of the U.S. military.[14]

Since then, China has invested in a broad array of counterspace capabilities, including KKVs, ground-based lasers, jamming, and electromagnetic interference. Observers have similarly noted China's development of dual-use capabilities, including co-orbital capabilities and a robotic arm. At the same time, in 2021, China tested a fractional-orbital bombardment system, which could theoretically enable it to evade U.S. missile defenses. Analysts, however, note that the Soviet Union already

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9 "Joint Statement between CNSA and ROSCOSMOS Regarding Cooperation for the Construction of the International Lunar Research Station," China National Space Administration, April 29, 2021 ~ https://www.cnsa.gov.cn/english/n6465668/n6465670/c6811967/content.html.

10 Dean Cheng, "China's Military Role in Space," *Strategic Studies Quarterly* 6, no. 1 (2012): 55–77.

11 Minnie Chan, "'Unforgettable Humiliation' Led to Development of GPS Equivalent," *South China Morning Post*, November 13, 2009 ~ https://www.scmp.com/article/698161/unforgettable-humiliation-led-development-gps-equivalent.

12 Gregory Kulacki, "An Authoritative Source on China's Military Space Strategy," Union of Concerned Scientists, March 2014, 9 ~ https://www.ucsusa.org/sites/default/files/2019-10/China-s-Military-Space-Strategy.pdf.

13 Rush Doshi, *The Long Game: China's Grand Strategy to Displace American Order* (New York: Oxford University Press, 2021), 68–101.

14 Wang Hucheng, "The U.S. Military's 'Soft Ribs' and Strategic Weaknesses," *Liaowang* 27 (2000), cited in Ashley J. Tellis, "China's Military Space Strategy," *Survival* 49, no. 3 (2007): 49.

tested such technology in the mid-1960s and that there already exist several channels to evade U.S. missile defenses.[15]

Technological Trends and New Challenges to China's Counterspace Strategy

Strategically, China's comprehensive pursuit of counterspace capabilities contributes to its broader A2/AD strategy in its near periphery, most importantly in the Taiwan Strait. Through counterspace capabilities, China can potentially deny or threaten to deny the United States access to its traditional information dominance in the time of war, increasing the difficulty of communications, targeting, intelligence, and reconnaissance capabilities for U.S. troops fighting far from American shores. Beyond counterspace capabilities, China is similarly using space assets to enable PLA troops to operate further from Chinese shores. China is also using space capabilities to extend the reach of its long-range ballistic missiles stationed on mainland Chinese territories—expanding the area of its A2/AD "bubble."

Yet the rise of megaconstellations such as Starlink may be undermining the logic behind the space component of China's A2/AD strategy. Previously, disabling or destroying a small number of satellites could plausibly be sufficient for denying space access in the event of a conflict. However, megaconstellations provide a proliferated satellite architecture that does not have a single node of failure. As such, they significantly complicate an adversary's targeting efforts and increase the resilience of these capabilities.[16] Thus, megaconstellations offer the potential to enhance a U.S. deterrence-by-denial strategy, making it so difficult for China to deny the United States access to space as to significantly reduce the utility of using counterspace weapons. This potential has been demonstrated during the Russia-Ukraine war, which analysts have referred to as the "first commercial space war" due to the prominence of Starlink satellites.[17] Despite efforts to jam Starlink satellites, as of this writing, Russia has been unable to degrade their capabilities.[18]

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15 Bleddyn Bowen and Cameron Hunter, "Chinese Fractional Orbital Bombardment," Asia-Pacific Leadership Network, Policy Brief, no. 78, November 1, 2021.

16 Sandra Erwin, "Starlink's Survivability in War a Good Sign for DOD's Future Constellation," SpaceNews, October 25, 2022 ~ https://spacenews.com/starlinks-survivability-in-war-a-good-sign-for-dods-future-constellation.

17 Sandra Erwin, "On National Security | Drawing Lessons from the First 'Commercial Space War,'" SpaceNews, May 20, 2022 ~ https://spacenews.com/on-national-security-drawing-lessons-from-the-first-commercial-space-war.

18 Rishi Iyengar, "Why Ukraine Is Stuck with Elon (for Now)," *Foreign Policy*, November 22, 2022 ~ https://foreignpolicy.com/2022/11/22/ukraine-internet-starlink-elon-musk-russia-war.

However, it is important to note that while megaconstellations could undermine China's A2/AD strategy, they are not a "silver bullet" for altering the country's counterspace strategy. Although Starlink was useful for Ukrainian soldiers, analysts note that SpaceX CEO Elon Musk has extensive business interests within China that could make him reluctant to provide these services to Taiwan. Given this concern, Taiwan has looked to other potential companies such as the Eutelsat OneWeb.[19]

The existence of a megaconstellation may also incentivize China to find more provocative or indiscriminate means of countering these satellite networks, as Russia's pursuit of a nuclear weapon in space suggests.[20] Yet, in contrast with Russia, China's space power is rising. Moreover, China is increasingly dependent on space and may not be as willing to risk a massive indiscriminate attack in space that could harm its own satellites. Nonetheless, Chinese analysts are already discussing whether a "combination of soft and hard kill methods should be adopted to make some Starlink satellites lose their functions and destroy the constellation operating system."[21]

Internal Challenges to China's Counterspace Strategy

Perhaps more fundamental than these technological challenges, China continues to be plagued by internal bureaucratic dysfunction. One of the most important organizational changes is the recent dissolution of the PLA's SSF. In 2015, China created the SSF to centralize space, cyber, electronic, and psychological warfare capabilities.[22] Likened by some analysts to the United States' 1986 Goldwater-Nichols Act (an organizational restructuring of the U.S. military to enhance joint warfighting and counter interservice rivalry), the creation of the SSF was an effort by the PLA to transition from a land-dominated structure to focus on new "strategic frontiers."[23] The government

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19 Meaghan Tobin and John Liu, "Why Taiwan Is Building a Satellite Network without Elon Musk," *New York Times*, March 14, 2024 ~ https://www.nytimes.com/2024/03/14/business/taiwan-starlink-satellite.html.

20 Aaron Bateman, "Why Russia Might Put a Nuclear Weapon in Space," *Foreign Affairs*, March 7, 2024 ~ https://www.foreignaffairs.com/russian-federation/why-russia-might-put-nuclear-weapon-space.

21 Ren Yuan-zhen et al., "Xinglian jihua fazhan xianzhuang yu duikang sikao" [The Development Status of Starlink and Its Countermeasures], *Modern Defence Technology* 50, no. 2 (2022): 11–17 ~ https://www.xdfyjs.cn/article/2022/1009-086X/1009-086X-2022-50-2-11.shtml.

22 John Costello and Joe McReynolds, *China's Strategic Support Force: A Force for a New Era* (Washington, D.C.: National Defense University Press, 2018) ~ https://ndupress.ndu.edu/Portals/68/Documents/stratperspective/china/china-perspectives_13.pdf.

23 Phillip C. Saunders and Joel Wuthnow, "China's Goldwater-Nichols? Assessing PLA Organizational Reforms," *Joint Force Quarterly*, no. 82 (2016): 68–75.

touted the single command structure as demonstrating China's innovative capacity and promoting synergies across the PLA that would enhance joint warfighting capabilities and Chinese advantages in information and network-centric warfare. Some analysts claimed the SSF was a profound transformation of China's organizational structure that would "enhance the Chinese military's future deterrence and warfighting capabilities."[24]

However, for all of the attention given to the development of this force, on April 19, 2024, China announced that it was formally ending the SSF. In its wake, China created three coequal services: the Aerospace Force (which comprises the Aerospace Systems and Network Systems Department), the Cyber Force, and the Information Support Force.[25] The reasons for and the implications of the SSF's dissolution remain opaque. While the reasons for its dissolution may eventually become clearer, analysts are left with a few different potential explanations. Some Chinese sources claim that the SSF largely constituted a transition institution for developing these separate services (seen as part of a long-planned process). Other analysts argue that the dissolution may indicate a significant failure of the institution or be symptomatic of more systemic corruption within it.[26] The facts that China restructured the PLA to improve its joint operations through the SSF and that the SSF has since disintegrated suggest that China has yet to overcome organizational infighting. As a result of such dysfunction, China could face considerable challenges in the future to incorporate space assets into joint operations.

While some analysts might welcome Chinese bureaucratic dysfunction as a constraint, such organizational divisions could also have worrisome consequences. As suggested during China's 2007 anti-satellite test, the PLA may not have been coordinating its activities with the Ministry of Foreign Affairs.[27] Similarly, China's seemingly puzzling launch of a spy

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24 Elsa B. Kania and John Costello, "Seizing the Commanding Heights: The PLA Strategic Support Force in Chinese Military Power," *Journal of Strategic Studies* 44, no. 2 (2021): 218.

25 Colin Clark, "China Creates New Information Support Force, Scraps Strategic Support Force in 'Major' Shakeup," Breaking Defense, April 22, 2024 ~ https://breakingdefense.com/2024/04/in-major-shakeup-china-creates-new-information-support-force-scraps-strategic-support-force.

26 J. Michael Dahm, "A Disturbance in the Force: The Reorganization of People's Liberation Army Command and Elimination of China's Strategic Support Force," Jamestown Foundation, China Brief, April 26, 2024 ~ https://jamestown.org/program/a-disturbance-in-the-force-the-reorganization-of-peoples-liberation-army-command-and-elimination-of-chinas-strategic-support-force; and Joe McReynolds and John Costello, "Planned Obsolescence: The Strategic Support Force In Memoriam (2015–2024)," Jamestown Foundation, China Brief, April 26, 2024 ~ https://jamestown.org/program/planned-obsolescence-the-strategic-support-force-in-memoriam-2015-2024.

27 Bates Gill and Martin Kleiber, "China's Space Odyssey: What the Antisatellite Test Reveals about Decision-Making in Beijing," *Foreign Affairs*, May/June 2007, 2–6.

balloon over the United States in 2023 may have similarly been a product of dysfunctional bureaucratic politics.[28] As some scholars argue, such divisions within bureaucracies can result in poor information being delivered to decision-makers, leading to costly miscalculations.[29] This could be especially worrisome in the space domain.

Diplomacy and Space Governance

China's growing capabilities in space provide the country with greater tools for pursuing its diplomatic goals. In a 2021 white paper, China announced that it seeks to play a more active role in promoting rules and norms in space.[30] This ambition reflects the broader turn in Chinese foreign policy, seeking to play a more active role in international governance. Since the "reform and opening" era (*gaige kaifang*), China has typically followed Deng Xiaoping's dictum of "keeping a low profile"—even leading then U.S. assistant secretary of state Robert Zoellick to argue that China needed to assume greater leadership responsibilities so as to become a "responsible stakeholder."[31] Today, by contrast, China is increasingly seeking to translate its growing capabilities into playing a significant role through conventional UN institutions as well as through alternative institutions such as the Asian Infrastructure Investment Bank and large multilateral initiatives such as the Belt and Road Initiative (BRI).

China is similarly seeking to translate its growing space capabilities into increased diplomatic influence. There are a few different tools it might use to achieve these goals. China hosts the Asia-Pacific Space Cooperation Organization in Beijing, which provides a convening venue for regional space powers.[32] It likewise provides rocket launches, satellite services, and data to

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28 Tyler Jost, "The Bad Advice Plaguing Beijing's Foreign Policy: How China's Bureaucracy Guides Its Leaders into Error," *Foreign Affairs*, April 27, 2023.

29 Tyler Jost, "The Institutional Origins of Miscalculation in China's International Crises," *International Security* 48, no. 1 (2023): 47–90.

30 State Council Information Office (PRC), "China's Space Program: A 2021 Perspective," January 28, 2022 ~ https://english.www.gov.cn/archive/whitepaper/202201/28/content_WS61f35b3dc6d09c94e48a467a.html.

31 Robert B. Zoellick, "Whither China: From Membership to Responsibility?" (remarks to the National Committee on U.S.-China Relations, New York, September 21, 2005) ~ https://2001-2009.state.gov/s/d/former/zoellick/rem/53682.htm.

32 "Asia-Pacific Space Cooperation Organization (APSCO)," International Astronautical Federation ~ https://www.iafastro.org/membership/all-members/asia-pacific-space-cooperation-organization-apsco.html.

other countries through its spatial corridor as part of the spatial BRI.[33] In addition, China is already using its space station to host experiments for other countries. This is a form of influence that could increase should the United States de-orbit the International Space Station.[34] China, likewise, has announced a memorandum of understanding with Russia to jointly construct a lunar base—the previously mentioned International Lunar Research Station—by 2035.[35]

By providing public goods, China may increase its ability to advance its interests both terrestrially and in space. In the space domain, it could advance an alternative form of space governance that is at odds with U.S. goals. U.S. policymakers, for example, have opposed China and Russia's jointly proposed Prevention of the Placement of Weapons in Outer Space Treaty (PPWT)—citing the lack of verification and noting that the treaty would allow China to continue pursuing ground-based anti-satellite weapons. China has similarly been unsupportive of other U.S. initiatives.[36] For example, it voted against the U.S.-led UN resolution calling for a moratorium on destructive anti-satellite testing.[37] In addition, following revelations that Russia was developing a space-based nuclear weapon, the United States and Japan proposed a resolution to reaffirm the 1967 Outer Space Treaty's ban on placing weapons of mass destruction in space, which China abstained from voting on.[38]

While China may be able to oppose U.S. resolutions in formal bodies, it is unclear whether, besides the PPWT, the country has its own vision for space governance that is distinctive from that of the United States, or whether China could even translate such a vision into reality. While China

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33 Michael S. Chase, "The Space and Cyberspace Components of the Belt and Road Initiative," in "Securing the Belt and Road Initiative: China's Evolving Military Engagement Along the Silk Roads," ed. Nadège Rolland, National Bureau of Asian Research, NBR Special Report, no. 80, September 2019, 19–32 ~ https://www.nbr.org/publications/the-space-and-cyberspace-components-of-the-belt-and-road-initiative.

34 Kaity Kline, "The International Space Station Retires Soon. NASA Won't Run Its Future Replacement," NPR, February 21, 2024 ~ https://www.npr.org/2024/02/21/1232639289/international-space-station-retirement-space-stations-future.

35 "China and Russia Sign a Memorandum of Understanding Regarding Cooperation for the Construction of the International Lunar Research Station," China National Space Administration, March 9, 2021 ~ https://www.cnsa.gov.cn/english/n6465652/n6465653/c6811380/content.html.

36 Jeff Foust, "U.S. Dismisses Space Weapons Treaty Proposal as 'Fundamentally Flawed,'" SpaceNews, September 11, 2014 ~ https://spacenews.com/41842us-dismisses-space-weapons-treaty-proposal-as-fundamentally-flawed.

37 Jeff Foust, "More Countries Encouraged to Commit to Halt Destructive ASAT Tests," SpaceNews, June 15, 2023 ~ https://spacenews.com/more-countries-encouraged-to-commit-to-halt-destructive-asat-tests.

38 Theresa Hitchens, "Russia Vetos U.S.-Japan Resolution Against Nukes in Space, 'Unprecedented Escalation' in UN Fight," Breaking Defense, April 25, 2024 ~ https://breakingdefense.com/2024/04/russia-vetos-us-japan-resolution-against-nukes-in-space-unprecedented-escalation-in-un-fight.

has been critical of the NASA-led Artemis Accords, which some state-sanctioned media outlets compare to colonialism, it has yet to articulate an alternative vision of governance.[39] The only existing statement China has made about the use of space resources is a submission by Chinese delegates to the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space. Yet China's statement was largely consistent with the U.S. stance on lunar resources.[40] With the exception of discussions for "safety zones," the Chinese statement largely reiterated principles of international law to which China is already a signatory. It is perhaps unsurprising that China does not yet have a clear position for an alternative to the Artemis Accords. As a powerful spacefaring actor, China may have incentives for allowing the use of space resources that are akin to those of the United States.

Even if China were to develop an alternative approach to resource governance, it does not have nearly the same political coalition as the United States does for implementing such a vision. While the U.S.-led Artemis Accords have 43 signatories, the initiative led by China and Russia to establish the International Lunar Research Station is supported by a much smaller coalition with far less advanced space powers (including Belarus, Pakistan, Azerbaijan, Venezuela, South Africa, Egypt, Nicaragua, Thailand, Serbia, and the Beijing-led regional space organization).[41] Overall, as these examples suggest, while China may have the enhanced space capabilities necessary for implementing an alternative vision of space governance, it does not yet have a clear vision of what such an order might look like, nor does it lead the same level of political coalition as the United States for implementing this vision.

Conclusion

China continues to make significant strides in the space domain, providing it important tools for advancing its interests. Yet, despite such progress, the country faces several challenges. Its growing dependence on space, coupled with the rise of new technologies such as megaconstellations,

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39 Elliot Ji, Michael B. Cerny, and Raphael J. Piliero, "What Does China Think About NASA's Artemis Accords?" *Diplomat*, September 17, 2020 ~ https://thediplomat.com/2020/09/what-does-china-think-about-nasas-artemis-accords.

40 Andrew Jones, "China Outlines Position on Use of Space Resources," SpaceNews, March 6, 2024 ~ https://spacenews.com/china-outlines-position-on-use-of-space-resources.

41 Andrew Jones, "Serbia Becomes Latest Country to Join China's ILRS Moon Base Project," SpaceNews, May 10, 2024 ~ https://spacenews.com/serbia-becomes-latest-country-to-join-chinas-ilrs-moon-base-project.

is raising the costs and risks associated with China seeking to deny U.S. space access in the event of a conflict. Diplomatically, it remains unclear what China's space and lunar governance interests are, whether or how they will differ from those of the United States, and whether China will succeed in advancing an alternative system of rules and norms than the one supported by the United States.

As the United States seeks to respond to China's growing space capabilities, it must pursue policies that allow it to maintain its competitive edge. Yet, although technological advancement may indeed increase the United States' ability to pursue a deterrence-by-denial strategy, outcompeting and pursuing deterrence are no substitutes for strategy. Despite hype and enthusiasm about the future of space, not all space capabilities will equally advance U.S. strategic interests. It would be short-sighted for the United States to applaud itself for landing astronauts on the Moon in the near future, while neglecting to build a more resilient and responsive space architecture closer to Earth.

To promote space sustainability, the United States and China must address more fundamental challenges in the bilateral relationship, which are exacerbating broader security dilemma dynamics. As the world of international politics is rife with misperception, the two competitors should find channels or means of engaging one another to reduce its likelihood. Specifically, U.S. policymakers would benefit from greater insight into Chinese motives and the processes of Chinese space policy and national security decision-making. ◈

Japan in the International Space Order

Saadia M. Pekkanen

The international space order today presents novel challenges and opportunities.[1] All states are purposefully positioning themselves for a future not just in Earth orbits but also on celestial bodies from the Moon to Mars and beyond. Many countries are also interested in harnessing the potential of space for economic and military purposes, and this is especially remarkable in the dynamics of Asia. Noted for numerous political and security concerns, the region also boasts the world's greatest concentration of countries with independent space capabilities.[2]

All these aspirants confront the backdrop of a deepening U.S.-China rivalry that is reconfiguring the international system.[3] They know well that this bipolar competition also extends to the front lines of space.[4] As it unfolds amid the structural flux, all of them face unprecedented commercial opportunities as well as concerning military threats in the space domain.[5] As an established space power and a formal military ally of the United States, Japan too is proactively charting its own course through the present realities. This essay focuses on recent developments in Japan's space strategies and discusses their implications for the international relations of space.

