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ROUNDTABLE

Asia in Space: The Race to the Final Frontier

John M. Logsdon

Kevin Pollpeter

James Clay Moltz

Saadia M. Pekkanen

Hyoung Joon An

Namrata Goswami

Kai-Uwe Schrogl and Christina Giannopapa

Introduction

More than half a century since the United States and the Soviet Union jockeyed to be first in space and to put a man on the Moon, a new contest for space dominance has developed in recent years. In 2019, China successfully landed an unmanned craft on the Moon, and the country aims to both launch a Mars explorer in 2020 and complete its own space station around 2022. The Indian Space Research Organisation has plans to launch a variety of observation and communications satellites in 2020, and the Indian Regional Navigation Satellite System now covers the entire Indo-Pacific. Though still recovering from the Fukushima disaster, the Japan Aerospace Exploration Agency is preparing to launch its prototype Space Solar Power System this year, with full operational capacity scheduled for 2030.

In contrast to the growth of Asian space programs, Russia's reorganized state-led program Roscosmos struggles to maintain the country's Soviet-era capabilities. The European Union has only recently revived its Space Council and is determining objectives for joint European programs. The United States, for its part, has shifted toward robotic missions and a focus on military security applications, although there is renewed public- and private-sector interest in manned space missions.

Amid this global scramble by countries and private companies to launch satellites and spacecraft, a range of critical issues still must be addressed. For example, the aging International Space Station is now in its 22nd year, and space debris remains an unregulated, increasing problem. To better understand Asia's emerging role in the space domain, this *Asia Policy* roundtable surveys the space programs of key states and analyzes their present technological capabilities, strategic goals, and private and public R&D to determine policy implications for space activities, international law, and security.

The roundtable opens with John M. Logsdon's analysis of the United States. The essay examines the country's historical and current commitments to space as well as the important matters on its policy agenda. As one of the two veteran space powers—and the only one to maintain relevance in the 21st century—the United States faces different issues than its Asian allies and rivals. As Logsdon notes, Washington has a hand in nearly every international space initiative. The United States, as the country with the most seasoned space program, must rise to the pressing challenge of crafting "innovative and appropriate rules to govern the world's space activities, if they are to produce their maximum social, economic, and security benefits." In so doing, it will continue to play a significant role in international space forums.

At the same time, the influence of China in space is increasing. Kevin Pollpeter's essay for the roundtable succinctly summarizes the challenges the country poses vis-à-vis the United States: "China's use of space as an instrument of national power poses military, economic, and diplomatic challenges for the United States, much as its increasing capabilities and expanding global presence challenge other terrestrial domains." Like in other domains, China strives to reshape space governance to better suit its own geopolitical objectives in areas such as arms control and natural resource extraction in space. Pollpeter suggests that the United States could easily lose preeminence in space should it ignore China's rise and fail to invest in its own space program.

James Clay Moltz assesses the status of the Russian space industry and its transition from being a government-led powerhouse in the Soviet era to a program with joint civil and military capabilities. He concludes that "Russia's heavily state-run strategy is ill-suited to the rapid technological pace of the 21st-century space marketplace, leaving the country searching for a new formula for success." By contrast, Saadia M. Pekkanen argues that Japan has positioned itself well in the space domain through developing innovative technologies across the civilian, military, and commercial realms. Through international and regional engagements, the country has situated itself so as "to influence the policy positions of other countries on the principles governing outer space activities and the types of collaborative frameworks necessary for advancing peaceful governance." Japan has thus effectively adapted space diplomacy to meet its national interests. Hyoung Joon An next discusses South Korea's aspirations in space. Now that the country possesses a competitive space force with indigenous capabilities, he argues that it is imperative that South Korea become "a more active participant in developing an international legal framework for space activity."

Namrata Goswami's essay details the great advances India has made in its space program and the full range of capabilities the country has developed, including those needed for Moon and Mars missions and for various satellite activities. With the growth of its civil and military programs, and, controversially, by testing its anti-satellite capabilities despite international protest, India "has ensured that it will be included in any future space governance regime." The roundtable closes with Kai-Uwe Schrogl and Christina Giannopapa's analysis of the ambitions and contributions of Europe in space, as well as its potential for cooperation with new space entrants. In particular, they consider the implications of Asian space programs for the region and "whether developments in Asia will lead to concerns regarding not only economic competition but also stability and security interests in space."

This question frames an important theme of this roundtable. The countries of Asia are already shaping space policies and governance for the new era. It is thus paramount that any actor interested in the opportunities that this final frontier has to offer—whether military, civilian, or commercial—take note of the developments in Asian space programs. ◈

The United States in Space

John M. Logsdon

By almost every measure, the United States is the most space-active country in the world. The U.S. government spends more on space research, development, and operations than all the rest of the world's governments combined. Of the $70.9 billion worldwide government spending on space in 2018, $41 billion of that was spent by the United States—58% of the global total. Looking specifically at military and intelligence space activities, U.S. spending constituted almost 75% of such spending worldwide. Additionally, the U.S. private sector, from billionaires investing their wealth on space ventures to small entrepreneurial start-up firms, dwarfs the rest of the world in commercially oriented space activity.[1]

This essay highlights the historical and current roots of the U.S. commitment to space, discusses the processes through which U.S. space policy is determined and the fundamental premises of current policy, and examines a few of the many issues on the current U.S. space policy agenda. The United States views itself as the world's leading space power, with an interest in influencing the answer to virtually every international space policy question.