Recent Developments

Japan is already a competent space actor, credited as a reliable partner for technology collaboration. It has amassed a wide industrial base that

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SAADIA M. PEKKANEN is the Job and Gertrud Tamaki Endowed Professor in the Henry M. Jackson School of International Studies at the University of Washington (United States), where she is also Adjunct Professor in the Department of Political Science and Adjunct Professor at the School of Law. She heads the Space Law, Data and Policy Program at the University of Washington School of Law and directs the annual Space Diplomacy Symposium. She can be reached at <smp1@uw.edu>.

1 Paul B. Larsen, "Outer Space: How Shall the World's Governments Establish Order among Competing Interests?" *Washington International Law Journal* 29, no. 1 (2019): 1–60.

2 Saadia M. Pekkanen, "Asia's Ascendance in the New International Space Order," East Asia Forum, May 22, 2024 ~ https://doi.org/10.59425/eabc.1716372000.

3 Øystein Tunsjø, *The Return of Bipolarity in World Politics: China, the United States, and Geostructural Realism* (New York: Columbia University Press, 2018).

4 Xiaodan Wu, "The International Lunar Research Station: China's New Era of Space Cooperation and Its New Role in the Space Legal Order," *Space Policy* 65 (2023) ~ https://doi.org/10.1016/j.spacepol.2022.101537.

5 Saadia M. Pekkanen and P.J. Blount, eds., *The Oxford Handbook of Space Security* (New York: Oxford University Press, 2024) ~ https://doi.org/10.1093/oxfordhb/9780197582671.001.0001.

has developed and tested some of the most advanced dual-use space technologies over the postwar period, and it has done so in plain sight.[6] After decades, its institutional and bureaucratic restructuring has coalesced to elevate space development and security as a national priority.[7] Building on that foundation, Japan has not been deterred by setbacks.[8] Its public and private actors are moving forward on all pillars of space technologies, among them rockets, satellites, and other spacecraft.

Threat perceptions and the changed external environment are now significant factors in Japan's decision-making.[9] This applies to both the military and economic sides of things, particularly given the dual-use nature of space technologies. In stark contrast to the past, both defensive and offensive space capabilities are part of the official framework.[10] Whatever their shortcomings, the set of three documents released in December 2022—the National Security Strategy, the National Defense Strategy, and the Defense Buildup Program—clarified the kinds of space capabilities of interest to Japan, as well as both their passive and disruptive uses to protect the homeland.[11] In June 2023, Japan released its Space Security Initiative, which stressed the importance of security in and from space.[12] The initiative also highlighted the importance of cross-sectoral technological innovation. This theme alerted audiences to the Japanese government's interest in economic-security linkages and, in a more threatening external environment, the preservation of critical technologies for strategic autonomy and indispensability, as emphasized in the Economic Security Promotion Act.[13] Space technology has been singled out by the

6 Saadia M. Pekkanen and Paul Kallender-Umezu, *In Defense of Japan: From the Market to the Military in Space Policy* (Stanford: Stanford University Press, 2010).

7 Paul Kallender, "Japan's New Dual-Use Space Policy: The Long Road to the 21st Century," Institut français des relations internationals, Asie.Visions, no. 88, November 2016, 1–37.

8 Ryosuke Matsuzoe, "Japan Delays Next H-IIA Launch, Grounding All Space Rockets," *Nikkei Asia*, April 1, 2023 ~ https://asia.nikkei.com/Business/Aerospace-Defense-Industries/Japan-delays-next-H-IIA-launch-grounding-all-space-rockets.

9 Sheila A. Smith, *Japan Rearmed: The Politics of Military Power* (Cambridge: Harvard University Press, 2019), 5.

10 Yasuhito Fukushima, "Japan Endeavors to Utilize Space for Defense Purposes," Stimson Center, February 23, 2023 ~ https://www.stimson.org/2023/japan-endeavors-to-utilize-space-for-defense-purposes.

11 Kazuto Suzuki, "Space Security in Japan's New Strategy Documents," Center for Strategic and International Studies (CSIS), June 21, 2023 ~ https://www.csis.org/analysis/space-security-japans-new-strategy-documents.

12 Nanae Baldauff, "Space and Strategy: Japan's National Security in Space and Europe," Centre for Security, Diplomacy and Strategy, Brussels School of Governance, Policy Brief, December 13, 2023 ~ https://csds.vub.be/publication/space-and-strategy-japans-national-security-in-space-and-europe.

13 Kazuto Suzuki, "How Will the Economic Security Law Change Japan's Sci-Tech Policy?" Tokyo Foundation for Policy Research, May 9, 2023 ~ https://www.tokyofoundation.org/research/detail.php?id=943.

government as one of twenty designated critical technologies, and policy decisions are likely to be enabled through public-private partnerships. The newly minted Space Strategy Fund set up by the Japanese government further signals the leadership's concrete interest in growing and positioning Japanese actors in the competitive business of space security worldwide.[14] In all, the Japanese government has committed approximately $14 billion to advancing Japanese space technology for both commercial and security reasons in the years ahead, and so also improving knowledge exchanges across the business and defense sectors within the country.[15]

Among the latest principal developments, a few stand out. Japan's new flagship H-3 rocket finally launched successfully in February 2024 and is expected to become the workhorse for both government and commercial missions.[16] On the solid-fuel side, the Epsilon rocket remains a work in progress. Space One, a private venture backed by Canon Electronics and IHI, is also aiming to make a dent in the commercial launch business that is dominated worldwide by SpaceX.[17] There is a distinct policy interest in making rockets reusable, with the Japan Aerospace Exploration Agency (JAXA) engaged in cooperative projects among government, industry, and academia.[18] International partnerships are also important on this front and reflect an interest in maintaining strategic independence in space technologies—long a Japanese goal but one shared by other spacefaring countries. Since 2015, JAXA has been working on the reusable launcher project Callisto with its counterpart agencies in France and Germany.[19] Billed as a fully reusable launch vehicle, Callisto is projected to fly around 2025–26.

All actors in the space domain are attuned to and lured by the potential of crisscrossing civilian and defense applications in the present international context. Japan's newer private actors are making notable inroads. Astroscale, which is in the business of cleaning up space debris, has recently debuted

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14 "Seifu JAXA ni 10 nen de 1 cho kibo no 'uchu senryaku kikin' secchi e" [Government to Establish 1 Trillion Yen "Space Strategy Fund" in JAXA over 10 Years], NHK, November 12, 2023 ~ https://www3.nhk.or.jp/news/html/20231112/k10014255021000.html.

15 Interview with Masayasu Ishida, chair of the steering board of the Space Strategy Fund, Tokyo, August 2, 2024.

16 "Uchiage jisseki (2003 nen 10 gatsu)" [Launch Record (October 2003)], Japan Aerospace Exploration Agency (JAXA) ~ https://www.jaxa.jp/projects/result_j.html.

17 Mitsuru Obe, "Space One's Kairos Rocket Explodes Just After Liftoff in Japan," *Nikkei Asia*, March 13, 2024 ~ https://asia.nikkei.com/Business/Aerospace-Defense-Industries/Space-One-s-Kairos-rocket-explodes-just-after-liftoff-in-Japan.

18 "Uchu kihon keikaku" [Basic Space Plan], Cabinet Office (Japan), June 13, 2023, 17, 36–37 ~ https://www8.cao.go.jp/space/plan/plan2/kaitei_fy05/honbun_fy05.pdf.

19 "Callisto: Testing the Concept of a Reusable Launcher First Stage," Centre national d'études spatiales ~ https://cnes.fr/en/projects/callisto.

with a valuation of $1 billion on the Tokyo Stock Exchange.[20] It has also won a contract from the U.S. Space Force to develop a refueling spacecraft and clearly aims to grow its space defense business. Concerned with the lack of late-stage startup funding in Japan relative to the United States, banks and financial institutions are also beginning to fund space businesses before they go public.[21] Among them, Sumitomo Mitsui Financial Group (SMFG) has partnered with others to set up a fund for this purpose in Japan that is one of the largest of its kind (30 billion yen, or approximately $190 million). SMFG has bought into Axelspace, which focuses on advancing microsatellite technology and data.

Long-standing industry players may be even more pivotal in anchoring the new space business within not just their preexisting relationships but also their projected commercial ones. The promise of low-earth orbit activities has drawn high-profile conglomerates such as Mitsui into the space business.[22] Mitsui has been selected by JAXA to assess the feasibility of a module for attachment to a U.S. commercial space station. Mitsui has set up a subsidiary and has also invested in Axiom, a U.S. company already in the business of developing the world's first commercial space station.[23] Toyota, another well-known global player, has an eye on a lunar economic bloc led by the United States that might be worth $170 billion through 2040.[24] It is working with Mitsubishi Heavy Industries and JAXA to develop a lunar cruiser to transport astronauts on the Moon.

All these private players, with their public-private entanglements spread across borders, affect prospects for space security. Japan has long kept abreast of the leading edge in space technologies for defense purposes and has demonstrable counterspace capabilities for rendezvous and proximity operations.[25] It is also gearing up on emerging and disruptive technologies

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20 Jeff Foust, "Astroscale Shares Soar in Tokyo Stock Market Debut," SpaceNews, June 6, 2024 ~ https://spacenews.com/astroscale-shares-soar-in-tokyo-stock-market-debut.

21 Haruki Kitagawa, "Japan Banks Boost Funding to Late-Stage Startups," *Nikkei Asia*, December 30, 2023 ~ https://asia.nikkei.com/Business/Startups/Japan-banks-boost-funding-to-late-stage-startups.

22 "JAXA kara beikoku shogyo uchu suteeshon setsuzokugata no Nihon jikkento kokeiki no gainen kento no jisshisha ni sentei" [Selected by JAXA for Conceptual Study on Attaching a Successor Module of the Japan Experiment Module to a U.S. Commercial Station], Mitsui & Co., September 14, 2023 ~ https://www.mitsui.com/jp/ja/topics/2023/1247312_13930.html.

23 Jeff Foust, "Japanese Venture Seeks to Develop Commercial Space Station Module," SpaceNews, July 9, 2024 ~ https://spacenews.com/japanese-venture-seeks-to-develop-commercial-space-station-module.

24 Satoshi Kawahara, "Toyota's 'Lunar Cruiser' to Join NASA-Led Moon Mission," *Nikkei Asia*, April 13, 2024 ~ https://asia.nikkei.com/Business/Aerospace-Defense-Industries/Toyota-s-Lunar-Cruiser-to-join-NASA-led-moon-mission.

25 Saadia M. Pekkanen, "Neoclassical Realism in Japan's Space Security," in *The Oxford Handbook of Japanese Politics*, ed. Robert J. Pekkanen and Saadia M. Pekkanen (New York: Oxford University Press, 2022), 763–90 ~ https://doi.org/10.1093/oxfordhb/9780190050993.013.38.

like cyber and the electromagnetic spectrum that intersect with the space domain.[26] It has two dedicated space defense units: the Space Operations Squadron, which monitors space debris and satellites, and a second squadron focused on electromagnetic wave threats to satellites.[27]

Space is also rising in prominence in the context of the Quad, where Japan engages diplomatically with Australia, India, and the United States.[28] A prime focus is on space applications and technology to address challenges related to climate change, disasters, and marine resources. To enable concrete responses in these cases, the Quad Satellite Data Portal is in the works and might serve as the basis for pooling national space data across the four members. The interoperability of space data could also be of use in their initiative on maritime domain awareness more generally.

The geopolitical and geoeconomic components of space are especially notable in the context of Japan's relations with its formal ally, the United States.[29] To increase its credibility as a formal defense partner to the United States in the face of new threats and technologies, Japan has responded with concrete efforts to support a more operational alliance.[30] This has come at a time when the U.S.-Japan Security Treaty has been extended to space, with the affirmation that Article V could be invoked in certain circumstances.[31] As the protection of satellites is critical for space safety and security for all spacefaring actors, the U.S. Space Force will soon be activating a combatant component in Japan, mirroring one that was established earlier in South Korea.[32] At the end of March 2025, Japan is planning to set up a joint command headquarters for its Self-Defense Forces' land, sea, and air units

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26 "Japan Accelerates Defense Capability Enhancement in New Domains," Kyodo News, May 3, 2021 ~ https://english.kyodonews.net/news/2021/05/ea20811d21cc-japan-accelerates-defense-capability-enhancement-in-new-domains.html.

27 Park Si-soo, "Japan to Launch 2nd Space Defense Unit to Protect Satellites from Electromagnetic Attack," SpaceNews, November 15, 2021 ~ https://spacenews.com/japan-to-launch-2nd-space-defense-unit-to-protect-satellites-from-electromagnetic-attack.

28 "Nichibeigoin shuno kaigo kyodo seimei" [Quad Joint Statement], Ministry of Foreign Affairs (Japan), May 24, 2022 ~ https://www.mofa.go.jp/mofaj/fp/nsp/page1_001188.html.

29 Saadia M. Pekkanen, "Space and the U.S.-Japan Alliance: Reflections on Japan's Geopolitical and Geoeconomic Strategy," *Japanese Journal of Political Science* 24, no. 1 (2023): 64–79.

30 Christopher B. Johnstone and Jim Schoff, "A Vital Next Step for the U.S.-Japan Alliance: Command and Control Modernization," CSIS, February 1, 2024 ~ https://www.csis.org/analysis/vital-next-step-us-japan-alliance-command-and-control-modernization.

31 "Joint Statement of the 2023 U.S.-Japan Security Consultative Committee ('2+2')," U.S. Department of Defense, Press Release, January 11, 2023 ~ https://www.defense.gov/News/Releases/Release/Article/3265559/joint-statement-of-the-2023-usjapan-security-consultative-committee-22.

32 Unshin Lee Harpley, "Space Force's Japan Component Expected to Activate in 2024," *Air and Space Forces Magazine*, February 13, 2024 ~ https://www.airandspaceforces.com/space-force-japan-component-activated-this-year.

that will enable them to carry out integrated operations, including in newer domains such as space and cyberspace.[33]

Implications

Japan has a deep interest in situating and advancing its own technological capabilities in one of the world's most strategic sectors. Given the recent space developments, there is little question that it is doing so assiduously through its transnational web of public-private activities. But beyond the matter of industrial and technological competencies, the developments also speak to Japan's vision of itself in the space domain. Looking across the full spectrum of Japan's space activities, three interconnected themes rise to the surface.

Grand strategy at work. First, Japan is executing a grand strategy in the space domain. Grand strategy is the diverse means by which a state produces prosperity and security for national ends in a strategic domain, usually under some guiding intellectual architecture.[34] Japan already draws attention for the ways it has long improvised and adapted to external competition and threats.[35] This remains an overarching model for its behavior in the space domain, especially given the menacing risks, including nuclear, posed directly and indirectly by some actors.

Given its deeply developmental and historically realist orientation, Japan is engaged in proactive positioning on all fronts in the international relations of space, cutting across civilian and military strands and involving both established and emerging space players.[36] Japan's statecraft in the space domain is now more coordinated and coherent than ever before in the country's postwar history. It is being proactively structured to advantage Japan in a changed world order today in every direction in all quarters. Thanks to concerted and dedicated political leadership, Japan's space technology is enabled by greater legal and policy clarity than ever before.

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33 "Japan Enacts Laws to Set Up Joint Command for Self-Defense Forces," *Nikkei Asia*, May 10, 2024 ~ https://asia.nikkei.com/Politics/Defense/Japan-enacts-laws-to-set-up-joint-command-for-Self-Defense-Forces.

34 Hal Brands, *What Good is Grand Strategy? Power and Purpose in American Statecraft from Harry S. Truman to George W. Bush* (Ithaca: Cornell University Press, 2014), 3; and Barry Posen, cited in Thierry Balzacq, Peter Dombrowski, and Simon Reich, "Introduction: Comparing Grand Strategies in the Modern World," in *Comparative Grand Strategy: A Framework and Cases*, ed. Thierry Balzacq, Peter Dombrowski, and Simon Reich (Oxford: Oxford University Press, 2019), 6.

35 Michael J. Green, *Line of Advantage: Japan's Grand Strategy in the Era of Abe Shinzo* (New York: Columbia University Press, 2022), chap. 1.

36 Saadia M. Pekkanen, "Japan's Grand Strategy in Outer Space," in Pekkanen and Blount, *The Oxford Handbook of Space Security*, 334–62.

After decades, there is top-level strategizing directly under the prime minster. Japan is now potentially empowered by an unprecedented degree of open institutional coordination that helps fuse civilian, commercial, and military building blocks in the service of its grand strategy for space.

In 2008, Japan's Basic Space Law synchronized the country's understanding of the military uses of space with international interpretations. In 2012, JAXA's foundational law was amended, allowing the agency to engage on national security space projects. The 2022 strategic documents set expectations about the kinds of capabilities of interest to Japan's foreign and defense policy establishment. The 2022 legislation to promote economic security situated space in the context of broader concerns about making supply chains resilient and critical infrastructure secure for Japan. The Ministry of Defense has also raised its profile in this ecosystem, seeking to leverage the potential of commercial space innovations. The Japan Air Self-Defense Force's establishment of the Space Collaboration and Innovation Office in October 2023 is a high-profile example.[37] The 2023 whole-of-government initiative on space security details not just threats, risks, and the capabilities of interest but also the importance of leveraging and strengthening private efforts for developing critical technologies in the national interest.

All this strategizing does not mean that Japanese decision-makers are omniscient or that material advantages always work out in a straightforward linear manner. Far from it. This is strategizing under uncertainty, and the space domain is extremely hazardous. The point is more that we need to keep an eye across the board on where, with whom, and how Japan is positioning itself in the space domain in its own interest, which foundationally reflects its interests in preserving and advancing its industrial technology base at the cutting edge.

Proactive positioning in practice. Consistent with that grand strategy, Japan's proactive statecraft manifests on all fronts in the space domain—military, economic, and diplomatic. On the military and defense front, under the rubric of their formal alliance, Japan shares the United States' concerns about the nature of evolving threats and the importance of space domain awareness for the safety and security of space assets. Japan has positioned both its sensor technologies and its personnel in the sprawling and spreading space defense architecture centered on its ally's

[37] "New Japan Air Force Space Office to Promote Business Collaboration," Kyodo News, October 8, 2023 ~ https://english.kyodonews.net/news/2023/10/72887b82ed89-new-japan-air-force-space-office-to-promote-business-collaboration.html.

capabilities. With changes in its legal frameworks, as well as the Article V protections of the U.S.-Japan security alliance extended to space, Japan is poised to move into counterspace weapons and to rethink its disruptive and offensive actions (most likely nonkinetic) in, through, and at the nexus of space, which will involve cyber, artificial intelligence, and other emerging and disruptive technologies.

On the economic and technological front, Japan is keenly interested in ensuring that its firms are positioned to capture gains, market share, and spillovers in lucrative commercial markets. These include those centered on small satellites and big data more immediately, space stations further out in time, and eventually off-world outposts. The Japanese government's strategic fund should help catapult its industries into the crosscutting civilian, commercial, and military space markets worldwide.

As noted above, Japan's latest generation of space entrepreneurs is keeping abreast of broader trajectories, including the new lunar space race.[38] In addition to Astroscale and Axelspace, ispace has already sent one private lunar lander to the Moon and is poised to send another. Japan's long-standing space contractors, such as Mitsubishi Heavy Industries, are part of the new generation of rockets, which will intersect civil and military realities. Its older, established businesses have also gotten into the game, such as Mitsui with space stations and Toyota in lunar transportation niches.

Finally, on the regional and global diplomatic front, Japan has kept the door open to new and old players, as well as allies and rivals. It is a long-standing practitioner of space diplomacy, which has remained remarkably underappreciated.[39] One reason for this obscurity is that Japan's space diplomacy is channeled through many overlapping governing institutions at the bilateral, regional, and multilateral levels, making it hard to see and connect over time in a cohesive way. Japan's proactive positioning across these different contexts allows the country not only to situate its advanced technologies in the context of fierce technology competition but also to gain the moral high ground under the glare of the global diplomatic spotlight. It has skillfully engaged established players, such as the United States, as well as newer partners with spacefaring interests, such as the United Arab Emirates, Turkey, India, Vietnam, and Indonesia.

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38 Saadia M. Pekkanen, Setsuko Aoki and Yumiko Takatori, "Japan in the New Lunar Space Race," *Space Policy* (2023) ~ https://doi.org/10.1016/j.spacepol.2023.101577.

39 Saadia M. Pekkanen, "Japan's Space Diplomacy in a World of Great Power Competition," *Hague Journal of Diplomacy* 18, no. 2–3 (2023): 282–316 ~ https://doi.org/10.1163/1871191X-bja10157.

The Japanese state has diplomatically positioned its industrial interests in the commercial, civilian, and military space initiatives of its formal ally, the United States. With an eye on its human and economic capital in off-world infrastructure, Japan has signed up to the U.S.-led Artemis Accords, which establish principles to facilitate exploration of the Moon and beyond. It has also signed on to the Gateway project, a U.S.-led space lunar space station. Further, it has inked a broad space cooperation agreement with the United States to facilitate concrete projects. Japanese actors have also made significant inroads into the new commercial pathways in the United States. SpaceX, for example, has flown Japanese astronauts on commercial crew missions to the International Space Station, starting from the first one. And under the broader auspices of the Artemis Accords, Prime Minister Fumio Kishida announced that Japan wants to put its own astronaut's boots on the Moon. Japan is also diplomatically aligned with the U.S. quest to advance responsible behavior in space, such as by welcoming and supporting the principle of banning the destruction of satellites through direct-ascent missiles.[40]

Beyond the United States, which commands significant attention in Japan's foreign relations portfolio, there are other aspects of Japan's positioning over time that are remarkable. Among them, Japan has independently led the soft and informal Asia-Pacific Regional Space Agency Forum (APRSAF) for over three decades, dating back to 1993, all the while gathering networks, accumulating experiences, and stressing technology development and utilization. Thanks to APRSAF, Japan has reassured its neighbors that its advanced dual-use capabilities are not a threat but can be transposed to servicing their concrete economic and security interests as well. Japan has also plugged the APRSAF networks and initiatives into the global normative and rule-making plane. Under the auspices of the United Nations, it has increasingly moved in concert with partners from Europe, Oceania, and the United States. Like them, Japan stresses the importance of responsible behavior in outer space for international peace and security.

Strategic independence. Japan is proactively positioning itself for a space world independent of the United States. Its unfolding crosscutting statecraft in the space domain reveals that the United States is a dominant player but not the only pole of space interest to Japan. It is also diplomatically engaging on economic and defense issues with a range of other actors.

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40 "Beikoku seifu ni yoru hakaiteki na chijo hasshagata misairu ni yoru eisei hakai jikken o jisshi shinai mune no happyo ni tsuite" [On the U.S. Announcement of Principles Not to Conduct Destructive, Direct-Ascent Antisatellite Missile Testing], Ministry of Foreign Affairs (Japan), Press Release, April 25, 2022 ~ https://www.mofa.go.jp/mofaj/press/danwa/page3_003290.html.

At present, Japan and the United States share an understanding of threats in and through space, whether accidental or deliberate. But the United States is no longer the uncontested unipolar power in space, and China has made significant strides. A calculus in Japan's grand strategy in outer space concerns the internal political stability and cohesion of its formal ally. As democratic norms degrade and the United States' democratic standing is downgraded, these changes in the internal character of the United States will likely affect its alliances and partnerships. In particular, it is not clear that long-standing alliances, such as NATO in Europe or the U.S.-Japan alliance in Asia, will be valued by all political administrations in the United States in the years ahead.

Further, the United States is the world's most space-dependent power, with close to 70% of the total operational space assets today. That dependence is likely to grow with the U.S.-led megaconstellations of satellites going into space. The space-based critical infrastructure that fuels U.S. power is also its Achilles' heel, posing challenging vulnerabilities amid new global rivalries. Threats to space assets extend to all orbits, which also affects the fate of extended nuclear deterrence. Japan, meanwhile, is nowhere near as dependent on space, and this may affect its thinking in the years ahead about aligning with U.S. threat narratives in space.

Another complication is that Japan is economically integrated with China and has signed one of the world's largest economic pacts (the Regional Comprehensive Economic Partnership) with it. Japan also has a memorandum of understanding in place with China, which could be leveraged to facilitate space infrastructure investment projects in the name of economic development and poverty reduction across Asia. Japan has made small overtures to China through APRSAF, where it has the leadership potential to influence the course of such infrastructure projects with paying customers.

All this suggests we should be wary of any simplistic narratives about Japan's foreign relations that paint the United States as a perpetual ally and China as the forever rival. These same ambiguities in other contexts are also evident across U.S. partners and allies stretched from Europe, Africa, and onto the Asia-Pacific.[41] Japan has historically been attentive to structural shifts in international relations and is inclined to side with

[41] Sheena Chestnut Greitens and Isaac Kardon, "Playing Both Sides of the U.S.-Chinese Rivalry," *Foreign Affairs*, March 15, 2024 ⇝ https://www.foreignaffairs.com/united-states/playing-both-sides-us-chinese-rivalry.

the powerful.[42] The international relations of space, given the significant implications for economic-security linkages, will not be different. Japan will continue to proactively position itself in ways that serve its own national interests irrespective of the rise and decline of states engaged in great-power competition. ◈

[42] Kenneth B. Pyle, *Japan Rising: The Resurgence of Japanese Power and Purpose* (New York: Public Affairs, 2007), 44.

India's Space Program: Increasing Proactivism

Rajeswari Pillai Rajagopalan

India's space program has come a long way since the country launched its first sounding rocket from Thumba in southern India in 1963. The rocket was a Nike-Apache, which was supplied by NASA, one of the several international collaborations on which the Indian space program was built. As a developing country with scant resources, India's early focus was limited to using space for social and economic progress. Nevertheless, India also understood the importance of developing strategic technologies such as rockets, and technology demonstration was seen as important for gaining a seat at the high table with more capable powers.

Even as the Indian space program continues to follow the original purpose of using space for the pursuit of its social and economic goals, it has undergone some significant shifts over the past decade. India now appears to be expanding the space program to include military and security dimensions in a more determined manner. Some of the elements of this initiative are the development of anti-satellite capabilities and the establishment of the tri-service Defence Space Agency under the leadership of the Indian Air Force. In addition, India appears to be expanding its space exploration and scientific goals, which were clearly not a priority previously for the political and scientific leadership.

These developments reflect the intensifying space competition in India's neighborhood, especially China's growing counterspace capabilities. This competition is unlikely to decrease in the near future, suggesting that the change in India's space program, especially toward a greater focus on national security, will continue. This will likely manifest in India's development of space security capabilities and pursuit of appropriate policy measures, along with new institutional arrangements and space security diplomacy.

This essay begins with an outline of India's space vision and strategies, which in recent years have shifted from being purely social- and economics-driven to having a big focus on space exploration, including toward Mars and the Moon. Exploration was not part of the original vision of the Indian space program, but with a maturing space program, this is seen as a logical next step because it promises further technological spin-offs and reflects the

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RAJESWARI PILLAI RAJAGOPALAN is a Resident Senior Fellow at the Australian Strategic Policy Institute in Canberra (Australia). She can be reached at <rajiraja@aspi.org.au>.

increasing geopolitical competitiveness in Asia. The second section examines India's growing military space profile, which is increasingly reflected in its stand on space militarization and weaponization. This leads to the penultimate section on India's development of space security partnerships with several like-minded partners that share similar threat perceptions, the Quad being a prominent example. The final, concluding section argues that Indian space policy continues to lag on space security planning. An indicator of this is the fact that the 2023 space policy did not say much on national security.

Space Vision and Strategies

India began its space program with a vision of using the program for the social and economic development of its population. For the first several decades, it focused on programs that would help a country as vast as India, which was predominantly agricultural, such as meteorology, telecommunications, and remote sensing. Having reached sufficient maturity in its routine missions for earth-observation and communication purposes, the Indian Space Research Organisation (ISRO) has begun to move on from these routine missions and add other elements to its program. In particular, ISRO has been expanding its program to include space exploration as a key aspect to its space agenda. This is reflected in India's Moon and Mars missions. ISRO is currently preparing for its maiden human space mission called Gaganyaan, scheduled for the end of 2025.[1] All these missions have triggered different responses, with many questioning their utility for a country that is still confronted with significant developmental challenges. But there are several logical reasons for India to pursue such missions.[2]

First, as India's space program matures, pursuit of pure space exploration is a sensible next step. Developing more sophisticated space technologies beyond remote sensing and communication satellites is a sign of a maturing space program.

Second, pure space exploration programs such as the Moon and Mars missions have been criticized as a drain on the economy because they were perceived as not contributing to the developmental or social agenda

1 Pallava Bagla, "On India's First Human Mission's Launch Date, ISRO Chief Says...," NDTV, June 29, 2024 ~ https://www.ndtv.com/india-news/on-indias-first-human-mission-gaganyaans-launch-date-isro-chief-sr-s-somanath-says-5996094.

2 Rajeswari Pillai Rajagopalan, "India's Race to Mars Goes Way Beyond Science," *Wall Street Journal*, November 4, 2013 ~ https://www.wsj.com/articles/BL-IRTB-21122.

of the country. But even though they make no direct developmental or social contributions, these missions raise the profile and visibility of the Indian space program and highlight its competitiveness, all achieved at a fairly low cost. This has appealed to many countries, especially in the developing world, underscoring India as an attractive collaborator on space development. These missions also validate its ability to engage in complex missions on a frugal budget, which has added to India's revenue as well as its soft power. For example, countries from the developing world have partnered with India to launch their satellites.

Third, space missions have been important in the context of India's ability to increase its technological innovation. The development of deep space communication capabilities is a case in point. India's capability has seen an enhancement following the Chandrayaan (Moon) mission in 2008 and the Mangalyaan (Mars) missions. Less than a week prior to India's Chandrayaan-1 mission, it established the Indian Deep Space Network, a network of large antennas and communication facilities operated by ISRO around the globe.[3] It must be noted, however, that India received assistance from both NASA and the European Space Agency (ESA). NASA's Deep Space Network and the ESA's deep space stations provided deep space communication support to ISRO's Chandrayaan-3 mission.[4] Many other technologies, such as robotic technology developed by ISRO to remotely operate equipment in a spacecraft, have found their way in to other applications, such as developing smart artificial limbs. Gaganyaan and other missions aimed at sustaining human presence in space reportedly will find many spin-off utilities that serve more common purposes.[5] Finally, these technology demonstration missions have played a role in enhancing India's voice in global governance of space.

One of the reasons for this reorientation of India's space program to focus on exploration was simply compulsion, as the country has had to deal with a much more competitive environment in outer space. Given the adversarial political relationship between India and China, which is unlikely to change in the near term, India had to look at outer space as one more

3 ISRO Telemetry Tracking and Command Network (ISTRAC), "ISRO Telemetry Tracking and Command Network (ISTRAC)," Department of Space (India), 3 ⇝ https://www.istrac.gov.in/brochure.html.

4 "Chandrayaan-3 Also a Testament to Global Linkages Nurtured by ISRO," Indo-Asian News Service, August 27, 2023, available at https://www.zeebiz.com/india/news-chandrayaan-3-also-a-testament-to-global-linkages-nurtured-by-isro-250767.

5 "Not Just Space: How ISRO Is Touching Many Facets of Our Everyday Life," *Economic Times* (India), August 24, 2023 ⇝ https://economictimes.indiatimes.com/news/science/not-just-space-how-isro-is-touching-many-facets-of-our-everyday-life/articleshow/102983355.cms.

arena of this political contestation. While space accomplishments have not yet become as competitive as the "space race" of the Cold War between the United States and the Soviet Union in the 1950s and 1960s, there are some common elements. China, of course, has a much better funded and more advanced space program than India's, but New Delhi nevertheless wants to try keep up with its giant neighbor. This competition also leads to greater focus on military aspects of space.

Growing Military and Space Profile

While India was cognizant of the strategic and security relevance of space technology early on, this did not receive much attention from the Indian political leadership until the late 2000s. During the Cold War, India was a vehement critic of the militarization and weaponization of space by the then great powers, the United States and the Soviet Union. It loudly criticized the United States' Strategic Defense Initiative and the repeated tests of anti-satellite weapons (ASAT) by the two superpowers.

Despite these earlier sharp responses to the militarization and weaponization of space, India's approach began to change in the early 2000s. The change can be attributed to a number of factors, including the country's overall rising power profile. India was now playing a bigger role beyond South Asia in broader Asian and global politics in line with its growing economic means. This rising profile affected its approach and alignment on several policy issues, including space security. The changing threat environment in its neighborhood, including the space security conditions, also pushed India to become more pragmatic. New Delhi advanced a new approach to space security issues, altering its earlier morality-based approach into one that was shaped by national security interests and pragmatism. This approach was reflected in its position on militarization and weaponization of space, as India began to appreciate the utility of some of these capabilities and change policy tack in addressing its own security threats. The evolving threats in the neighborhood, for instance, pushed India to look for technologies such as missile defense that it had criticized in the past when the United States and others were pursuing such technologies.

Within the space domain, India began to pursue satellite capabilities that would enhance its national security credentials, focusing on a mix of satellites for military purposes such as intelligence, surveillance, and reconnaissance and earth observation. India has yet to come out with a military space policy, but its thinking about military space capabilities can

be seen in official statements in the Indian parliament that suggest a greater allocation of space resources for military utilities.[6] The growing military space capabilities wherewithal should have a multiplier effect in terms of strengthening the Indian armed forces' situational awareness, particularly in the immediate neighborhood.[7] One of the earliest such satellites is the radar-imaging satellite (RISAT) series, equipped with synthetic aperture radar that enables India to augment its surveillance capabilities irrespective of the time of the day or weather conditions, even including cloud cover. RISAT satellites were developed in the context of monitoring terrorist threats, especially after the Mumbai terrorist attack in 2008. The Indian military has also been deploying satellites for military communication, which has greatly facilitated coordination. Similarly, satellite-based maritime communication has been exceptionally useful for the Indian Navy because of deployments in distant operational theatres. This is particularly important as the Indian Navy used to rely on a foreign private company for its communication requirements. Therefore, the decision to launch a satellite for naval communications ensures a certain amount of self-sufficiency and avoids the vulnerability of relying on external agencies for time-sensitive and strategic data. Albeit on a smaller scale than the U.S. Global Positioning System (GPS), India has also developed its own satellite-based navigation system, which the armed forces find useful and which minimizes dependance on foreign navigation systems.

A significant manifestation of the Indian military's growing space profile is its ASAT demonstration in March 2019. The Chinese ASAT in January 2007 was a wake-up call to India about the kind of threats that it should be prepared for, sparking an internal debate among the different stakeholders on how India should defend against new threats. The response was unanimous across the political, scientific, and military bureaucracy that India needed to recognize the new threats as well as develop an appropriate response so as to deter an attack on its space assets. Hence, the Manmohan Singh government sanctioned the research and development for an ASAT capability. In 2012, V.K. Saraswat, the scientific adviser to the defense minister, claimed that India had the "building blocks" for an ASAT capability should it decide to demonstrate such a capability.[8] Several years

6 Rajeswari Pillai Rajagopalan, "India's Changing Policy on Space Militarization: The Impact of China's ASAT Test," *India Review* 10, no. 4 (2011): 354–78.

7 Ajey Lele, "Military Satellites: India Needs to FastTrack," *Financial Express*, November 25, 2021 ⇝ https://www.financialexpress.com/business/defence-military-satellites-india-needs-to-fasttrack-2373221.

8 Sandeep Unnithan, "'India Has All the Building Blocks for an Anti-satellite Capability,'" *India Today*, April 27, 2012 ⇝ https://www.indiatoday.in/india/story/agni-v-drdo-chief-dr-vijay-kumar-saraswat-interview-100405-2012-04-26.

later, Prime Minister Narendra Modi approved the ASAT test demonstration through Mission Shakti in March 2019.[9]

According to the Ministry of External Affairs, India's decision to finally conduct an ASAT test was driven by several factors, including developing "credible deterrence against threats to our growing space-based assets from long-range missiles."[10] Another factor was the country's increasing lack of confidence that the global community will be able to strengthen global norms against ASAT capabilities, as well as other rules and regulations, raising questions about whether global governance mechanisms could be trusted to protect Indian interests. Moreover, India consciously wanted to avoid a mechanism in space similar to the Nuclear Non-Proliferation Treaty. But it must be acknowledged that this was not an easy decision for India for many reasons. The ASAT test was a major departure from its decades-long stand against space militarization and weaponization. The test further destabilized the space domain at a time when the ability to maintain the sanctity of space as a peaceful domain was coming under grave challenges, which India found problematic.

In addition to technological developments, India has engaged in institutional reform so that its armed forces can fully utilize space for military purposes. Some of the recent changes include the establishment of the Integrated Space Cell under the Integrated Defence Services Headquarters of the Ministry of Defence in 2009[11] and under the Indian Navy's assistant chief of naval staff (communications, space and network-centric operations) in 2012.[12] Some of the institutional reforms, such as the creation of the Integrated Space Cell, were meant to be first steps toward improving coordination between the Department of Space and the Indian military as well as developing a common understanding of the emerging threats in space. A somewhat similar case was the establishment of the Defence Space Agency in 2018. The agency is meant to be a predecessor to a full-fledged aerospace command, which the Indian military has sought for more than two decades. The tri-service institution

9 Siddharth Varadarajan, "Former NSA Shivshankar Menon Says DRDO Head Never Sought Permission for ASAT Test," *Wire*, March 29, 2019 ~ https://thewire.in/security/former-nsa-shivshankar-menon-says-drdo-head-never-sought-permission-for-asat-test.