The United States and Space Preeminence

The U.S. commitment to space activity has deep historical roots. In reaction to the October 1957 launch of *Sputnik 1* by the Soviet Union, the United States in early 1958 began a highly classified spy satellite effort. Later that year, it created a separate civilian space agency, the National Aeronautics and Space Administration (NASA), and gave the new organization the lead role in carrying out civilian space activities, including human spaceflight. While then president Dwight D. Eisenhower limited NASA's aspirations and budget, his successor, John F. Kennedy, in May 1961 assigned to NASA the

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1 Simon Seminari, "Global Government Space Budgets Continues Multiyear Rebound," SpaceNews, November 24, 2019 ~ https://spacenews.com/op-ed-global-government-space-budgets-continues-multiyear-rebound.

national goal of landing astronauts on the Moon and returning them safely to Earth "before this decade is out." This assignment led to Project Apollo, a warlike but peaceful mobilization of technical, human, and financial resources that at its peak in the mid-1960s accounted for almost 5% of the government budget and made space leadership a key element of U.S. national strategy. It also created in NASA a large organization (currently just over seventeen thousand employees) with multiple research centers throughout the United States and capabilities in all areas of space science, development, and exploration.

With Kennedy's goal achieved by the Apollo 11 lunar landing in July 1969, the civilian space effort was quickly assigned a lower priority, and NASA's budget in recent years has fallen to less than 1% of government spending. Still, the U.S. budget of over $20 billion per year dwarfs the civilian space spending of other countries. The combination of the United States' persistently stated goal of global space leadership and the political influence of NASA's large industrial-university-congressional complex that emerged during the Apollo program provides political support for maintaining a high level of U.S. civilian space spending. Furthermore, beginning in the late 1960s and extending until the current day, other civilian agencies, such as the National Oceanic and Atmospheric Administration with its meteorological satellites, have become involved in implementing space programs and assuming regulatory and policy functions with respect to space activities. The State Department leads the international dimensions of U.S. space policy.

After *Sputnik*, the U.S. military branches, particularly the air force, prepared ambitious space activity plans, but these plans were not approved by either Eisenhower or Kennedy. Space activity focused on national security gradually grew in the 1960s and 1970s as its utility in support of U.S. military posture became evident. The Department of Defense found that various types of space systems—communications, meteorological, positioning, navigation, timing, and early-warning, among others—provided essential support to U.S. warfighting capabilities. By the early 1980s the national security space budget had surpassed that of NASA. Despite several attempts, the United States has so far resisted the temptation to develop dedicated space weapons. During the 1980s, there was an attempt to develop a space-based defense against ballistic missiles, the Strategic Defense Initiative, but the effort proved technologically infeasible and was abandoned. By the 1990–91 Gulf War, space systems had become a central element of U.S. military strategy, a position they remain in today. In addition, since the 1970s, technologically sophisticated and expensive systems to gather photographic, radar, electronic, and other forms of intelligence have been developed and managed by the National Reconnaissance Organization, an agency separate from the military services and whose very existence was kept secret until the 1990s.

The combination of a government-funded civilian effort at a fairly stable share over the past four decades and a large national security effort has led to the current U.S. position of dominance with respect to government expenditures on space. These expenditures continue to be motivated by a desire for space "preeminence"—a clearly leading role in all areas of space activity. As the United States faces competition for space leadership from other emerging space powers, particularly China, its preeminent position in space is increasingly under challenge.

U.S. Space Policies

U.S. space activities are carried out within a policy framework defined by the joint decisions of the president, his White House associates, and the actions of Congress. Historically, the president has taken the initiative on most space policies and major space program decisions, with Congress modifying presidential proposals and deciding on the funding levels for various activities.

National space policy is thus the result of complex interactions between the White House and the various government agencies actually carrying out the activities; several bodies within the White House structure advise the president on space policy and program issues. Since its revival in 2017, the lead organization in this regard is the National Space Council, an interagency body chaired by the vice president and composed of senior officials from a number of space-active agencies. The council has a small staff to support its deliberations and recommendations, which become space policy directives when approved by the president. The Office of Management and Budget also plays a crucial role by reviewing funding requests from various government agencies and recommending funding levels for the president's budget proposal to Congress.