10 "Frequently Asked Questions on Mission Shakti, India's Anti-satellite Missile Test Conducted on 27 March, 2019," Ministry of External Affairs (India), March 27, 2019 ~ https://www.mea.gov.in/press-releases.htm?dtl/31179/Frequently_Asked_Questions_on_Mission_Shakti_Indias_AntiSatellite_Missile_test_conducted_on_27_March_2019.

11 Ministry of Defence (India), *Annual Report 2009–2010* (New Delhi, 2010), 15 ~ https://www.mod.gov.in/sites/default/files/AR910.pdf.

12 Rajat Pandit, "Navy Creates New Post to Harness Space-Based Capabilities," *Times of India*, June 3, 2012 ~ https://timesofindia.indiatimes.com/india/navy-creates-new-post-to-harness-space-based-capabilities/articleshow/13774463.cms.

under the leadership of the Indian Air Force aims to create greater jointness and integration among the three services.[13]

Given the increasingly hostile environment in space and the development and testing of ASAT and co-orbital ASAT capabilities, it is unlikely that India will slow down its efforts to bolster its space security capabilities. The next section examines the role of space security partnerships.

Space Security Partnerships

India is increasingly approaching its space partnerships also through a security lens. In addition to the development of ASAT capabilities, the growth of cyber and electronic warfare measures as well as high-energy weapons has also been significant. Potentially, these weapons are even more dangerous because, unlike ASAT weapons, they do not cross a certain threshold and are seen to be deployed on a more regular basis, causing disruptions in space-based services.[14]

For India, China's development and use of cyber and electronic warfare capabilities in space are particularly concerning. This has become the primary reason for much of India's evolving space diplomacy. One of its prominent partnerships is the Quad, involving the United States, Japan, and Australia as partners. India's engagement with the Quad as a whole and with each of its members has seen a momentous shift in recent years.[15] India has also pursued an extensive agenda for space cooperation with France. It has engaged each of these partners in both the civil and security aspects of space cooperation, as well as in global governance debates regarding the development of norms of responsible behavior and regulations. Within the context of the Quad, such discussions are clearly focused on China, whose activities in outer space are a concern for all of India's partners. Engaging in consultations on new norms and regulations within an exclusive grouping like the Quad is quite new for India, which traditionally had partnered with nonaligned and global South countries in multilateral platforms on space issues. New Delhi has thus begun to deviate from its decades-old insistence on multilaterally negotiated, legally binding, and verifiable mechanisms

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13 Ministry of Defence (India), *Annual Report 2018–19* (New Delhi, 2019), 12 ~ https://www.mod.gov.in/dod/sites/default/files/MoDAR2018.pdf.

14 By contrast, the use of ASAT weapons typically requires a response because not responding can be seen as normalizing undesirable behavior.

15 Rajeswari Pillai Rajagopalan, "India's Space Cooperation with the U.S.—and the Quad—Intensifies," *Diplomat*, March 29, 2021 ~ https://thediplomat.com/2021/03/indias-space-cooperation-with-the-us-and-the-quad-intensifies.

rather than norms-based agreements. It is also noteworthy that India has begun more specific dialogues on space security with a handful of countries that do not include China or Russia but instead the United States, Japan, and France. This reflects again the dominance of China-related threats in India's space security diplomacy and partnerships.

Moreover, as India becomes a maturing space power, there is a sense that for the country to advance its space security interests in a more determined manner, as well as to gain more options in terms of the global governance debates, it must proactively engage and partner more with like-minded countries. Whether through the Quad or other minilateral partnerships, New Delhi feels the need for greater coordination. Space security threats and other issues, such as the problem of usable orbits in space becoming scarcer, are likely to intensify exponentially in the coming years. Coordination on space security should be an equally important imperative for many of India's minilateral partners, leading to a growing consensus on a concrete agenda for space security cooperation. While such cooperation could include partners such as France, the United Kingdom, and Canada, it could also involve many more countries from the global South, such as the Philippines, Singapore, and Vietnam. These and other global South countries rely heavily on outer space and are therefore interested in developing new norms of responsible behavior. Many of these partnerships not only are between governments but also include other stakeholders, such as civil society and private-sector players. The role of the commercial sector in the context of the Quad has been striking if one looks at its potential—from creating new jobs in the Quad countries to augmenting space supply chain resilience, as well as championing the case for norms, standards, guidelines, and best practices.[16]

Beyond collaborating on new norms and regulations, keeping track of space security developments and crafting appropriate technical countermeasures are important activities in these new space security partnerships. A third concrete area for cooperation within groupings like the Quad is space domain awareness, which is the capability to monitor the space environment for any kind of threat, ranging from natural events to intentional attacks. The United States has the largest network of radars and sensors, but growing space insecurities in the Indo-Pacific suggest the need for more extensive coverage of the Southern Hemisphere. This would entail building or enhancing tracking systems to continuously monitor space

[16] "Quad Leaders' Summit Fact Sheet," White House, May 20, 2023 ~ https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/quad-leaders-summit-fact-sheet.

security threats in the Indo-Pacific, which could be useful for determining mitigation measures. The other three members of the Quad have very limited space domain awareness capabilities, but nevertheless combining the capabilities of all four could produce an enhanced view of threats. Some of these could have related benefits—for instance, monitoring space for threats could be beneficial in tracking of China's space security activities. Similarly, there is increasing collaboration in space to address threats related to climate change, such as by sharing information for earth observation and disaster management and mitigation.[17] All of these initiatives within a space security agenda should usher in an exciting phase of cooperation in the Indo-Pacific, considering that the primary drivers of such cooperation—the threats from China and Russia—are unlikely to diminish anytime soon.

India's Space Policy Continues to Lag

In April 2023 the Cabinet Committee on Security approved India's space policy.[18] This was an important achievement, considering that interdepartmental consultations within the government had been going on for more than a decade. Though the existence of a space policy document in the open domain is a positive development, the policy falls short in many respects, especially as it pertains to national security and space security. The document did a great deal in terms of spelling out the roles and responsibilities of different stakeholders, including ISRO, NewSpace India Limited (NSIL), and the Indian National Space Promotion and Authorization Center (IN-SPACe), as well as private players in the Indian space sector. The release of the 2023 policy along with the establishment of dedicated institutions in recent years has had a beneficial impact, enhancing private-sector participation in the Indian program. This is critical for India to augment the competitiveness of its space program because capacity constraints have been a major issue confronting ISRO.

Nevertheless, even though ISRO has done quite well, especially considering the small budget with which it operates, the growing demand for space-based services has in effect resulted in a problem of inadequate capacity. Thus, bringing in Indian private stakeholders on a somewhat level playing field is a much-needed step. In November 2022, for instance,

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17 Adriana Reinecke and Mizumi Fujita Dutcher, "The Possibilities for Quad Cooperation in Space," *Diplomat*, May 23, 2023 ~ https://thediplomat.com/2023/05/the-possibilities-for-quad-cooperation-in-space.

18 "Indian Space Policy—2023," Indian Space Research Organisation ~ https://www.isro.gov.in/media_isro/pdf/IndianSpacePolicy2023.pdf.

Skyroot Aerospace, an Indian private-sector entity, launched India's first privately built rocket, Vikram-S.[19] With the Prarambh mission, as it was called (meaning "beginning" in Hindi), there was a widespread expectation that this was the start of a new phase in ISRO's engagement with the Indian private sector.[20] Another example is that of Agnikul Cosmos, a start-up incubated at the Indian Institute of Technology that "launched the world's first rocket with a single piece 3D printed engine" in May 2024.[21]

Therefore, the space policy of 2023 has been effective to the point of opening up the Indian space sector to the private sector. Until now, India was making slow progress on this front, but there is growing recognition that ISRO needs the Indian private sector to stay competitive and fulfill India's space agenda. Thus, in May 2024, IN-SPACe issued a new document outlining norms and processes for the implementation of the space policy.[22] As the title indicates, the document is primarily focused on developing guidelines and formats to further strengthen the participation of nongovernmental entities. For a long time ISRO was keen to deliver on all of India's needs, but this has proved to be challenging given the growing demand across multiple sectors, including with respect to security requirements. Engaging the private sector for many routine missions will free up ISRO to focus more on strategic programs as well as pure space exploration. ◈

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19 Manish Pant, "Skyroot Aerospace Makes History! India's First Privately Built Rocket Successfully Launched Into Space," *Business Today*, November 18, 2022 ~ https://www.businesstoday.in/latest/trends/story/skyroot-aerospace-makes-history-indias-first-privately-built-rocket-successfully-launched-into-space-353321-2022-11-18.

20 Rajeswari Pillai Rajagopalan, "Skyroot Creates a New 'Prarambh' for Indian Space," Observer Research Foundation, Space Tracker, November 21, 2022 ~ https://www.orfonline.org/expert-speak/skyroot-creates-a-new-prarambh-for-indian-space.

21 "Agnikul Launches World's First Rocket with Fully 3D Printed Engine," Press Information Bureau (India), May 30, 2024 ~ https://pib.gov.in/PressReleasePage.aspx?PRID=2022161.

22 Indian National Space Promotion and Authorization Centre, Department of Space (India), *Norms, Guidelines and Procedures for Implementation of Indian Space Policy–2023 in Respect of Authorization of Space Activities (NGP)* (Ahmedabad, May 2024).

South Korea's Space Policy and Leap to Space Power

Sangwoo Shin

In 2024 the Korea Pathfinder Lunar Orbiter (KPLO), also known as Danuri, experienced a significant event in lunar orbit.[1] During its mission, KPLO engaged in collision avoidance maneuvers with several other lunar orbiters, including NASA's Lunar Reconnaissance Orbiter, India's Chandrayaan-2, and Japan's Smart Lander for Investigating Moon. This collaboration involved sharing critical information to prevent mission interference and collisions, a practice that is expected to become more frequent as lunar exploration activities increase.[2] Recently, the UN Committee on the Peaceful Uses of Outer Space (COPUOS) has initiated mechanisms to promote the sharing of scientific data obtained from lunar missions, recognizing that lunar exploration should benefit all of humanity. South Korea is actively participating in these efforts, contributing to the development of a collaborative framework for future missions.[3]

Until now, South Korea's space policy has emphasized the acquisition of technology, such as satellites and launch vehicles. However, recent developments indicate a qualitative shift in the country's space policy, including the establishment of the Korea AeroSpace Administration (KASA).[4] The government announced a new national agenda in August 2022 centered on the concept of a "leap to a space power and the opening of Korea's space age." The subsequent unveiling of a future space economy

SANGWOO SHIN is a Senior Researcher at the Korea Aerospace Research Institute (South Korea). He can be reached at <swshin@kari.re.kr>.

NOTE: The views expressed here are those of the author only and do not represent the views of organizations with which he is affiliated.

1 KPLO's mission represents a significant milestone for South Korea, marking its first lunar exploration mission. Launched on August 4, 2022, by a SpaceX Falcon 9 rocket, KPLO entered lunar orbit on December 17, 2022. The mission involves six scientific instruments, including the lunar terrain imager, wide-angle polarimetric camera, KPLO magnetometer, KPLO Gamma ray spectrometer, Delay-Tolerant Networking experiment, and NASA's ShadowCam. These instruments are designed to study the lunar surface, investigate the Moon's magnetic environment, and search for water and ice in permanently shadowed regions.

2 Moon-Jin Jeon, "Lessons Learned for Safe and Sustainable Lunar Exploration: The Case of KPLO Operations" (presentation at the 67th Session of the Committee on the Peaceful Uses of Outer Space, Vienna, June 21, 2024).

3 Jeff Foust, "Lunar Spacecraft Receive Dozens of Collision Warnings," SpaceNews, July 11, 2024 ~ https://spacenews.com/lunar-spacecraft-receive-dozens-of-collision-warnings.

4 Dennis Normile, "South Korea Launches Its Own NASA," *Science*, May 27, 2024 ~ https://www.science.org/content/article/south-korea-launches-its-own-nasa.

roadmap formalized the establishment of the space agency amid various controversies and issues.

South Korea's new approach to space policy was solidified with the passage of the "Special Act on the Establishment and Operation of the Aerospace Agency" on January 9, 2024, leading to KASA's establishment on May 27, 2024, in Sacheon, a city in the southern part of the Korean Peninsula. Modeled after the Toulouse Space Center in France, KASA is anticipated to become a pivotal government body overseeing policies and research in the aerospace sector, creating new momentum for the aerospace industry nationwide.

The establishment of a new space agency in South Korea has several implications at the ministerial level and above. Most importantly for this essay, space development, previously considered an integral part of research and development, has been recognized as an independent field with its own policy initiatives. In addition, KASA aims to enhance operational efficiency by consolidating and coordinating South Korea's dispersed space capabilities.

The remainder of this essay provides an overview of South Korea's new space policy. The first section examines the achievements of the country's catching-up strategy, which focuses on technological accumulation, and considers the prospects for the period after this strategy.[5] The subsequent section then delineates the direction of South Korea's current space policy and presents the outlook for the future. Finally, the essay concludes by reviewing the challenges and implications associated with these developments.

South Korea's Catching-Up Strategy in Space

A catching-up strategy in space policy is best exemplified by South Korea's development of launch vehicles. A nation that seeks to close the technological gap with leading countries employs this strategy by investing heavily in R&D, adapting existing technologies, and collaborating internationally in a strategic way. Despite commencing space development four decades later than other spacefaring nations, South Korea has

[5] Keun Lee, "How Can Korea Be a Role Model for Catch-Up Development? A 'Capability-Based View,'" World Institute for Development Economics Research, United Nations University, Research Paper, no. 2009/034, June 2009.

achieved rapid progress through initiatives led by the government and public research institutions.[6]

The necessity for South Korea to develop its own launch vehicles using indigenous technology was first recognized in 1987.[7] In October 1989 the Aerospace Industry Development Promotion Act was passed, leading to the establishment of the Korea Aerospace Research Institute (KARI).[8] This milestone set the stage for the development of Korea's scientific observation rockets (KSR). In 1993, within three years of KARI's establishment, the institute successfully conducted two experimental launches of the KSR-I, a single-stage solid-propellant rocket that reached an altitude of 39 kilometers (km) and a range of 77 km.[9]

Subsequently, South Korea launched the two-stage solid-propellant scientific rocket KSR-II in June 1998, followed by the successful launch of the liquid-propellant scientific rocket KSR-III in November 2002.[10] Although these KSR rockets did not reach orbit and were primarily used for meteorological observations through parabolic trajectories, they were crucial in developing South Korea's technology capabilities in liquid propulsion engine design and manufacturing, engine testing, guidance control, and attitude control. These technological advancements laid the foundation for the development of the Nuri (KSLV-II) launch vehicle.

From 2002 to 2013, South Korea aimed to develop the Naro (KSLV-I) to launch small satellites weighing around 100 kilograms (kg) into low-earth orbit. However, due to limitations in technology, the project required collaboration with Russia. Russia was responsible for designing and developing the critical first-stage rocket and related equipment, while South Korea focused on developing the second-stage solid motor and overseeing the Goheung Space Center. Construction of the space center was completed in June 2009, enabling South Korea to launch vehicles without relying on foreign land. The first Naro launch attempt in August 2009 failed after 216 seconds due to one side of the fairing not separating properly. A second

6 Hyoung Joon An, "National Aspirations, Imagined Futures, and Space Exploration: The Origin and Development of Korean Space Program 1958–2013" (PhD diss., Georgia Institute of Technology, 2015); and James Clay Moltz, *Asia's Space Race: National Motivations, Regional Rivalries, and International Risks* (New York: Columbia University Press, 2012).

7 Chin Young Hwang, "Space Activities in Korea—History, Current Programs and Future Plans," *Space Policy* 22, no. 3 (2006): 194–99.

8 Youngshin Ahn, "Recent Developments in the Republic of Korea's Space Policy: An Overview of Space Activities and National Laws," *Air and Space Law* 44, no. 2 (2019): 169–83.

9 Moltz, *Asia's Space Race*.

10 Seungjoo Lee and Sangwoo Shin, "Evolution and Dynamics of the Space Industry in South Korea," Institut français des relations internationals, Asie.Visions, no. 137, January 2024, 8–9.

attempt in June 2010 also failed, with the rocket exploding 137 seconds after liftoff. These setbacks highlighted the challenges faced in developing space launch capabilities and underscored the need for continued technological advancements and international collaboration.

After experiencing two failed attempts, South Korea persisted and succeeded with the third launch of the Naro on January 30, 2013. This launch placed a 100 kg small scientific satellite into low-earth orbit. Despite this success, the Naro was not fully recognized as a completely indigenous South Korean space launch vehicle because Russia had designed and developed the critical first-stage rocket. Nonetheless, the project was pivotal in advancing South Korea's space technology. It included preliminary research on a 30-ton liquid propulsion tank, which laid the groundwork for the development of the 75-ton engine used in the subsequent Nuri project.

Nuri is a South Korean space launch vehicle developed entirely with domestic technology and is built to endure extreme space environments.[11] Development faced significant challenges, including a tank manufacturing setback that was overcome by repeated redesigns and tests by domestic researchers. After the first Naro launch failure, Nuri's development began, culminating in the successful test launch of the KRE-075 engine in November 2018. In October 2021, Nuri's first launch with a satellite mockup was only partially successful, as the prototype failed to reach orbit. However, in June 2022, the second launch successfully carried a payload of 1,500 kg, including a 1.3-ton satellite mockup and a 180 kg verification satellite, demonstrating South Korea's capability to launch significant payloads into low-earth orbit. This achievement positioned South Korea as a country capable of launching over 1-ton satellites. Following this success, it launched the third Nuri mission on May 25, 2023, carrying a next-generation small satellite and six cube satellites, marking the beginning of an era of commercial space exploration in South Korea.

The development of launch vehicles in South Korea illustrates how the catching-up strategy can be successfully applied to aerospace technology. South Korea has become a formidable player in the global space industry by leveraging international expertise, encouraging domestic innovation, and fostering public-private partnerships. As well as providing valuable insights for other countries aspiring to enhance their technological capabilities, this

[11] Choe Sang-Hun, "South Korea Launches Satellite with Its Own Rocket for the First Time," *New York Times*, June 21, 2022 ~ https://www.nytimes.com/2022/06/21/world/asia/south-korea-rocket-launch-nuri.html.

case study emphasizes the importance of strategic planning and investment when it comes to achieving technological self-sufficiency.

The Current Direction of South Korea's Space Policy

Following the successful second launch of Nuri in 2022, the South Korean government accelerated the establishment of a space agency. In November 2022 the Ministry of Science and ICT launched the Aerospace Administration Establishment Promotion Team. In March 2023 the "Special Act on the Establishment and Operation of the Aerospace Administration" was enacted. Upon passing this legislation, the government planned to establish KASA.[12] The agency oversees R&D, policy, industry promotion, civil-military cooperation, international cooperation, talent cultivation, and infrastructure development in the aerospace sector (see **Figure 1**). It was organized and operated as an R&D-focused entity.

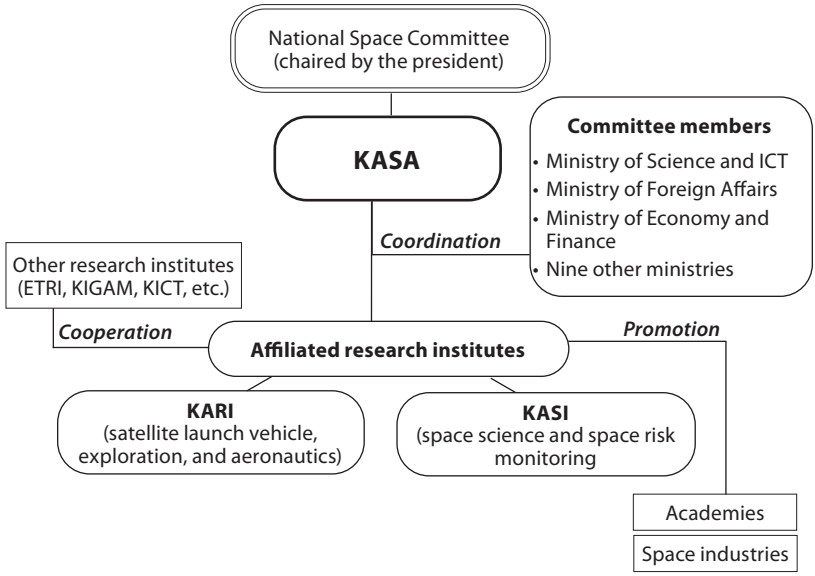
KARI and the Korea Astronomy and Space Science Institute (KASI) were originally supposed to remain under the National Research Council of Science & Technology, but KASA repositioned them during legislative review. The creation of a new aerospace administration had long been discussed, but it was often considered a political matter. As South Korea's aerospace industry is modestly valued at about three trillion won and less than ten trillion won across the aerospace and aviation sectors, KASA hopes to lead the country's high-tech economy in the future.

The organizational structure in **Figure 2** and related law about establishing an aerospace administration provide insight into its policy directions. According to Article 7 of the Special Act, the main roles of the agency include (1) establishing aerospace policies, (2) conducting R&D and talent development, (3) promoting the aerospace industry, and (4) fostering civil-military and international cooperation. The vice administrator oversees the Planning and Coordination Office, the Space Policy Bureau, and the Aerospace Industry Bureau, while the vice administrator of mission

[12] The Special Act includes provisions allowing for the establishment of remuneration standards for term-based public officials within KASA, independently of the National Public Officials Act. This legislation also contains measures aimed at enhancing the functions of space industry clusters. Furthermore, an amendment to the Space Development Promotion Act was passed, which elevates the position of the chairperson of the National Space Committee from the prime minister to the president. The Special Act also stipulates that any relocation of the main offices of KARI and KASI, currently situated in Daejeon, must be approved by the National Assembly.

FIGURE 1

Governance of Current Space Policy



Note: The full names of these actors are Korea AeroSpace Administration (KASA), Electronics and Telecommunications Research Institute (ETRI), Korea Institute of Geoscience and Mineral Resources (KIGAM), Korea Institute of Civil Engineering and Building Technology (KICT), Korea Aerospace Research Institute (KARI), and Korea Astronomy and Space Science Institute (KASI).

directorates oversees four sections of R&D: space transportation, satellites, space science exploration, and aviation innovation.[13]

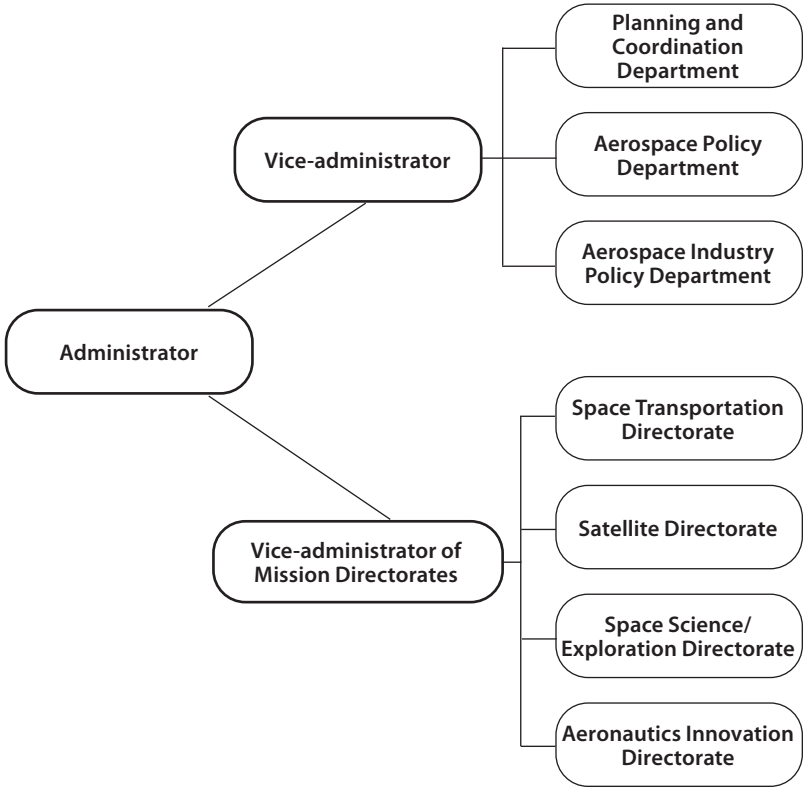
As part of South Korea's "Towards Aerospace, Creating South Korea's Third Miracle" vision, the new space agency has outlined a comprehensive plan for positioning the country as one of the world's top-five aerospace powers as well as establishing aerospace as a key national industry. There are four principal domains of aerospace technology in this policy: space transportation, satellite development and utilization, space exploration, and future aviation leadership.[14]

[13] The full text of the "Special Act on the Establishment and Operation of the Aerospace Administration" is available in Korean at https://www.law.go.kr/LSW//lsInfoP.do?lsiSeq=259383&chrClsCd=010202&urlMode=lsInfoP&efYd=20240527&ancYnChk=0#0000.

[14] KASA, "Ujuhang-gongcheong jeongchaekbanghyang" [KASA and Policy Direction], May 30, 2024 ~ https://www.kasa.go.kr/web/board/brdDetail.do?menu_cd=000024&num=1193.

FIGURE 2

Organizational Structure of KASA



The space transportation strategy emphasizes entering the launch service market. This involves the development of next-generation launch vehicles, repeated launches and performance enhancements of the Nuri launch vehicle, and the early acquisition of reusable launch vehicle technology. Additionally, the strategy includes establishing a diversified portfolio of launch vehicles, developing infrastructure such as a second space center, and refining the launch authorization system to ensure an efficient and safe national framework for launch management. Recognizing the exclusivity of the Goheung Space Center, the plan includes developing a facility accessible to the private sector. For private enterprises engaged in repeated launches, a regulatory system will be implemented to permit sequential launches under a single authorization.

In the domain of satellite development and utilization, KASA aims to advance satellite technology and foster a private-led satellite information utilization ecosystem. This includes the development of advanced satellites with a resolution of 15 centimeters and the acquisition of core technologies for future satellites, such as space optical communication and space internet. The policy also prioritizes continued development and enhancement of national satellite systems, the establishment of the Korean Positioning System, and the promotion of satellite information utilization to foster new industries and services.

The space exploration strategy seeks to secure autonomous deep space exploration capabilities beyond the current lunar exploration objectives. This involves the formulation and announcement of the "Korea Space Exploration Roadmap," development of lunar landers, and establishment of a lunar base for observation and exploration. Furthermore, the strategy includes identifying missions for Mars exploration, including orbiters and landers, and developing strategies for asteroid exploration. Long-term objectives include securing a lunar base by 2040, developing and conducting Mars exploration missions with landers by 2045, and considering exploration of the Apophis asteroid.[15]

To establish leadership in future aviation, KASA will focus on developing future hybrid air mobility and advanced aircraft engines. This strategy also includes expanding civilian-military cooperation and international joint development, encompassing the civilian application of unmanned aerial vehicles and military transport aircraft. Moreover, the acquisition of core technologies for materials, components, and equipment and the development of technologies to address global environmental regulations are critical objectives. These efforts aim to transform South Korea into a global production hub for future aviation technologies.

Conclusion: Challenges Ahead for South Korea's Space Policy

A catching-up strategy has been adopted by South Korea in the past to achieve success, and the same strategy has been used in space as well. Governments introduced and industry quickly imitated technologies and best practices that advanced countries had invested considerable resources and time in discovering, resulting in rapid results. KARI is an excellent example of a government research institute that has developed a number

[15] Jeff Foust, "South Korea's New Space Agency Outlines Plans," SpaceNews, July 20, 2024 ~ https://spacenews.com/south-koreas-new-space-agency-outlines-plans.

of satellites and launch vehicles in low-earth orbit and geostationary orbit within a relatively short period of time.

In contrast with the typical catching-up scenario, which involves the exploration and cultivation of markets and development paths by leading players in advanced countries, the phase that follows the catching-up phase entails innovation activities. In this phase, latecomer countries must establish new technological trajectories for innovation within a changing competitive environment in which imitation opportunities are limited. Moving forward, South Korea's space policy aims to transition from a catching-up strategy to taking a leading role in space innovation. The focus will be on conducting original R&D, fostering international collaborations, and establishing the country as a pioneer in space technology. By prioritizing long-term investments in advanced space technologies and encouraging a culture of creativity and independent innovation, South Korea seeks to become a major player in the global space industry.

Despite its recent success, South Korea's space policy faces three challenges as it seeks to enter this new phase. The first challenge pertains to the organizational efficiency of the space agency. In addition to elevating the chairperson of the National Space Committee from the prime minister to the president, a professional and flexible networked operational system is proposed. KASA serves as the National Space Committee's secretariat and control tower responsible for space and aviation activities. It is imperative to centralize space and aviation-related functions, which are currently distributed across the Ministry of Land, Infrastructure and Transport; the Ministry of Trade, Industry and Energy; and the Ministry of Science and ICT, under the purview of KASA. Additionally, it is essential to delineate the R&D activities of institutions such as KARI and KASI to avoid redundancy.

A second challenge South Korea faces is in transforming its space agency into a catalyst for economic growth in line with its goals of becoming a world-class space power by 2045. According to the Space Industry Survey 2023, 422 firms are involved in space development and have a market share of approximately less than 1%.[16] The space agency is intended to foster the growth of 2,000 companies and increase market share to 10%. It also aims to accomplish a lunar landing by 2032 and Mars exploration by 2045, as outlined by the Ministry of Science and ICT. In order to achieve these goals, a systematic organizational structure needs to be established, roles

16 Ministry of Science and ICT (South Korea), "2023 ujusan-eop silt'ae josasa" [The Space Industry Survey 2023], December 29, 2023 ~ https://www.msit.go.kr/bbs/view.do?sCode=user&mId=244&mPid=243&bbsSeqNo=65&nttSeqNo=3017412.

must be delineated, specialized personnel must be recruited, budgets must be allocated, legal and institutional frameworks must be established, and international cooperation projects must be identified.

As a final challenge, the space agency needs to be adapted to the South Korean context and modeled after the Toulouse Space Center. This adaptation requires extensive research and analysis to be aligned with the unique circumstances of South Korea. As part of the EU framework, the Toulouse Space Center cooperates with European entities such as the German Aerospace Center and France's European Aeronautic Defense and Space Company to facilitate technological development and financial support in France. However, significant differences exist between France and South Korea in terms of geography, geopolitics, industry, and technology. South Korea is the only nation in the world that is divided from its northern half. In contrast with the relatively homogeneous European environment, neighboring countries in Northeast Asia have significant disparities in economic, technological, and industrial development. Therefore, it is imperative to develop a strategy that accounts for these diverse factors on both a national and international scale. ◈

Canada's Next Frontier: Connecting Commercial Capabilities to a National Strategy

Brian Gallant and Jordan Miller

The extent to which space affects our daily lives and our collective quality of life here on Earth is hard to comprehend. Indeed, space has an impact on us all—daily—by enabling GPS navigation, weather forecasting, telecommunications and broadband connectivity, banking, air traffic control, and disaster response, only to name a few contributions from space technology and innovations.

The multitude of functions from space explains in part how the global space sector is growing at such a fast pace and is poised to accelerate in the coming decades. In 2021 the global space sector was worth an estimated $370 billion. By 2030 that figure is expected to rise by 74% to $642 billion,[1] and it is projected by some to grow further to $2 trillion by 2040.[2] The global space market is currently dominated by the United States, with $62 billion in annual expenditure, followed by China ($11.9 billion), Japan ($4.9 billion), France ($4.2 billion), and Russia ($3.4 billion).[3] Canada ranks twelfth globally at roughly $540 million, with significant potential for growth.[4] If Canada were to increase its share of the space economy to match its proportion of the global economy—a quite reasonable goal—the country's share of the global space economy could be worth up to $40 billion by the year 2040.[5]

With increasing global demand for space solutions and a growing domestic space industrial base, Canada is well positioned to expand its

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BRIAN GALLANT is the Chief Executive Officer of Space Canada and a frequent business and political media commentator (Canada). He was the 33rd premier of New Brunswick. He is also a board member of the Asia Pacific Foundation of Canada. He can be reached at <brian@space-canada.ca>.

JORDAN MILLER is a PhD candidate at the Royal Military College of Canada and works in the defense and space industry (Canada). He is also Vice-Chair of Space Canada's Public Policy and Advocacy Committee.

1 Euroconsult, "Euroconsult Estimates That the Global Space Economy Totaled $370 Billion in 2021," Press Release, January 11, 2022 ~ https://www.euroconsult-ec.com/press-release/euroconsult-estimates-that-the-global-space-economy-totaled-370-billion-in-2021.

2 Deloitte, "Reaching Beyond: A $40 Billion Canadian Space Economy by 2040," 2023 ~ https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/ca-reaching-beyond-AODA.pdf.

3 Euroconsult, "Euroconsult Estimates That the Global Space Economy Totaled $370 Billion in 2021."

4 Ibid.

5 Deloitte, "Reaching Beyond: A $40 Billion Canadian Space Economy by 2040."

commercial innovations for consumers both at home and around the world. Achieving this goal will require enhancing incentives for turning innovative ideas into in-service solutions; forming strong partnerships within Canada for a national vision that includes commercialization; and building and sustaining partnerships with friends and allies around the world.

Canadian Space Activities

Canada has a long legacy of being a spacefaring nation. The Department of National Defence supported the development of the Alouette-I satellite to monitor the Earth's ionosphere. Canada was the third nation to fully design and manufacture its own satellite, which was successfully launched into space in September 1962.[6] A Canadian invention, Canadarm, went into orbit in 1981 on the *Columbia* space shuttle, and in 1998 it was used to move, manipulate, and connect modules that make up the International Space Station. Canada also sent researchers to the International Space Station to support human health and science research in a micro-gravity environment.

Canada's space sector is highly diversified, including researchers, academics, small and medium-sized businesses, and large publicly traded companies delivering capabilities across the full range of space applications. Canadian companies provide satellite telecommunications and broadband capabilities in space and on the ground, including upcoming low-earth orbit (LEO) constellations, which will enhance connectivity opportunities to rural and remote communities around the world. Sensing and earth-observation capabilities monitor weather on Earth, provide early warning for floods and wildfires, and track the movement of ice floes and sea levels. The Canadian agriculture sector benefits from space technology, with sensing technologies monitoring crop health and the potential for new arable lands, and GPS enabling the more precise use of vehicles and drones. Reliable GPS accessibility is also essential for autonomous vehicles that rely on space systems for positioning, navigation, and timing.

Sensing capabilities are also tracking greenhouse gas emissions to measure and monitor the impacts of climate change. For space exploration, Canadian companies are delivering world-leading robotics, command-and-control technologies for space vehicles, and deep-space research capabilities. Leading-edge technologies for health, mining, and manufacturing in space are being developed to sustain human life

6 More information on the Alouette-I and -II satellites is available from the Canadian Space Agency at https://www.asc-csa.gc.ca/eng/satellites/alouette.asp.

in space, with significant potential for applications on Earth to support life in remote places. For defense and national security, Canadian companies develop and deliver sensing and communications technologies to detect threats to sovereignty at home and to provide vital data and communications support to missions abroad.

Space and cybersecurity are becoming more connected and cannot be ignored when we think about space capabilities. Both electronic jamming and cyberattacks on space infrastructure on Earth and in orbit present significant challenges for the future of space. For instance, a suspected wiper malware attack on modems and routers in the Viasat KA-SAT satellite network cut service for tens of thousands of people in Ukraine and Central Europe and eliminated the remote-monitoring capability of 5,800 wind turbines generating power in Germany.[7] With an increasing amount of the world's cyber infrastructure in space, cybersecurity must be considered for all space capabilities.

Canada's Interests and Ambitions

Canada is pursuing its space interests through the Canadian Space Agency (CSA) and through national defense programs. The country committed $1.1 billion to continue its role in the International Space Station until 2030.[8] For humanity's return to the Moon, Canada has committed to developing the Canadarm3 for Gateway (a lunar space station); committed to develop, launch, and operate a rover for exploring the Moon; committed to two astronaut flights to the Moon as part of the Artemis mission; and launched the Lunar Exploration Accelerator Program (LEAP) to support development of new and innovative technologies for lunar exploration.[9]

For deep-space imaging and exploration, Canada provided the fine-guidance sensors and near-infrared imager and slitless spectograph for the James Webb Space Telescope though a network of universities and National Research Council laboratories, and it will have access to Webb's

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7 CyberPeace Institute, "Case Study: Viasat," June 2022 ~ https://cyberconflicts.cyberpeaceinstitute.org/law-and-policy/cases/viasat.

8 Canadian Space Agency, "Significant Investments to Further Propel Canadian Space Exploration," March 23, 2023 ~ https://www.asc-csa.gc.ca/eng/news/articles/2023/2023-03-29-significant-investments-to-further-propel-canadian-space-exploration.asp.

9 Canadian Space Agency, "Canada's Role in Moon Exploration," June 12, 2024 ~ https://www.asc-csa.gc.ca/eng/astronomy/moon-exploration/canada-role.asp.

observation time.[10] For health in space, the CSA's Connected Care Medical Module is supporting the development of innovative and sustainable medical solutions for LEO and for deep space, allowing astronauts to travel farther into space with access to health services.[11]

For large programs focused on Earth, Canada has provided support to the Lightspeed program that will bring LEO broadband connectivity to Canadians. It has also committed to the next generation of Earth observation by pledging over $1 billion to RADARSAT 3, which will improve tracking of wildfires and the impacts of climate change.[12] For defense and national security, Canada presented plans for continental defense modernization in its defense policy *Our North, Strong and Free*. The document commits to polar over-the-horizon radar, surveillance from space and of space, advanced command-and-control systems, an arctic landing station, satellite communications, space-based navigation and timing infrastructure for Canada's north, and the necessary basing and infrastructure to sustain those capabilities.[13] The country is also making strides toward a domestic commercial space launch capability, allowing both the government and Canadian companies to launch satellites at home rather than relying solely on foreign launch providers.[14]

Missing from Canada's vision is a meaningful role for the commercial space sector. Most of the innovation for space is currently being driven by companies providing commercial capabilities. This is not an argument for less civil or defense investment. Instead, the salient point is how Canada's current strategic vision and policies could be bolstered by finding a meaningful role for the commercial space sector, including in supporting civil and defense programs with dual-use and dual-purpose technologies. Commercial capabilities are vital to the future of space and should be part of Canada's national strategic vision for space. They are certainly embedded in the national strategies of many of the country's allies.