Relatively few members of Congress give focused attention to space policy issues; rather, specific subcommittees within the Senate and House deal with these issues, and it is their senior members who become specialists. Other members of Congress become involved with space issues if they are particularly important in their states or districts. Authority is divided between the authorizing subcommittees, which provide a policy framework for space activities and oversee their implementation, and appropriations subcommittees, which decide on the funding available for those activities. Most of the time, Congress makes only marginal modifications to White House space proposals, though on occasion it takes the policy initiative—for example, in the now long-standing prohibition on most forms of civilian space cooperation with China.

Current U.S. space policy, reflecting the priorities of President Donald Trump, has a strongly nationalistic tone. In March 2018 the White House released an "America First National Space Strategy" that captures the essence of the Trump administration's approach.[2] Among the strategy's precepts are the following:

- "National Space Strategy prioritizes American interests first and foremost, ensuring a strategy that will make America strong, competitive, and great."
- "The new strategy ensures that international agreements put the interests of American people, workers, and businesses first."
- "While the United States would prefer that the space domain remain free of conflict, we will prepare to meet and overcome any challenges that arise….The United States will seek to deter, counter, and defeat threats in the space domain that are hostile to the national interests of the United States and our allies."

These perspectives are coloring U.S. decisions on what space efforts to pursue and on the U.S. position in various international forums in which space issues are discussed.

Space Policy Issues

Given the comprehensive scope of U.S. space activities, it is only possible in this short essay to discuss issues high on the national space policy agenda. These include what the future direction of the human spaceflight program will be, how best to organize the national security space effort, how to deal with burgeoning private-sector space activities, and how to shape an international regime for space that best serves U.S. interests.

2 "President Donald J. Trump Is Unveiling an America First National Space Strategy," White House, Press Release, March 23, 2018 ~ https://www.whitehouse.gov/briefings-statements/president-donald-j-trump-unveiling-america-first-national-space-strategy.

A return to the Moon? Since the end of the Apollo program, U.S. human spaceflight programs have only operated in low-earth orbit. Starting with the space shuttle, which entered service in 1981, and followed by the International Space Station (ISS), which welcomed its first occupants in 2000, the United States and its partners have carried out a wide range of research, development, and public outreach activities as their astronauts circle the planet. During the 1960s, Apollo was a unilateral effort designed to demonstrate U.S. strength in a highly visible way, but both the shuttle and station have involved other countries in U.S.-led cooperative ventures. In particular, the ISS has engaged Russia, Japan, Canada, and eleven European countries in large-scale technological cooperation.

The space shuttle was retired in 2011, and since then the United States has been forced to depend on Russia's Soyuz spacecraft to transport its astronauts to and from the ISS. Years overdue, the United States in the coming months is scheduled to regain its ability to launch humans into space through a still unproven government-industry partnership to develop two crew-carrying spacecraft—Boeing's Starliner and SpaceX. Whether such public-private partnerships are the future of human spaceflight, how long the ISS will remain a government-funded facility, whether a private entity will assume the lead responsibility for ISS operations, how long the facility will remain active, and what will happen in low-earth orbit after the space station is retired are all open questions.

There has been pressure since the mid-1980s to resume human spaceflight beyond low-earth orbit. Four of the five past U.S. presidents have called for a return to the Moon or travel to Mars, and current U.S. policy directs NASA to "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." The policy envisions that "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."[3] The directive's program is called Artemis (the twin sister of Apollo in Greek mythology). In March 2019, Vice President Mike Pence declared that the United States would return to the Moon by the end of 2024. How to organize NASA and the U.S. space community to meet this challenging deadline, what technological

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

approach is most likely to succeed, and what follows the initial Artemis missions are current concerns. The United States has stated its intention to open Artemis to international participation. If the experience in crafting the ISS partnership is any guide, this will require complex and contentious international negotiations. Whether the United States will persist with Artemis if there is a change in government after the upcoming election is, of course, far from certain; the coalition supporting human space exploration is bipartisan but not politically powerful.

How to organize for national security? The U.S. Air Force has historically developed and operated most military space systems. In recent years, both its performance in this role, given the priority the service assigns to aircraft activities, and the increasing importance of military space systems to U.S. security have led to the creation of a separate military service dedicated to space—the U.S. Space Force. Calls for this step originated with a few members of Congress but were then embraced by the Trump administration. In February 2019, President Trump signed a directive that called upon the Department of Defense to "develop a legislative proposal to establish a United States Space Force as a sixth branch of the United States Armed Forces within the Department of the Air Force." The U.S. Space Force "would be authorized to organize, train, and equip military space forces of the United States to ensure unfettered access to, and freedom to operate in, space, and to provide vital capabilities to joint and coalition forces in peacetime and across the spectrum of conflict."[4]

This directive is currently being implemented. Legislation establishing the Space Force was signed into law in December 2019, a Space Force commander has been named, and initial personnel and facilities have been identified. What will be unclear for some time is whether the new Space Force will simply be a more efficient way of organizing existing military space activities or whether it will expand the scope and character of those activities in ways that enhance U.S. military power. In addition, the space-based intelligence activities of the National Reconnaissance Organization are not being transferred to the Space Force portfolio; thus far, it will remain a separate organization.

What about the space billionaires? There are several extremely wealthy individuals who are financing innovative space activities, some of them independent of the U.S. government and some through

4 "Text of Space Policy Directive-4: Establishment of the United States Space Force," White House, Press Release, February 19, 2019 ~ https://www.whitehouse.gov/presidential-actions/text-space-policy-directive-4-establishment-united-states-space-force.

a government-industry partnership. In addition, there are numerous smaller entrepreneurial space ventures that can only thrive in a supportive regulatory and policy context. Blue Origin, founded by Amazon's Jeff Bezos, is focusing on developing new launch vehicles, with the vision of eventually moving large elements of heavy industry into space. Elon Musk's SpaceX has developed reusable launch vehicles and is working on a large spaceship capable of carrying a number of people to the Moon and eventually to support settling Mars. Smaller companies, such as Planet, have had initial business success in providing frequent images of most of the earth's surface. Developing policies and regulations that at a minimum do not hinder private-sector innovation, and at best stimulate and promote it, is an ongoing challenge for policymakers.

A new international regime for space? Over the past decade there have been a number of international initiatives (inside and outside the United Nations) related to the management of global space activities. These initiatives include developing guidelines for the long-term sustainability of space activities and rules for the conduct of space activities, limiting and ameliorating the impact of space debris, increasing global capabilities for space situational awareness, discussing approaches to space traffic management, and keeping space free of weapons. There are even suggestions to revise the basic charter for the international space regime, the 1967 Outer Space Treaty.

Conclusion

Given its continuing world-leading position in space activities, the United States will play a crucial role in all these issues and initiatives. Most space activities are global in character and not limited to the boundaries of any one country. In recent years, space has become crowded, competitive, and conflicted. Even with the current "America first" policy of the Trump administration, the United States will continue to be a central, and likely demanding, participant in international space discussions. No international treaty or agreement can achieve success without U.S. concurrence with its provisions. There is today a pressing need for innovative and appropriate rules to govern the world's space activities, if they are to produce their maximum social, economic, and security benefits. Developing those rules, given the nationalistic character of current U.S. space policy, will pose a continuing challenge to international space diplomacy. ◈

China's Space Program: Making China Strong, Rich, and Respected

Kevin Pollpeter

In 2012 the Chinese Communist Party (CCP) under Xi Jinping began what it calls "the great rejuvenation of the Chinese nation," a plan to make the People's Republic of China (PRC) strong, rich, and influential by midcentury.[1] China's space program is one element of this rejuvenation. Similar to his other ambitions, Xi has stated the goal of transitioning the PRC from being a "major space power" (*hangtian daguo*) to being a "strong space power" (*hangtian qiangguo*) that surpasses the United States as the leading space power by midcentury.[2] This ambition is driven by a belief that space contributes significantly to China's national power by serving its political, economic, and military interests.[3]

The PRC's space program poses military, economic, and political challenges to the United States. China's military doctrine stresses the crucial nature of space in winning wars. In terms of the economic impact, observers in the United States are concerned that the PRC's nascent commercial space industry may displace the U.S. commercial space industry through mercantilist trade policies. From a technology standpoint, the PRC has conducted robotic missions to the Moon, and its space station will become operational at a time when the International Space Station is nearing the end of its service life.

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NOTE ~ This essay is adapted from the forthcoming CNA study "China's Space Narrative: Examining the Portrayal of the U.S.-China Relationship in Chinese Sources," written for the U.S. Air Force China Aerospace Studies Institute.

1 "Xi Jinping: Chengqianqihou jiwangkailai jixu chaozhe Zhonghua minzu weida fuxing mubiao fenyong qianjin" [Xi Jinping: Inherit the Past and Usher in the Future, Carry Forward the Revolutionary Cause and Forge Ahead into the Future, Continue Forging Valiantly Ahead toward the Chinese People's Mighty Goal of Rejuvenation], Xinhua, November 29, 2012 ~ http://news.xinhuanet.com/politics/2012-11/29/c_113852724.htm; and "Xi Jinping zai Zhongguo gongchandang di shijiuci quanguo daibiao dahui shang de baogao" [Xi Jinping's Speech at the 19th Congress of the Chinese Communist Party], *People's Daily*, October 28, 2017 ~ http://cpc.people.com.cn/n1/2017/1028/c64094-29613660.html.

2 "Jianshe hangtian qiangguo, Xi Jinping yinyin zhutuo" [Building a Strong Space Power, Xi Jinping Full of Enthusiasm], Xinhua, April 12, 2019 ~ http://www.xinhuanet.com/politics/xxjxs/2019-04/12/c_1124357478.htm.

3 State Council Information Office of the People's Republic of China (PRC), *China's Space Activities in 2011* (Beijing, December 2011) ~ http://www.gov.cn/english/official/2011-12/29/content_2033200.htm.