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10 Canadian Space Agency, "Canada's Role in Webb," December 15, 2023 ~ https://www.asc-csa.gc.ca/eng/satellites/jwst/canada-role.asp.

11 Canadian Space Agency, "Connected Care Medical Module (C^2M^2)," February 5, 2024 ~ https://www.asc-csa.gc.ca/eng/funding-programs/health-beyond-canadian-flagship-c2m2.asp.

12 "Canada to Invest C$1.1 Bln in Satellite Tech for Better Earth Data," Reuters, October 18, 2023 ~ https://www.reuters.com/technology/space/canada-invest-c11-bln-satellite-tech-better-earth-data-2023-10-18.

13 Department of National Defence (Canada), *Our North, Strong and Free: A Renewed Vision for Canada's Defence* (Ottawa, 2024) ~ https://www.canada.ca/en/department-national-defence/corporate/policies-standards/our-north-strong-free-renewed-vision-canada-defence.html.

14 Transport Canada, "Government of Canada Supports Commercial Space Launches in Canada," Press Release, January 20, 2023 ~ https://www.canada.ca/en/transport-canada/news/2023/01/government-of-canada-supports-commercial-space-launches-in-canada.html.

Canada's Objectives

Canada's current space objectives are focused on space exploration and national defense programs. The country has committed to a wide range of robotics, health, space exploration, national defense, and research programs, as discussed above. However, the central limitation of these objectives is that they focus on capabilities that Canada will own and operate. A strategic vision for how Canada will connect the commercial sector to its space enterprise—including civil, defense, and commercial sector roles—would help elevate the Canadian space ecosystem to new heights.

Budget 2024 committed to the creation of the National Space Council to "establish a new whole-of-government approach" that will "enable the level of collaboration required to secure Canada's future as a leader in the global space race, addressing crosscutting issues that span commercial, civil and defence domains."[15] This is a positive step that allows Canada to better organize space priorities domestically, including the integration of the commercial domain into a whole-of-government approach, and signals its commitment to global partners and allies. During the Trump administration, the United States in 2017 re-established a similar body, also called the National Space Council, to coordinate its space strategy and policy. This initiative was continued by the Biden administration, signaling the bipartisan nature of support for space.

The challenge now is to connect the commitment for the National Space Council to a national strategic vision that includes the industrial base in a meaningful way. Many of Canada's allies and partners have already connected their civil, defense, and commercial sectors together through strategic policy documents, underlining how commercial sector capabilities will support a broader vision. Australia, the United Kingdom, and the United States have all done this though strategic policy documents and frameworks for space. For Canada to get the most out of its National Space Council and space industrial base, a comprehensive strategic vision that includes the commercial sector—and focuses on the commercialization of new space capabilities across sectors—is required.

Value-Added Technology

There is significant value and potential to unlock in Canada's space industrial base. The space sector is very R&D-intensive, with eighteen

[15] Department of Finance (Canada), "Budget 2024: Fairness for Every Generation," 2024, 176 ~ https://budget.canada.ca/2024/report-rapport/budget-2024.pdf.

times as much investment as in other manufacturing sectors.[16] The country also contributes to innovation for space through partnerships with post-secondary education research centers. Canadian companies deliver meaningful return on those investments, generating an average of 2.21 times the revenue on research investments.[17]

These investments are important because the future of space technology relies on innovation and commercialization of new capabilities. Sustaining human exploration of space—including returning to the Moon and striving to put humans on Mars—will demand new capabilities. Healthcare for humans traveling into space is non-negotiable. Access to healthcare when needed is essential to successfully completing a mission and protecting astronauts. Sustaining missions will also require things such as agriculture in space, manufacturing of spare parts and tools, the potential for mining and harvesting material from planet surfaces, and maintenance of secure communications and data flows with Earth throughout the exploration process.

Moreover, new and more powerful sensing technologies and higher-capacity space-based broadband and communications technologies will allow humans to understand more about our planet and connect more people to the internet. Better early warning on changes to the planet—and the threat of natural disasters—will allow for risk mitigation and help save lives. Greater internet connectivity will enable people in remote and rural areas to participate in the global economy and access more digital services, narrowing the global digital divide.

These ambitions will require technology that is currently in development as well as technology that has been only imagined and not yet invented. The R&D and commercialization processes will be what connects imagination with delivery. Canada's space industrial base is well equipped to meet this challenge.

Global Space Governance

The rules that states and companies play by in space will likely need to be continuously strengthened as human ambition for space grows. Current space governance rests largely on the UN Outer Space Treaty,

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16 "Three…Two…One…Space Canada Lifts Off!" Space Canada, Press Release, March 3, 2022 ~ https://space-canada.ca/media/2022/03/three-two-one-space-canada-lifts-off.

17 Canadian Space Agency, "2021 & 2022 State of the Canadian Space Sector: Facts and Figures, 2020 & 2021," Report, 2023 ~ https://www.asc-csa.gc.ca/pdf/eng/publications/2021-2022-state-canadian-space-sector-facts-figures-2020-2021-v2.pdf.

which emphasizes peaceful use of space, free use of space by all states, no possible claim to sovereignty over space, and the responsibility of states for their actions and the actions of companies based in them.[18] However, the term "peaceful use" is poorly defined and provides incentives for a broad interpretation of what constitutes "peaceful" to veil aggressive or disruptive acts against others. This ambiguity provides a "gray zone" of governance wherein the ambiguity of language allows for the spirit of a treaty to be challenged by aggressive behavior without clearly violating the letter of the treaty.[19] The Outer Space Treaty was written in 1967 when space technology was largely limited to communications satellites orbiting Earth. Humanity had not yet gone to the Moon, invented the internet, or made satellite imagery available to any person with a smartphone or a laptop. The governance structure for the future of space clearly needs modernizing.

Making any progress on space governance presents a massive challenge. Some countries have stated ambitions to put nuclear weapons in space as another layer of deterrence and second-strike capability.[20] Others are reported to have robotic capabilities onboard satellites to allow physical disruption or destruction of other satellite capabilities while in orbit through "close rendezvous" in space.[21] The risk of "dazzling" or other means of electronic interference with electro-optical sensors to deny service, or even the destruction of components onboard satellites with energy from Earth, is growing as competition in space grows.[22] Implementing new governance measures, however, requires consent from all parties to a new treaty or agreement. Based on the examples above, states engaging in hostile acts in space are arguably satisfied with the current governance structures and will continue to exercise a

18 UN Office for Outer Space Affairs, "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies," 1967 ~ https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html.

19 Jessica West and Jordan Miller, "Clearing the Fog: The Grey Zones of Space Governance," Centre for International Governance Innovation, CIGI Papers, no. 287, November 2023 ~ https://www.cigionline.org/publications/clearing-the-fog-the-grey-zones-of-space-governance.

20 Clementine G. Starling-Daniels and Mark J. Massa, "Russian Nuclear Anti-Satellite Weapons Would Require a Firm U.S. Response, Not Hysteria," Atlantic Council, February 15, 2024 ~ https://www.atlanticcouncil.org/blogs/new-atlanticist/russian-nuclear-anti-satellite-weapons-would-require-a-firm-us-response-not-hysteria.

21 Robert Beckhausen, "China's Mystery Satellite Could be a Dangerous New Weapon," Medium, August 22, 2013 ~ https://medium.com/war-is-boring/chinas-mystery-satellite-could-be-a-dangerous-new-weapon-630a858923ec.

22 U.S. Defense Intelligence Agency, *2022 Challenges to Security in Space: Space Reliance in an Era of Competition and Expansion* (Washington, D.C., 2022) ~ https://www.dia.mil/Portals/110/Documents/News/Military_Power_Publications/Challenges_Security_Space_2022.pdf.

broad interpretation. States engaged in this kind of behavior are unlikely to give up those capabilities without a strong incentive.

Improved governance should be pursued by states that see value in more comprehensive rules, even if not all states are party to the process. Incremental gains in strengthening governance are preferable to larger change that is unlikely to be realized. The Artemis Accords are a good example of this approach, where principles were defined among nations on space exploration. The Artemis Accords reaffirmed states' commitment to using space peacefully and transparently, creating interoperability for space exploration systems, providing mutual emergency assistance, registering space objects, deconflicting activities, preventing orbital debris, allowing for data sharing, and protecting space heritage.[23] With 45 signatories, including Canada, India, Japan, South Korea, and Singapore, the Artemis Accords are an example of countries voluntarily agreeing to adopt common guidelines and principles for space governance. Improved space governance has implications for daily space activities too. Safety for orbital pathways, collision avoidance, appropriate distances between satellites, and launch and de-orbiting protocols are important today for the safe use of space and will become increasingly important as the pace of new satellite launches accelerates.

International Collaboration

The future of space is collaborative, and many of the big ambitions have been collaborative for decades. Collaboration is no longer optional between government and the commercial space sector. The U.S Space Force, for example, recently established the Commercial Space Office to better leverage commercial innovations that have defense and security applications.[24] This will enable greater engagement with commercial innovators to bring the best and latest technologies forward. Canada has followed suit by creating the Commercial Integration Cell with the Royal Canadian Air Force to share relevant information with industry partners in a more timely fashion.[25] In an address to the entire U.S. Space Force, General Chance Saltzman, chief of space operations, was clear: "The simple

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23 "The Artemis Accords," NASA, 2020 ~ https://www.nasa.gov/artemis-accords.

24 Linda Kane, "Commercial Space Office Brings Unity of Effort to Industry Collaboration," U.S. Space Force, Space Systems Command, June 1, 2023.

25 Department of National Defence (Canada), "Establishment of 7 Wing (Space)'s Commercial Integration Cell," May 30, 2024.

fact is we can't succeed without allies and partners. Operations in space are too complex, too risky, and too variable for us to go it alone…we depend on commercial partners for technical acumen and a robust industrial base."[26] Bringing expertise and facilitating innovation, commercial space providers are central to the success of space force operations. Partners, including the commercial sector, are a vital part of the delivery team.

For non-defense applications, collaboration with partners should be expanded. The speed at which innovation and commercialization are happening means that no country can do everything itself. Collaboration between partners has the potential to accelerate the pace of commercialization of new technologies, expanding the horizons of what is possible in space and what space can do for the quality of life here on Earth.

Conclusion

The space sector is growing at an exceptional pace and is poised to continue in that direction. This means that Canada needs to be ready now. For space exploration, it has committed to the Artemis mission and will be sending an astronaut to orbit the Moon as well as providing ongoing support for the International Space Station and the James Webb Space Telescope program. For national defense, Canada has committed to the modernization of its continental defense with space capabilities and to greater defense-commercial collaboration on developing future capabilities.

Currently, the main limitation to Canada's space enterprise is an absence of a strategic vision and policy framework that includes the private sector and commercialization of new technology. Many of Canada's allies and partners have developed national strategies that include the private sector, with a clear vision for how they will collaborate. The announcement of the National Space Council in the 2024 budget was a positive step for Canada. However, there is still a clear need for developing a national strategic vision for space and for integrating commercial capabilities specifically. Greater collaboration with the commercial sector would promote new technologies and strengthen Canada's global position in space. Canada should also expand collaboration with its partners around the world. More international collaboration is a net benefit to the entire space sector, stimulating innovation and accelerating the pace of commercialization.

[26] Chance Satlzman, "CSO Notice to Guardians. SUBJECT: Integrated by Design (UNCLAS)," U.S. Space Force, July 12, 2024.

Building stronger relationships with partners also lowers the barriers to expanding governance measures by building durable, trusted relationships.

Canada is right to continue investing in its space ambitions and capabilities and would be well served to further prioritize space moving forward. It is difficult to overstate the significance space has in our daily lives, with multiple touchpoints daily. The Organisation for Economic Co-operation and Development (OECD) observes that "it can be difficult to express the effects of space activities in quantitative units. Earth observation, national security applications, space exploration and science, for example, are all associated with considerable intangible social and strategic benefits."[27]

The global space economy continues to grow at an exceptional pace, capturing the imagination of young and old alike and challenging us to think about what the future may hold and the role space will play. As the OECD rightfully points out, "The Moon landing is one of the most iconic events of the 20th century and is thought to have inspired an entire generation of scientists."[28] That is indeed an important contribution to our collective quality of life. ◈

[27] OECD, *OECD Handbook on Measuring the Space Economy*, 2nd edition (Paris: OECD Publishing, 2022).

[28] Ibid.

Australia's Maturing Space Capabilities in a National and Regional Context

Cassandra Steer

In Australian popular culture, there is a love of stories that reflect the underdog rising up to meet gargantuan challenges or scoring the single goal that changes the direction of a competition in an unexpected was. The same is true of Australia's identity as a space nation. It does not have any sovereign space missions, nor any sovereign launch capability (the current development of commercial spaceports are focused on foreign and commercial launch vehicles) and the only Australians to have flown in space thus far did so under dual U.S. citizenship, not wearing an Australian flag. Given that national narratives of space often center on pride in major achievements, such as rocket launches and sovereign space missions, or individual astronauts, Australia's national space narrative is harder to identify. The country also lacks a clear national policy as to the importance of space capabilities to its larger interests, unlike other space middle powers such as Canada, Japan, South Korea, or the United Kingdom.[1] Yet if we consider space systems to be made up not only of assets in space (the space segment) but also of the ground segment (such as satellite dishes and space situational awareness), the data segment (the link between satellites and the ground, as well as management of data integrity), and the human segment (operators, users, and ordinary citizens who depend in so many ways on space-based services), it is in these three support segments that Australia excels. Satellite dishes and data processing are not as exciting as rockets and astronauts, and so there is far less public awareness of these activities. However, there is a quiet sense of contributing in critical yet often unseen ways, which is arguably at the core of Australia's identity as a space nation.

As a reflection of this identity, in the first-ever comprehensive study of Australian opinions on and understanding of space, undertaken in 2023 by the Australian Centre for Space Governance, only 16.7% of those

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CASSANDRA STEER is Chair and Founder of the Australian Centre for Space Governance and Deputy Director (Mission Specialists) at the Australian National University Institute for Space (Australia). Globally recognized for her expertise in space law, governance, and security, she has consulted for the Australian, Canadian, and U.S. governments on these issues. She can be reached at <cassandra.steer@anu.edu.au>.

[1] Cassandra Steer, "Who Is Australia in Space? The Need for a National Space Policy," in "Regional Commentary: The Foundations of Australia's Space Policy," ed. Tristan Moss, Griffith Asia Institute, 2023 ~ https://www.spacegovcentre.org/_files/ugd/cd297f_9445fef3435740329ec6a15c62c6495c.pdf.

surveyed knew that in 1967 Australia became the third country to launch its own satellite from its own territory, and only around 36% had heard of Australian-born astronauts Andy Thomas and Paul Scully-Power.[2] Indeed, nearly 20% of those surveyed did not know that Australia has its own space agency.[3] By contrast, over 58% were familiar with the 2001 film *The Dish*, which tells the story of how Australia provided mission communications and public TV images for the *Apollo 11* Moon landing in 1969 from a small setup in an isolated, rural setting—and briefly lost all contact, although it did not tell the mission control center in Houston that it had.[4] This film has become part of Australian pop culture because it tells the story of an underdog's crucial role in enabling the world's most powerful nation to achieve the first human lunar landing—something that it could not have done on its own. Still today, the majority of Australia's space actors across government, industry, and academia contribute in ways that are largely unknown to the public but absolutely critical to the success of global efforts.

As Australian space historian Tristan Moss makes clear, Australian leaders have made policy decisions over the decades that have been deliberately limited, pragmatic, and based heavily on defense or strategic alliance interests.[5] They have consistently decided not to invest in a large national space program but to continue to lean on Australia's international partnerships for the nation's space service needs, such as earth-observation (EO) data, satellite communications, and position, navigation, and timing (PNT). With the establishment of a small Australian space agency in 2018 and a space command within the Department of Defence in 2022, there has been an uplift of the Australian space industry and research. But there is still a great deal of debate across the industry and research sectors as to what the country's priorities should be and whether it has done enough to invest public money into space technologies. Australia still lacks a strong, coordinated national approach, and its emerging identity as a space nation is nascent. In both respects, Australia would benefit from an explicit national policy statement regarding the investments it has made into the ground and

2 Tristan Moss, Kat Robison Hasani, and Aleksandar Deejay, "Looking Up from Down Under: Australian Attitudes to National Space Activities," Australian Centre for Space Governance, 2023, 20 ~ https://www.spacegovcentre.org/_files/ugd/ed2eed_d028d1b713fe425d98f0ecb0064c1329.pdf.

3 Ibid., 7.

4 Rob Sitch, *The Dish* (Australia, Working Dog Productions, 2000), film.

5 Tristan Moss, "'There Are Many Other Things More Important to Us Than Space Research': The Australian Government and the Dawn of the Space Age, 1956–62," *Australian Historical Studies* 51, no. 4 (2020): 442–58.

data segments over the decades.[6] The medium- and long-term future holds enormous potential for Australia as a space middle power, particularly in terms of what it can contribute to the Indo-Pacific's needs.

Investing in International Partnerships

There is a myth which persists that Australia "gave up" on international opportunities in space after the 1960s. Following the use of the South Australian Woomera site for British and U.S. rocket tests, it took great efforts on the part of the United Kingdom to convince Australia to contribute this site to the European Launcher Development Organisation (ELDO), the predecessor to the European Space Agency. After some early ELDO rocket tests, the Australian government at the time did not see sufficient benefits to justify the large costs of continuing to invest in this infrastructure, and the sentiment in the Department of the Prime Minister and Cabinet was that "there are many other things more important to us than space research."[7] Australia withdrew from the ELDO in 1966, a decision which has been criticized domestically, including during parliamentary hearings in 2008 and 2020 on Australia's future direction in space.[8] However, there is less public awareness of continued strategic federal investment in space research and infrastructure in partnership with other countries.

Rather than having given up on space, Australia has emerged as a world leader in the ground and data segments—capabilities that it provides in return for provision of EO, communication, and PNT capabilities from its international allies and partners. In the 1960s the Bureau of Meteorology first installed weather satellite receivers, NASA tracking facilities were established in Western Australia and the Australian Capital Territory—including "the dish" at Honeysuckle Creek that provided communications, data, and TV images of the *Apollo* Moon landing—and a significant federal investment of 4.5 million pounds was made into the establishment of Intelsat after the government determined that Australia's communication

6 Brett Biddington, "Is Australia Really Lost in Space?" *Space Policy* 57 (2021): 101431; and Steer, "Who Is Australia in Space?"