This essay examines the role of space in advancing China's national interests. The PRC leadership's primary motivation for developing space technologies is national security. However, as this program advances, its commercial and scientific activities will become more prominent and extend the competition to encompass economics and diplomacy. These developments will challenge U.S. leadership in space just as the PRC now challenges U.S. power across the full range of diplomatic, military, and economic realms.

China's Space Program

Since 2000, China has made important progress across a broad range of space technologies, including launchers, satellites, lunar exploration, human spaceflight, and counterspace technologies. It is launching more rockets and satellites than at any other time in its history. China has 323 satellites in orbit, the second-largest number of satellites behind the United States, and now has nearly every type needed to carry out the full range of space missions.

The year 2020 marks an important milestone for China's program. By the end of this year, it will have developed a "global, all-weather, 24-hour remote sensing capability," in part through the use of space-based technologies, and established a global navigation satellite system, BeiDou, to compete with the United States. China has also developed a new generation of launch vehicles designed to meet its needs for the next 30 to 50 years.[4] Later this year the country is planning to send a robotic probe to the Moon to gather and return samples of the lunar surface, as well as a rover to Mars.[5] By 2022, it plans to complete a 60-ton space station with a ten-year service life.[6]

China is also developing a wide range of counterspace technologies intended to threaten adversary space systems from the ground to geosynchronous orbit.[7] These include direct-ascent kinetic-kill vehicles,

4 Zhang Feng, "Zhongguo de changzheng wu hao yunzai huojian" [China's Long March 5 Launch Vehicle], *Weixing yingyong*, no. 5 (2012): 29.

5 Andrew Jones, "China Targets Late 2020 for Lunar Sample Return Mission," SpaceNews, November 1, 2019 ~ https://spacenews.com/china-targets-late-2020-for-lunar-sample-return-mission; and Andrew Jones, "China's First Mars Spacecraft Undergoing Integration for 2020 Launch," SpaceNews, May 29, 2019 ~ https://spacenews.com/chinas-first-mars-spacecraft-undergoing-integration-for-2020-launch.

6 "CMSP," China Manned Space Engineering ~ http://en.cmse.gov.cn.

7 Daniel R. Coats, "Statement for the Record: Worldwide Threat Assessment of the U.S. Intelligence Community," January 29, 2019, 17 ~ https://www.dni.gov/files/ODNI/documents/2019-ATA-SFR---SSCI.pdf.

co-orbital satellites, directed-energy weapons, jammers, and cyber capabilities.[8] The People's Liberation Army (PLA) has deployed a ground-based anti-satellite missile for use against targets in low-earth orbit and is expected to deploy a ground-based laser this year.[9]

Military Benefits

Space plays a central role in China's plans to project power far from home, as well as in its ability to defeat high-tech adversaries, such as the U.S. military. The PLA has designated outer space as a warfighting domain—described as a "new commanding height of war"—that China must fight for and seize if it is to win future wars. Since the early 2000s, Chinese military writings have concluded that without space superiority, China will be at a disadvantage in all other domains.[10] The 2013 *Textbook for the Study of Space Operations*, for example, predicts that future wars will likely begin in outer space and that "achieving space superiority and cyber superiority are critical for achieving overall superiority and being victorious over an enemy."[11] It argues that China must prepare for an enemy to attack from all domains, including space, and identifies outer space as one of five major military threats facing the PLA and one of nine "main operational activities."[12]

PLA officers and analysts assert that space is the ultimate high ground, and that whoever controls space, controls the Earth.[13] These analysts describe space-based C4ISR (command, control, communications, computers, intelligence, surveillance, and reconnaissance) systems as a critical part of

8 U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2016* (Washington, D.C., 2016), 37 ~ https://dod.defense.gov/Portals/1/Documents/pubs/2016%20China%20Military%20Power%20Report.pdf.

9 Coats, "Worldwide Threat Assessment of the U.S. Intelligence Community," 17; and Patrick M. Shanahan, "Remarks by Acting Secretary Shanahan at the 35th Space Symposium, Colorado Springs, Colorado," U.S. Department of Defense, April 9, 2019 ~ https://dod.defense.gov/News/Transcripts/Transcript-View/Article/1809882/remarks-by-acting-secretary-shanahan-at-the-35th-space-symposium-colorado-sprin.

10 Academy of Military Science (PRC), *Zhanle Xüe* [Science of Strategy] (Beijing: Military Science Press, 2013), 96; and Jiang Lianju and Wang Liwen, *Kongjian zuozhan jiaocheng* [Textbook for the Study of Space Operations] (Beijing: Military Science Press, 2013), 13.

11 Jiang and Wang, *Kongjian zuozhan jiaocheng*, 96.

12 Academy of Military Science (PRC), *Zhanle Xüe*, 100.

13 See, for example, Xu Qiliang, "Fenfei zai xinshijide tiankong: Zhongyang junwei weiyuan, kongjun silingyuan xu qiliang benbao jizhe wen" [Flying with Force and Vigor in the Sky of the New Century: Central Military Commission Member and PLA Air Force Commander Xu Qiliang Answers Reporter's Questions in an Interview], Sina, November 1, 2009, 13 ~ http://mil.news.sina.com.cn/2009-11-02/0625572165.html.

a modern military sensor-to-shooter network.[14] At the same time, Chinese military analysts regard space as a critical vulnerability that can debilitate an enemy if denied.[15] To further integrate space into military operations, the PLA created the Strategic Support Force in 2015, an organization that is in part responsible for elements of the PLA's space program.