7 Moss, "'There Are Many Other Things More Important to Us Than Space Research,'" 456.

8 "Lost in Space? Setting a New Direction for Australia's Space Science and Industry Sector," Senate Standing Committee on Economics (Australia), November 12, 2008 ~ https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Completed_inquiries/2008-10/space_08/report/index; and "The Now Frontier: Developing Australia's Space Industry," Standing Committee on Industry, Innovation, Science and Resources (Australia), November 2021 ~ https://www.aph.gov.au/Parliamentary_Business/Committees/House/Former_Committees/Industry_Innovation_Science_and_Resources/SpaceIndustry/Report.

needs were growing far beyond its domestic capacity. U.S. defense satellite tracking facilities were also established at Pine Gap and Nurrungar, which has led to ongoing benefits to Australia in terms of national security intelligence data.[9]

Australia's geography is exceptional for tracking stations, downlink satellite dishes, and space situational awareness (tracking and monitoring space traffic and debris) because of its large, sparsely populated areas and the resulting dark, quiet skies. Yet its comparatively small population means that there is a relatively small public budget for large technology infrastructure. Successive governments have therefore determined that rather than build sovereign space missions, Australia can continue to benefit from space services provided by others and instead invest in ground and data segments. Indeed, the only explicit national space policy that Australia has adopted, the 2013 Satellite Utilisation Policy, highlights that the country cannot continue to rely on others without contributing to global infrastructure, and that "the most effective contributions Australia can make are nationally coordinated offers in areas of niche Australian strength, particularly in ground infrastructure and in the application of space information to achieve cost effective outcomes."[10]

This is one of the reasons two federal government agencies, Geoscience Australia and the Commonwealth Scientific and Industrial Research Organisation (CSIRO), have managed large satellite dishes for the downlink of EO data from U.S., European, and Japanese programs for many years. As a result, Australia has established itself as the world's leading custodian of EO data—from processing and managing different sources and forms of this data, to quality control through calibration and validation, to redistributing EO data globally to others.[11]

For example, Australia has been a beneficiary of the U.S.-led Landsat EO program for over four decades. Early iterations were only available to smaller countries if they could afford to purchase and knew how to process the Landsat data. The U.S. Geological Survey (USGS) Landsat archive was made freely and openly available in 2008, and Geoscience Australia created

9 Tristan Moss, "'Consider Carefully the Best Use of Our Limited Resources': Australian Space Policy, 1960–72," *Australian Journal of Politics and History* (2024): 1–18.

10 Quoted in Steven Freeland, "The Final Piece of the Puzzle: The Launch of Australia's Satellite Utilisation Policy 2013," *German Journal of Air and Space Law* 62, no. 3 (2013): 439.

11 See "Digital Earth Australia," *Geoscience* (Australia) ~ https://www.ga.gov.au/scientific-topics/dea; and "Earth Observation Calibration and Validation," Commonwealth Scientific and Industrial Research Organisation (CSIRO) ~ https://www.csiro.au/en/research/technology-space/astronomy-space/calval.

the Unlocking the Landsat Archive project, which led to the creation of the DataCube, in collaboration with CSIRO, to make archived Landsat data available, accessible, and manageable for Australian purposes.[12] Australia then led the partnership with other countries and stakeholders through the nongovernmental Committee on Earth Observation Satellites (CEOS) to develop the global Open Data Cube, which is a nonprofit that provides open source EO data freely to all users and aims to support global priorities such as the sustainable development goals.[13] With the newest iteration of Landsat Next, which adds three new satellites, ten times as much data, and significantly higher resolution, there is an even greater need for processing, management, quality control, and distribution of this data to those who need it globally. This is the role that Australia has committed to take on.[14] Similarly, CSIRO, Geoscience Australia, and some state governments collectively support the Copernicus Australasia Regional Data Hub, which provides free, open, trusted, and reliable access to European EO data for Australasia, Southeast Asia, the South Pacific, the Indian Ocean, and the Australian Antarctic Territory.[15]

Early computing and storage limitations meant it was impossible for the wealth of all Landsat data that had been captured over decades to be centrally stored. Instead, a network of receiving stations around the world was operated by a community of international cooperators, where the data was locally downlinked and stored on tapes, with no consolidated efforts to ensure that the data was being preserved or accessible. The USGS, which leads Landsat, had no way of knowing how many images had been downlinked globally and no way to access this data. In 2010 it launched the Landsat Global Archive Consolidation initiative, with Australia taking a lead role in accessing and digitizing data stored in Indonesia, Thailand, and other Indo-Pacific nations, as a form of data aid.[16] As a result of the initiative,

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12 Adam Lewis et al., "The Australian Geoscience Data Cube—Foundations and Lessons Learned," *Remote Sensing of Environment* 202 (2017): 276–92; and "The Open Data Cube," Geoscience (Australia), June 18, 2024 ~ https://www.ga.gov.au/scientific-topics/dea/about/open-data-cube.

13 Open Data Cube ~ https://www.opendatacube.org.

14 "Joint Statement on Australia-U.S. Ministerial Consultations (AUSMIN) 2024," U.S. Department of Defense, August 6, 2024 ~ https://www.defense.gov/News/Releases/Release/article/3863759/joint-statement-on-australia-us-ministerial-consultations-ausmin-2024; and Cassandra Steer, "Australia Just Committed $207 Million to a Major Satellite Program. What Is It, and Why Do We Need It?" Conversation, March 27, 2024 ~ http://theconversation.com/australia-just-committed-207-million-to-a-major-satellite-program-what-is-it-and-why-do-we-need-it-226621.

15 Copernicus Australasia Regional Data Hub ~ https://www.copernicus.gov.au.

16 Kristi Kline, "WGISS-41 Data Preservation: Landsat Global Archive Consolidation" (41st Meeting of the Working Group on Information Systems and Services, Canberra, March 14–18, 2016) ~ https://ceos.org/document_management/Working_Groups/WGISS/Meetings/WGISS-41/1_Monday%20(3.14)/2016.03.13_15.30_LGAC.pptx.

many regions have markedly improved Landsat data coverage, which means that they can better monitor change and capture historic conditions.[17] The data provided the baseline carbon measurements that were the basis of the Kyoto Protocol and other agreements to reduce carbon emissions. Australia then established the International Forest Carbon Initiative to assist Indo-Pacific nations in implementing national carbon accounting schemes modeled on that established by the Department of Climate Change and Energy Efficiency.[18]

With the signing of a Landsat Next partnership in 2024, Australia has promised to continue to be a steward of EO data and to "provide critical ground station infrastructure, personnel, services and science in support of the Landsat Next mission" in return for a guarantee that the data will remain freely accessible in the Indo-Pacific region, "empowering regional users to access highly advanced datasets, cutting-edge science, informed insights and user-friendly platforms to support evidence-based decision making on economic, social and environmental opportunities and challenges."[19]

Australia engages in strong bilateral space cooperation with the UK, as illustrated by the Space Bridge, which provides funding for industry partnerships between the two countries.[20] But the driving partnership in space for Australia is still with the United States, which is Australia's closest ally. The two countries have both historical defense ties and contemporary civil ties.

On the civil side, Australia was one of the original seven signatories to the Artemis Accords in 2020, and Australian industry and researchers have won various grants and contracts to provide infrastructure to the Artemis program, including robotics, lunar rovers, and advanced communications. A joint statement by President Joe Biden and Prime Minister Anthony Albanese in 2023 highlighted the beginning of a new "innovation alliance." The statement explicitly referred to further space technology cooperation, such as "joint commercial investment across all sectors, including space

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17 Michael A. Wulder et al., "The Global Landsat Archive: Status, Consolidation, and Direction," *Remote Sensing of Environment* 185 (2016): 271–83.

18 J. Kingwell, V.M. Symour, and R.A. Coghlan, "A Comprehensive Satellite Archive to Support the International Forest Carbon Initiative (IFCI)" (paper delivered at the 15th ARSPC, 2010) ~ https://ecat.ga.gov.au/geonetwork/srv/api/records/a05f7892-f8d6-7506-e044-00144fdd4fa6.

19 Department of Industry Science and Resources (Australia), "Australia Joins United States on Landsat Next Satellite Mission as Core Partner," August 6, 2024 ~ https://www.industry.gov.au/node/93749.

20 Space Agency (Australia), "Three Years of the UK-AU Space Bridge," February 23, 2024 ~ https://www.space.gov.au/news-and-media/three-years-of-uk-au-space-bridge.

situational awareness and commercial space stations."[21] The signing of the Technology Safeguard Agreement in 2024 also indicated the desire for U.S. government and industry to bring its rocket and satellite technologies to Australia for launch or return. This is a particularly significant step forward for future point-to-point suborbital flights.[22]

On the defense side, Australian military personnel have benefited from the presence of U.S. space tracking stations in Australia for many years and have attended training at U.S. Space Command and (more recently) with the U.S. Space Force. Since the establishment of Australia's Defence Space Command in 2022, there are more officers who attend training or placements in the United States and take an active part in the space-focused Schriever Wargames. Australia is a member of the Combined Space Operations initiative, which expands on the long-standing Five Eyes intelligence-sharing agreement between Australia, Canada, New Zealand, the UK, and the United States to include space situational data sharing. In 2022 it adopted the Vision 2031 Statement, which commits the member states to being "partners in national security space operations leading as responsible actors and seeking and prepared to protect and defend against hostile space activities in accordance with applicable international law."[23] The initiative has expanded to include France, Germany, Italy, Japan, and Norway, signaling the increase in international space cooperation for security needs.

Australia and Space in the Asia-Pacific

The Australian government has always seen space technology cooperation as "a medium in which to achieve other policy ends, primarily security and diplomacy related."[24] This pragmatic, internationalist approach may be exactly what is needed in the second quarter of the 21st century as the Indo-Pacific becomes the central focus geopolitically. Australian strategic decisions about space investment in the Indo-Pacific region could act as a potential policy lever.

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21 "United States–Australia Joint Leaders' Statement: Building an Innovation Alliance," White House, October 25, 2023 ~ https://www.whitehouse.gov/briefing-room/statements-releases/2023/10/25/united-states-australia-joint-leaders-statementbuilding-an-innovation-alliance.

22 Space Agency (Australia), "Everything You Need to Know about the TSA" ~ https://www.space.gov.au/technology-safeguards-agreement-facts.

23 "Release of the Combined Space Operations Vision 2031 Statement," Department of Defence (Australia), February 23, 2022 ~ https://www.defence.gov.au/news-events/releases/2022-02-23/release-combined-space-operations-vision-2031-statement.

24 Tristan Moss, "History and Australia's Space Policy," in Moss, "Regional Commentary: The Foundations of Australia's Space Policy," 6.

A key diplomatic partnership is the Quad, consisting of Australia, India, Japan, and the United States. The partnership was established as a security dialogue in 2007 and later transformed into a broader diplomatic minilateral grouping.[25] At the leaders' summit in 2023, the Quad adopted its first-ever vision statement, which included a focus on how space-based applications can contribute to the central commitments of the Quad to address climate issues, maritime domain awareness, sustainable management of oceans and maritime resources, and space sustainability. As a result, the priority technology areas are EO and space situational awareness.[26] Commercial space cooperation was also highlighted as contributing toward the other commitments of the vision statement, such as critical and emerging technologies, technology standards, cybersecurity, maritime cooperation, and STEM education. This represents an explicit step toward greater space collaboration between these four partners, with an eye to strength and stability in the Indo-Pacific.

Australia has proved itself to be a trusted partner to various space powers in the region over time, including through a memorandum of understanding (MOU) with the Republic of Korea on "space cooperation for peaceful purposes."[27] While Australian and South Korean astronomers have worked in collaboration for many years, this 2021 MOU served to expand this collaboration into the space sector. Given South Korea's concern with North Korea's missile launches, this MOU can advance civil space cooperation as well as establish a strong foundation for space diplomacy partnership. Australia was also a key partner in Japan's Hayabusa2 science mission and provided the return landing site for a capsule that had successfully extracted samples from an asteroid.[28] Its ongoing partnership with these two Northeast Asian nations has foreign policy significance. Japan and South Korea are influential middle powers in the Indo-Pacific, and both nations explicitly recognize the importance of space technology for their aspirations and needs.

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25 Department of Foreign Affairs and Trade (Australia), "The Quad" ~ https://www.dfat.gov.au/international-relations/regional-architecture/quad.

26 "Quad Leaders' Summit Fact Sheet," White House, May 20, 2023 ~ https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/quad-leaders-summit-fact-sheet; and "Quad Leaders' Summit 2023: Space," Department of the Prime Minister and Cabinet (Australia) ~ https://www.pmc.gov.au/resources/quad-leaders-summit-2023/space.

27 "Memorandum of Understanding between the Australian Space Agency and the Republic of Korea's Ministry of Science and ICT," December 13, 2021 ~ https://www.space.gov.au/about-agency/publications/memorandum-understanding-between-australian-space-agency-and-republic-koreas-ministry-science-and-ict.

28 Space Agency (Australia), "Hayabusa2 Mission Accomplished," December 11, 2020 ~ https://www.space.gov.au/news-and-media/hayabusa2-mission-accomplished.

Similarly, as Australia's trade relationship with India grows, the two countries are building a strong partnership on space research. Several major bilateral grants were awarded in 2024 under the International India Space Investment Projects program for research on EO, space debris mitigation, and PNT.[29] In parallel, an MOU was signed between the Space Industry Association of Australia and the SatCom Industry Association India to foster greater industry collaborations in both countries.[30] One major direct partnership is the Space Mission for Australia-India's Technology, Research and Innovation, whereby NewSpace India Limited will launch an on-orbit servicing vehicle built by Australian company Space Machines in 2026.[31]

Further, in 2024, Australia is the host country for the Asia-Pacific Regional Space Agency Forum (APRSAF), a Japanese-led initiative to bring the civil space sectors across the region together. As host country, Australia seeks to increase its engagement in the region and build on past leadership roles, such as the establishment of Sentinel Asia, which is a regional exchange of EO data in situations of natural or climate disasters, to mirror the global Disaster Charter.[32] Sentinel Asia allows members of APRSAF to request EO data from any other members to assist in disaster response. The project also encompasses capacity-building for nations in the region. Building on its Aquawatch program to monitor water quality, Australia is now seeking to develop a similar arrangement for EO data sharing for water management.[33]

International Space Governance

While the focus of Australia's space initiatives is increasingly on the Indo-Pacific region, it has always played an important role in wider multilateral space governance. Australia was one of the founding member states of the UN Committee on Peaceful Uses of Outer Space, and an early adopter of the core space treaties. It is one of a small handful of countries

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29 Space Agency (Australia), "Boosting Australian-Indian Commercial Space Partnerships," April 30, 2024 ~ https://www.space.gov.au/news-and-media/boosting-australian-indian-commercial-space-partnerships.

30 Space Industry Association of Australia, "India and Australia Unite in Pioneering Space Collaboration," February 7, 2024 ~ https://www.spaceindustry.com.au/media_releases/india-and-australia-unite-in-pioneering-space-collaboration.

31 Space Agency (Australia), "Historic Signing to See India Launch Largest Australian-Made Spacecraft," June 27, 2024 ~ https://www.space.gov.au/news-and-media/historic-signing-to-see-india-launch-largest-australian-made-spacecraft.

32 Sentinal Asia, "About Sentinel Asia" ~ https://storymaps.arcgis.com/stories/ae487f74e92741c2b14bb396cc1e3cd7.

33 "AquaWatch Australia," CSIRO ~ https://www.csiro.au/en/about/challenges-missions/aquawatch.

that has signed all five treaties, including the Moon Agreement, which has only seventeen signatories. India, Mexico, and Australia are the only three countries to have signed both the Moon Agreement and the Artemis Accords, which arguably have competing interpretations on the legality of mining the Moon and other celestial bodies for resources.[34] While Australia has stated that it reads these two instruments as being in harmony with each other,[35] whether it will take a lead on the obligation under Article 11 of the Moon Agreement to establish a legal framework to govern these activities remains to be seen. Lunar mining will become feasible this decade.[36]

Australia has a reputation as a "norms entrepreneur" at the multilateral level and remains an active presence in international space forums. It participates in the Committee on the Peaceful Uses of Outer Space and UN space security discussions, demonstrating its commitment through several key actions: cosponsoring the 2020 General Assembly Resolution that established the Open-Ended Working Group on Reducing Space Threats, engaging proactively in this group's meetings from 2021 to 2023, and participating in the Group of Governmental Experts on the prevention of weapons in outer space in 2013 and 2024. In 2023 it made the unilateral commitment not to test direct-ascent anti-satellite weapons—a commitment that 37 countries have now made.[37] Building on its reputation for advancing gender-responsive approaches to broader security and arms control issues, Australia was also a cosponsor, together with the Philippines and the UN Institute for Disarmament Research, of an event that addressed the need for a gender lens in space security.[38] It is currently a driver, together

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34 Stefan-Michael Wedenig and Jack Wright Nelson, "The Moon Agreement: Hanging by a Thread?" *McGill Institute of Air & Space Law*, January 26, 2023 ~ https://www.mcgill.ca/iasl/article/moon-agreement-hanging-thread.

35 Legal Subcommittee of the UN Committee on Peaceful Uses of Outer Space, "Statement—Australia, Item 14, General Exchange of Views on Potential Legal Models for Activities in Exploration, Exploitation and Utilization of Space Resources," 2021 ~ https://www.unoosa.org/documents/pdf/copuos/lsc/2021/statements/item_14_Australia_ver.1_4_June_PM.pdf; and Legal Subcommittee of the UN Committee on Peaceful Uses of Outer Space, "Statement by Australia: Agenda Item: 9—General Exchange of Views on Potential Legal Models for Activities in the Exploration, Exploitation and Utilisation of Space Resources," April 24, 2024 ~ https://www.unoosa.org/documents/pdf/copuos/lsc/2024/Statements/4_Australia_as_delivered.pdf.

36 "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies," UN Treaty Series 1363, no. 23002 (1979), art. 11(5); and Melissa de Zwart, "To the Moon and Beyond: The Artemis Accords and the Evolution of Space Law," in *Commercial and Military Uses of Outer Space*, ed. Melissa de Zwart and Stacey Henderson (Singapore: Springer, 2021), 74.

37 Richard Marles, "Australia Advances Responsible Action in Space," Defense (Australia), October 27, 2022 ~ https://www.minister.defence.gov.au/statements/2022-10-27/australia-advances-responsible-action-space; and Jacqueline Feldscher, "Industry Backs International ASAT Ban," Payload, November 14, 2023 ~ https://payloadspace.com/industry-backs-international-asat-ban.

38 "For the Benefit of All Humankind: Why Space Security Needs Gender Perspectives," Indico, September 13, 2022 ~ https://indico.un.org/event/1002352.

with Canada, for advancing the application of the UN Women, Peace, and Security agenda to space.

Australia's commitment to develop and promote norms of responsible behavior to reduce space threats was also highlighted in the 2024 joint statement on Australia-U.S. ministerial consultations, signed by Australia's foreign minister and minster for defence and the U.S. secretary of state and secretary of defense.[39] This statement highlighted the two countries' commitment "to further strengthen cooperation across the space domain, noting the centrality of outer space to global prosperity, security, and connectivity." The interconnectedness of safety, security, and sustainability in space is increasingly recognized by decision-makers and was reflected in the focus on sustainability at the APRSAF hosted by Australia in 2024. This issue will also be addressed at the 2025 meeting of the International Astronautical Congress, the world's largest space congress, which Australia will host.