Commercial Benefits

China's space program is also increasingly focused on generating commercial benefits. The PRC currently has more than 140 commercial space companies offering products and services ranging from manufacturing satellites to orbital launch. The commercial space market is still developing, however, with most companies established in the past five years. Moreover, Chinese analysts perceive a sizeable gap between Chinese and U.S. companies. For example, Chinese commercial launch companies were founded by space industry or finance professionals with no apparent entrepreneurial background or means to self-fund. "NewSpace" companies in the United States, such as SpaceX, Blue Origin, and Virgin Galactic, by contrast, were founded by technology-oriented billionaire entrepreneurs with experience running large, complex organizations in a true commercial environment.

Chinese commercial space launch companies also have relatively small staffs when compared to their U.S. counterparts, suggesting that some of these companies are not conducting the type of R&D necessary to build true, independent launch capabilities. The companies LandSpace, OneSpace, and ispace, for example, appear to employ between several dozen to just over 100 employees. By comparison, U.S. companies employ hundreds to thousands of staff who are responsible for researching, developing, and manufacturing spacecraft. SpaceX, for example, employs 5,000 people, Blue Origin employs more than 1,000, and Virgin Galactic has 360 personnel.[16]

In addition, several indicators suggest that Chinese commercial space launch companies lack the innovation of their competitors. ExPace, a subsidiary of the state-owned China Aerospace Science and Industry

14 Jiang and Wang, *Kong Jianzuozhan jiaocheng*, 14.

15 Ibid., 44.

16 Peter B. de Selding, "Blue Origin's Older Than SpaceX in More Ways Than One," Space Intel Report, April 14, 2017 ~ https://www.spaceintelreport.com/blue-origins-older-than-spacex-in-more-ways-than-one; and "Virgin Galactic's Competitors, Revenue, Number of Employees, Funding and Acquisitions," Owler ~ https://www.owler.com/company/virgingalactic.

Corporation (CASIC), appears to have benefited from a transfer of rocket technology from its parent company. The same can probably be said for LandSpace, whose LS-1 rocket appears to have been derived from the CASIC Long March 11 rocket.[17] OneSpace also appears to have received support from state-owned enterprises in product development and rocket launch.[18]

China's growing commercial space sector is also involved in national efforts to build a space information corridor, the space element of the Belt and Road Initiative. This corridor is intended to provide the benefits of space-based earth observation, communications and broadcasting, and navigation and positioning capabilities to member countries in the initiative.[19] According to a *People's Daily* article, "China is expanding its 'circle of friends' among the Belt and Road countries by taking an active role in serving those countries with advanced space technologies." To support this effort, China has signed "98 intergovernmental and interdepartmental agreements with 30 countries and 3 international organizations, including 23 pacts with 11 countries along the route" for space-related cooperative activities.[20]

Political Benefits

The Chinese government also uses its space program for international political gain. Paralleling its foreign policy message of "building a community of shared future for mankind,"[21] China advocates the building of "a shared vision for humanity in space" that emphasizes the role of its space diplomacy in promoting the peaceful uses of space, international cooperation in this domain, and the advancement of humankind, while downplaying the national security aspects of its space program. The narrative of a "shared vision for humanity in space" is intended to increase the PRC's influence in space-related diplomacy and build relationships with foreign partners. Using space for peaceful purposes and working to bring the benefits of space to all countries is one element of its larger endeavor

17 "The Numbers of LS-1," LandSpace ~ http://www.landspace.com/w36447.jsp.

18 "China's First Privately-Developed Rocket to Launch in 2018," *China Daily*, January 29, 2018 ~ http://www.chinadaily.com.cn/a/201801/29/WS5a6e911aa3106e7dcc137570.html.

19 State Council Information Office (PRC), *China's Space Activities in 2011*.

20 Feng Hua, "Space Cooperation Expands China's Belt and Road 'Circle of Friends,'" *People's Daily*, May 14, 2017 ~ http://en.people.cn/n3/2017/0514/c90000-9215306.html.

21 See, for example, Fu Ying, "China's Vision for the World: A Community of Shared Future," *Diplomat*, June 22, 2017 ~ https://thediplomat.com/2017/06/chinas-vision-for-the-world-a-community-of-shared-future.

to reduce U.S. power and influence. In this context, China's space policy reinforces the broader governmental narrative of building a world with a "community of shared future."[22]

China thus uses international space cooperation to demonstrate that it is an enlightened, benevolent hegemon that is able and willing to fulfill other countries' security and economic needs through the application of space-based capabilities. These efforts may have a more salient effect in promoting Chinese influence in the developing world, an area that the U.S. space program has traditionally undervalued.

Implications and Conclusion

China's use of space as an instrument of national power poses military, economic, and diplomatic challenges for the United States, much as its increasing capabilities and expanding global presence challenge the United States in the terrestrial domains.

The acquisition of space-based intelligence and navigation information to enable long-range strikes and offensive space-control measures against U.S. satellites demonstrates the prominent role of space in China's efforts to establish effective anti-access/area-denial capabilities. The PLA can use space-based capabilities to identify land- and sea-based targets and provide targeting intelligence for naval, aviation, and missile forces. With space-based intelligence, surveillance, and reconnaissance capabilities, in combination with the 1,500-kilometer-range DF-21D and CJ-10 missiles and the 4,000-kilometer-range DF-26 missile, the PLA can attack both land and naval targets in the western Pacific, the Indian Ocean, and the South China Sea. The denial of critical U.S. space-based capabilities by anti-satellite weapons, when integrated with cyber and kinetic attacks against ground-based C4ISR nodes, could complicate the ability of the U.S. military to flow forces to the region and conduct operations there effectively.[23]

The rapid expansion of Chinese commercial space companies, the lowering of technological hurdles to space, and mercantilist industrial policies could result in China flooding markets with cheap alternatives to U.S. space products and services. Similar export policies to those

22 Echo Huang, "Here's What We Know about China's Future Space Station," Quartz, May 30, 2018 ~ https://qz.com/1292014/heres-what-we-know-about-chinas-future-space-station.

23 U.S. Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2019* (Washington, D.C., 2019) ~ https://media.defense.gov/2019/May/02/2002127082/-1/-1/1/2019_CHINA_MILITARY_POWER_REPORT.pdf.

seen in sectors such as solar panels and steel could be applied to the commercial space sector. Such actions would undermine the profitability of the U.S. commercial space industry and exacerbate an already saturated international space launch market. U.S. and European panelists speaking at an international conference, for instance, doubted this market's ability to support more than a handful of commercial launch providers.[24] China alone has up to fourteen such companies.

As in other domains, as its capabilities and interests increase, the PRC will likely try to shape international space governance by courting developing countries and proactively interacting with the United Nations. China could use its influence to shape international efforts on arms control, sustainability, the commercial uses of space, and natural resource extraction in its favor. In 2018, for example, China was able to insert language referring to its "shared vision" narrative into international documents on space governance in statements by the Group of 77, a coalition of developing countries at the United Nations, as well into a report written by the Committee on the Peaceful Uses of Outer Space, a UN organization that governs the exploration and use of space.[25] PRC influence was also used to stymie Western approaches to space governance, such as through opposition to the European Union's proposed International Code of Conduct for Outer Space Activities that was intended to be a "non-legally binding, voluntary international instrument aimed at building norms of responsible behavior in space activities."[26]

Despite China's progress, the United States remains the leading space power and will likely retain that position for decades. The United States, however, could lose this position if it does not invest in its space program sufficiently and effectively. Coordinated action that emphasizes U.S.-led diplomatic, scientific, military, and economic approaches to space and helps other states achieve their objectives in this domain will be the best guarantee of maintaining U.S. preeminence in space affairs. ◈

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24 Jeff Foust, "The Launch Industry Prepares for a Shakeout," Space Review, May 20, 2019 ~ http://www.thespacereview.com/article/3716/1.

25 Carlos Játiva, "Statement of the G-77 and China during the Sixty-First Session of the United Nations Committee on the Peaceful Uses of Outer Space," H.E. Ambassador and Permanent Representative of Ecuador, June 19–20, 2018 ~ https://www.g77.org/vienna/wp-content/uploads/2019/03/UNOVMatters_OOSA-Committee-on-the-Peaceful-uses-of-Outer-Space-61st-session-20-29-June-2018.pdf.

26 Chris Johnson, "Draft International Code of Conduct for Outer Space Activities Fact Sheet," Secure World Foundation, February 2014 ~ https://swfound.org/media/166384/swf_draft_international_code_of_conduct_for_outer_space_activities_fact_sheet_february_2014.pdf.

The Russian Space Program: In Search of a New Business Model

James Clay Moltz

Over the past three decades, Russia's space program has ridden a wild and at times unpleasant roller coaster. Following the Soviet Union's breakup in 1991, its once world-leading space sector suffered a near-death experience over the following decade after state funding plummeted. Under this duress, the space program rapidly transformed itself into a low-cost commercial provider of launch and human spaceflight services to the rest of the world, but only barely getting by. After 2000, Vladimir Putin's resurrection of the space program into a condition of functionality, relative power, and even international respect by the first decade of the 21st century constituted a remarkable turnaround. Since 2014, however, in the wake of Russia's annexation of Crimea, Western sanctions, and a series of government policies that have reasserted central control over space enterprises, the space program has become less innovative and more militarily focused, while lacking a clear future direction. In this context, Russia is struggling to find a formula for space success in the 21st century. As Prime Minister Dmitry Medvedev stated recently about Russia's space situation, "This is not just a question of prestige, it is a question of national security."[1]

The vast resources Moscow has poured into a new launch complex in the Russian Far East have thus far yielded few benefits, and millions of rubles have been lost to corruption. But even more worrisome is the fact that Russia's civil and commercial space technology has failed to keep up with world standards, making Russian space products and services no longer competitive in the global marketplace. Most critically, Russia has lost almost all of its share in the commercial space launch market, depriving the country of much-needed revenue. Only in the military sector has Russia kept pace with global space developments. In terms of diplomacy, ironically

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NOTE The views expressed here are those of the author only and do not constitute official statements of U.S. Department of Defense or U.S. Navy policies.