A Uniquely Australian Approach to Space

As the global space ecosystem becomes more competitive, and as space services continue to form critical infrastructure for global needs, it is increasingly important for middle powers and smaller nations to identify how they wish to operate in this ecosystem. How will they strike a balance in being consumers of space services provided by others and determining what aspects they need to have as sovereign infrastructure? What role will they play in space diplomacy and sustainability efforts, and how will they best serve their national space technology needs? Australia's potential as a space middle power depends on its ability to identify a national approach to these questions.

One challenge is that Australia's federal history has led to a competition between its internal states and territories for financial resources, industry presence, and recognition for achievement in various sectors. This competition has extended to space, with narratives emerging about which state is best for the space industry or leading nationally. Such discord risks undermining a national approach and causing uncertainty among foreign partners about which entities to engage with for space cooperation. There has also been competition between segments of the space industry due to scant federal spending, leading to disagreements about which capability

[39] "Joint Statement on Australia-U.S. Ministerial Consultations (AUSMIN) 2024."

areas should be a priority.[40] However, a national narrative is beginning to emerge. This is partly a result of the fact that Australia is hosting important regional and international space events, but also perhaps due to its status as an underdog in the space sector.

When the Australian Space Agency was established in 2018, it received a globally unique mandate not to build national space missions but instead to build a space industry and create 20,000 new jobs within a decade. At first this was seen by many as an exciting, forward-looking approach, given the commercialization of space globally. However, the mandate did not include the direction to build an industry in the service of national needs but simply to create jobs and distribute limited grant funding to Australian businesses. While the 2019 Civil Space Strategy outlined seven capability "priority areas," it did not advance any explicit national policy or strategy in terms of why these capabilities matter to national needs and why Australia should invest in them.[41] Similarly, the 2022 "Defence Space Power eManual" focuses on capabilities but formulates no central agenda for securing Australia through space technologies.[42] There is an opportunity to revisit the 2013 Satellite Utilisation Policy and define Australia's deliberate national approach of continuous investment in and contribution to global space infrastructure.

Perhaps the biggest challenge was—and remains—that the Space Agency is not a statutory body. Instead, it is a small subagency under the Department of Industry, Science and Resources, allowing the head of the Space Agency limited autonomy. It is also severely under-resourced, with a founding budget in 2018 of only A$26 million over four years, which is one-eighth the size of what many had argued was necessary.[43] Moreover, its budget was significantly cut in 2023 as part of federal budget reductions. One commentator has estimated that Australia's space budget for 2023 was

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40 Australian Centre for Space Governance, "Building a National Approach to Space," Australian Space Outlook, 2024 ~ https://www.spacegovcentre.org/_files/ugd/ed2eed_c7d94b9d486e44ee9a66dea2261ed541.pdf.

41 Space Agency (Australia), *Advancing Space: Australian Civil Space Strategy 2019–2028* (Canberra, 2019) ~ https://publications.industry.gov.au/publications/advancing-space-australian-civil-space-strategy-2019-2028.pdf; and Steer, "Who Is Australia in Space? The Need for a National Space Policy."

42 Department of Defence (Australia), "Defence Space Power eManual," 2022 ~ https://www.airforce.gov.au/our-work/strategy/defence-space-strategy.

43 Denham Sadler, "Just $26m for New Space Agency," Innovation Australia, May 8, 2018 ~ https://web.archive.org/web/20190329123753/https:/www.innovationaus.com/2018/05/Just-26m-for-new-space-agency; and Alice Gorman and Andrew Dempster, "What We're Looking for in Australia's Space Agency: Views from NSW and SA," Conversation, March 29, 2018 ~ http://theconversation.com/what-were-looking-for-in-australias-space-agency-views-from-nsw-and-sa-92278.

less than one-third of NASA's daily budget.[44] Despite these challenges, the Space Agency has remained an excellent interface for Australian companies to explore international opportunities. Since a federal mandate in 2023 to focus on strategy and policy, it has adopted a more targeted public communication strategy to emphasize the benefits of space technologies for life on Earth. It has also assumed greater leadership over the role Australia can play at APRSAF, as host of the International Astronautical Congress in 2025, and in the Committee on the Peaceful Uses of Outer Space.

A unique, national narrative may well be emerging in Australia, therefore, as a middle player highly committed to impacting space security and space sustainability efforts in partnership with other middle powers and smaller nations. Given Australia's commitments to stability in the Indo-Pacific and advancement of neighboring countries, key government departments are beginning to advocate for space technology cooperation in the region as a policy lever for shared interests. This aligns with historical federal government approaches to utilize space investment as a means to broader political ends and benefits.

Another important aspect of a national approach is engagement with Indigenous Australians. For example, there are opportunities offered to Indigenous space businesses to visit the United States under the Innovation Alliance commitments, and the National Indigenous Space Academy offers scholarships in partnership with NASA and the Australian Space Agency.[45] Many federal and state government agencies involved in the ground and data segments of space have explicit policies for engaging with Indigenous peoples, such as requirements to ensure that free, prior, informed consent has been obtained for any activities on Indigenous lands, and ensuring government procurement takes into account Indigenous businesses. One example is the lease of Indigenous infrastructure by CSIRO and Geoscience Australia in central Australia in support of Landsat.[46] In 2024 the Australian Space Agency established a First Nations Engagement team to ensure that Indigenous communities obtain better access to space technologies, that economic benefits of space activities and infrastructure on their lands flow to them,

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44 "Lack of Budget Funding Signals Australian Government's Ongoing Disinterest in Space," Space and Defense, May 16, 2024 ~ https://spaceanddefense.io/lack-of-budget-funding-signals-australian-government-ongoing-disinterest-in-space.

45 Space Agency (Australia), "Australian Indigenous Students Chosen for NASA Internship," August 14, 2023 ~ https://www.space.gov.au/news-and-media/australian-indigenous-students-chosen-nasa-internship.

46 Mikayla Keen, "Indigenous-Owned Ground Station Supports Our NovaSAR-1 Satellite Research Facility," CSIRO, July 9, 2021 ~ https://www.csiro.au/en/news/all/articles/2021/july/novasar-1-research-facility.

that job opportunities are offered, and that co-governance principles and care of Indigenous lands are integrated into these activities. The team's mission statement is to build cultural intelligence in the space agency and across the space sector to drive a "uniquely Australian approach to space." Given that Indigenous Australians are the world's oldest scientists and astronomers, and have millennia of knowledge about how to manage difficult environments sustainably and for intergenerational equity, integrating Indigenous involvement in solving the biggest challenges of space sustainability could be one of Australia's key contributions moving forward.

Indeed, Indigenous governance principles could provide the key to making explicit that there already is a "uniquely Australian approach to space": one that is committed to space sustainability and to partnerships with others. The consistent government narrative over time has been to build strong international partnerships with larger space nations, so that Australians can continue to benefit from space services without needing to invest in national missions when there have been competing economic priorities. While this approach has been criticized and may not be sufficient for the rest of this century, it has served a purpose. What is less commonly known is the underdog aspect of the Australian approach: investment has been overwhelmingly into ground and data infrastructure, including in support of some smaller nations in the region. This has meant Australia is now a world leader in the segments that underpin its international partners' space systems, from space situational awareness to EO and future communications infrastructure. There is an opportunity for the government and the commercial space sector to embrace this narrative explicitly and implement it into everything Australia does going forward, especially as space sustainability and secure access to space capabilities are now key global imperatives. ◈

Navigating the Cosmos: Singapore's Strategic Ambitions in Space amid U.S.-China Competition

Hema Nadarajah

The global space industry is undergoing a significant transformation. Some have dubbed this transformation of the industry as "space 4.0," as space "evolve[s] from being the preserve of the governments of a few spacefaring nations to a situation in which there is the increased number of space actors around the world, including the emergence of privates companies, participation with academia, industry and citizens, digitalisation and global interaction."[1] Broadly speaking, this expanded array of actors is hoping to reap some of the many benefits of space study and activities. These include advancements in military and security intelligence, better monitoring of climate change, and improved navigation capacity, as well as less direct but no less important benefits to healthcare, communication, and other technological innovations that are often transferred from space-related research.

Asia is a major factor in this revolution: China and India have each expanded their national space programs exponentially and actively nurtured their commercial space sectors with investment incentives. For example, over the past decade, the Chinese government has invested an impressive $1.8 billion to develop its commercial space sector.[2] In 2022 alone, start-ups in India brought in $120 million in new investments, numbers that are projected to grow exponentially.[3] And countries in the region are tapping into the growth of these major space actors while also developing their own space capabilities—with Singapore being a prime example.

As the world transitions into a new era of technological advancement, space exploration and utilization have become increasingly critical for national security, economic development, and scientific innovation.

HEMA NADARAJAH is Program Manager, Southeast Asia, with the Asia Pacific Foundation of Canada. She can be reached at <hema.nadarajah@asiapacific.ca>.

1 "What Is Space 4.0?" European Space Agency ~ https://www.esa.int/About_Us/Ministerial_Council_2016/What_is_space_4.0.

2 "Private Investment Fuels China Commercial Space Sector Growth, alongside State-Backed Investment," Euroconsult, June 4, 2020 ~ https://www.euroconsult-ec.com/press-release/private-investment-fuels-china-commercial-space-sector-growth-alongside-state-backed-investment.

3 Alex Travelli, "The Surprising Striver in the World's Space Business," *New York Times*, July 4, 2023 ~ https://www.nytimes.com/2023/07/04/business/india-space-startups.html.

For Singapore, a nation renowned for its strategic foresight and economic dynamism, space represents both an opportunity and a necessity. Positioned at the crossroads of major geopolitical currents, Singapore's space ambitions are intricately linked to its national objectives, the broader regional context, and the intensifying strategic competition between the United States and China, as well as to opportunities presented elsewhere, such as in India. In 2023, for example, India placed seven Singaporean satellites into orbit in a single launch.[4] During 2024–25, India is set to conduct 30 launches.

Singapore is steadily carving a niche in the global space industry. Although geographically small, the city-state has shown significant ambition and initiative in the field of space exploration and technology. This essay examines Singapore's current space activities, its strategic interests and objectives in space, and how these ambitions are shaped by and contribute to the global space governance landscape amid the evolving U.S.-China rivalry.

Singapore's Strategic Interests in Space

Singapore's space ambitions are deeply rooted in its broader strategic interests. As a small, resource-constrained nation, Singapore has consistently prioritized innovation, technology, and international cooperation to secure its economic and national security. In the context of space, these priorities are reflected in several key areas.

Economic competitiveness and technological leadership. Space technology offers Singapore a pathway to diversify its economy and maintain its position as a global technology hub. The space sector's potential for high-value industries, such as satellite communications, remote sensing, and space-based data analytics, aligns with Singapore's goal to become an innovation-driven economy. Furthermore, developing indigenous space capabilities can enhance its technological leadership in the region and beyond.

National security and strategic autonomy. Space is increasingly seen as a domain critical to national security. For Singapore, developing space capabilities, particularly in satellite communications, earth observation, and navigation, is essential for ensuring strategic autonomy and enhancing its defense capabilities. These capabilities are crucial for maintaining

[4] Debarshi Dasgupta, "India Launches Seven Singapore-Made Satellites," *Straits Times*, July 2023 ~ https://www.straitstimes.com/asia/south-asia/india-launches-seven-singaporean-satellites.

situational awareness, improving disaster management, and safeguarding critical infrastructure.

Diplomatic leverage and international collaboration. Singapore's approach to space is also shaped by its emphasis on multilateralism and international cooperation. By actively participating in global space governance and engaging in bilateral and multilateral space collaborations, Singapore can enhance its diplomatic leverage, contribute to global stability, and ensure that its interests are represented in the evolving rules and norms governing outer space such as peaceful use.

Recent Developments in Singapore's Space Sector

In recent years, Singapore has made significant strides in advancing its space capabilities and establishing itself as a credible player in the global space sector. In 2022 the government announced its plan to invest $110 million in developing its space program.[5] These developments can be categorized into three main areas: institutional framework, industry growth, and international collaborations.

Institutional framework. Singapore's space ambitions are underpinned by a robust institutional framework. The establishment of the Office for Space Technology and Industry (OSTIn) in 2013 marked a significant milestone in the country's space journey. OSTIn serves as the focal point for coordinating space-related activities, fostering industry growth, and promoting international collaboration. Singapore's space policy is believed to prioritize support for commercial space ventures and active participation in international space forums.[6]

These ambitions in space are further buttressed by regional initiatives, such as those of the Association of Southeast Asian Nations (ASEAN). As a member of ASEAN, Singapore plays a key role in promoting regional cooperation in space activities. Initiatives include efforts to encourage collaboration among ASEAN member states in space research, technology development, and satellite applications as well as programs aimed at building the capacity of ASEAN member states in space technology and applications, enhancing regional capabilities, and fostering shared growth.

5 Robert S. Wilson and Robin Dickey, "Singapore: Country Brief," Center for Space Policy and Strategy, February 2023 ~ https://csps.aerospace.org/sites/default/files/2023-02/Wilson-Dickey_Singapore_20230201_0.pdf.

6 Ibid.

Industry growth. Singapore's space sector is characterized by a vibrant and rapidly growing commercial industry. Over the past decade, several Singaporean companies have emerged as leaders in niche areas of space technology. For instance, ST Engineering, which is a major player in the global aerospace and defense industry, has expanded its portfolio to include satellite communications and earth-observation services. Start-ups such as Addvalue Technologies and Astroscale have also made significant contributions to the space ecosystem. Addvalue Technologies is known for its innovations in satellite-based communication solutions, while Astroscale, originally founded in Japan but with strong ties to Singapore, is a pioneer in technologies to remove space debris.

International collaborations. Recognizing the importance of collaboration in space, Singapore has actively pursued partnerships with leading spacefaring nations and organizations. The country has signed several memoranda of understanding with space agencies, including NASA, the European Space Agency, and the Japan Aerospace Exploration Agency (JAXA). These partnerships facilitate technology transfer, joint research, and the sharing of best practices. Additionally, Singapore is a member of the Asia-Pacific Regional Space Agency Forum (APRSAF) and has engaged in space-related dialogues under the ASEAN framework.

Singapore's Position on Global Space Governance

Singapore's approach to global space governance is informed by its broader foreign policy principles, which emphasize multilateralism, the rule of law, and the peaceful use of space. As space becomes increasingly contested and congested, Singapore advocates for the development of norms and rules that ensure the sustainability and security of space activities.

Long-term sustainability of space activities. The island state has been a vocal proponent of initiatives aimed at ensuring the long-term sustainability of space activities. The country has expressed support for the UN Committee on the Peaceful Uses of Outer Space and its guidelines on the long-term sustainability of space activities. These guidelines, which address issues such as space debris mitigation, space traffic management, and the responsible use of space, align with Singapore's interests in maintaining a safe and stable space environment.

Prevention of weaponization of space. Consistent with its stance on arms control and disarmament, Singapore supports international efforts to prevent the weaponization of space. It has endorsed the Outer Space

Treaty, which prohibits the placement of nuclear weapons or other weapons of mass destruction in space. The country also participates in dialogues on space security, including the UN's Conference on Disarmament, where it advocates for transparency and confidence-building measures to prevent an arms race in space.

Global space diplomacy. Singapore's active participation in regional and global space diplomacy underscores its commitment to shaping the evolving space governance landscape. Through its involvement in the APRSAF and ASEAN's space-related initiatives, Singapore contributes to the development of regional space policies and the promotion of peaceful cooperation in space. On the global stage, it has participated in the UN's Group of Governmental Experts on Space, which discusses developing norms to prevent security threats in space. Singapore has supported the Artemis Accords, a U.S.-led initiative that seeks to establish a framework for the peaceful exploration of the Moon and beyond. It has also been working closely with other leading space agencies, such as JAXA, holding workshops on the co-creation of a space economy in early 2024.[7]

The Impact of U.S.-China Strategic Competition on Singapore's Space Ambitions

The intensifying geopolitical and economic rivalry between the United States and China is reshaping the global space landscape, with significant implications for regional actors like Singapore. While the city-state has traditionally maintained a neutral stance in global power dynamics, the U.S.-China rivalry presents both challenges and opportunities for its space ambitions.

Balancing relations with the United States and China. Singapore's strategic location and its close ties with both countries necessitate a delicate balancing act. On the one hand, the United States is a key partner in defense and technology, and its leadership in space exploration offers Singapore valuable opportunities for collaboration, including on the use of space technology to address the climate crisis. On the other hand, China's rise as a space power and its initiative to develop a Belt and Road Space Information Corridor present attractive opportunities for economic and technological engagement, including in its commercial space sector. Singapore's challenge

[7] Global Space Technology Convention and Exhibition, "Innovation Workshop," 2024 ⇝ https://space.org.sg/gstce/gstc-2024-innovation-workshop.

is to navigate this rivalry without being drawn into the broader geopolitical tensions, while still advancing its space objectives.

Opportunities for technological and industrial collaboration. U.S.-China competition has spurred significant advancements in space technology, creating opportunities for Singapore to benefit from technology transfer and industrial collaboration. For instance, Singapore can leverage its strong ties with U.S. companies and institutions to access cutting-edge and low-cost satellite technologies. Simultaneously, collaboration with Chinese space enterprises could open up new markets and enhance Singapore's space industry capabilities, particularly in areas such as satellite manufacturing and space-based services.

Looking Ahead

Singapore's space ambitions are likely to evolve along several key trajectories, driven by both domestic imperatives and external geopolitical and economic factors. The city-state is expected to continue investing in the development of indigenous space capabilities, particularly in satellite technology, space-based data analytics, and advanced manufacturing for space applications. These investments will not only enhance its technological leadership but also reduce its dependence on foreign technologies and services.

As space becomes increasingly globalized, Singapore will likely deepen its international collaborations, both within the region and beyond. This includes expanding partnerships with established spacefaring nations, as well as engaging with emerging space actors in Southeast Asia and elsewhere. Such collaborations will be crucial for advancing Singapore's space objectives and ensuring its active participation in shaping the landscape of global space governance. Singapore is poised to play a more prominent role in global space governance and diplomacy. By advocating for the peaceful use of space, promoting the development of international norms and rules, and contributing to multilateral space initiatives, the island nation can enhance its diplomatic influence and help shape the future of space exploration and utilization.

Singapore's space ambitions are a reflection of its broader national strategy, which emphasizes innovation, technological leadership, and international collaboration. As the global space landscape evolves, shaped by intensifying U.S.-China competition and the growing importance of space for national security and economic development, Singapore's strategic

approach to space will be crucial for securing its long-term interests. By continuing to invest in indigenous capabilities, fostering international partnerships, and actively participating in global space governance, Singapore is well positioned to navigate the challenges and seize the opportunities that lie ahead in the new space age. Its journey into the space sector is a testament to its forward-thinking approach to economic development and technological innovation. ◈