1 "O pazvitii gosudarstvennoi korporatsii po kosmicheskoi deyatel'nosti 'Roskosmos'" [On the State Corporation for Space Activity "Roscosmos"], Portal Pravitel'stva Rossii [State Portal of Russia], June 13, 2019 ~ http://government.ru/news/36999.

Moscow has backed a new treaty to ban the placement of weapons in space, although it continues to test counterspace systems. It has stymied work at two UN bodies to score political points against the West—an old Soviet strategy. These confrontational tactics seem to have made many countries wary of Moscow's true intentions in space.

This essay briefly summarizes the transition of the highly secretive Soviet space program first to a loosely affiliated set of open commercial enterprises in the 1990s, then to a program with restored civil and military space capabilities by 2014, and finally to a situation today in many ways similar to the Soviet program: a government-run space organization under tight central control. It discusses the promise of Russia's ambitious plans for space in 2010–14 and then assesses what has gone wrong in the years since. Finally, the essay analyzes the current dynamics within Russia's space enterprise and the choices the Putin administration faces if it seeks to engage in a sustainable revival. It concludes that Russia's heavily state-run strategy is ill-suited to the rapid technological pace of the 21st-century space marketplace, leaving the country searching for a new formula for success.

A Brief History from 1985 to the Present

In the late Soviet period, space technology represented one of the few areas where Moscow had products in demand on the world market. Reformist general secretary Mikhail Gorbachev recognized that opening his closed, military-led space program might facilitate cooperation with the United States and generate much-needed income. In 1985, he created Glavkosmos, which began to market military launch services to Western commercial satellite manufacturers and, later, even high-resolution images from former spy satellites. U.S. military and space officials were initially aghast but ultimately pleased by these reforms, which provided information about previously hidden Soviet programs. By 1991, the West's fears of the Soviet space threat had largely subsided, and the U.S. commercial sector sensed new opportunities in the cash-strapped but technologically rich Russian space enterprises. Unfortunately for Gorbachev, the political freedoms he had unleashed caused the Soviet Union to spin toward its dissolution in December 1991.

While Russia inherited the bulk of the Soviet space industry, conditions under President Boris Yeltsin proved increasingly difficult. With a failing economy and a sharp drop in state orders for rockets and satellites, the newly liberated space enterprises faced a brave new world. Unpaid wages and high inflation drove thousands from the space sector, while those that remained stayed in business only by selling to Western companies and China. Yeltsin created the Russian Space Agency in 1992 to offer a civilian face to dozens of enterprises previously under the military. Cooperation with NASA on human spaceflight as well as Western commercial deals with the Khrunichev State Research and Production Space Center (manufacturer of the Proton booster), Energomash (maker of the RD-180 engine), and others barely kept the Russian space program afloat as federal support dipped from multiple billions a year to a mere $700 million by 1996.[2] China also purchased large amounts of Russian space hardware to lay the groundwork for its own human spaceflight efforts. Quickly, the Russian space program became one of the most commercialized in the world, with commercial launches and engine sales representing the biggest money-makers. Still, many enterprises struggled after decades of Soviet largesse, especially those that relied on contracts from the military, and thousands of specialists left the space sector—many leaving Russia altogether.

Putin's rapid entry onto the political scene and his election as president in 2000 marked a new start for the space program. The former KGB officer quickly identified space as a critical sector for restoring Russia's power and pride. He moved to increase funding and reconstitute a range of former military capabilities, including Russia's GLONASS (GPS) system, its missile early-warning network, and its constellations of military reconnaissance and communications satellites. To facilitate this process, the Russian military expanded and modernized its launch facility at the Plesetsk Cosmodrome, allowing it to accelerate the delivery of defense payloads into space. Meanwhile, Russian rocket manufacturers gradually increased their share to about half the global commercial launch market. In 2005, for example, Russia led the world with 22 successful space launches, of which 7 were lucrative commercial launches for Western companies. This pattern continued, given Russian launchers' reliability and lower prices than Western competitors (primarily U.S. Atlas and Delta rockets and the French Ariane rocket). Russia also continued to partner with NASA in constructing the International Space Station, restoring much of its prior international prestige.

Frustrated by President George W. Bush's withdrawal from the Anti-Ballistic Missile Treaty in 2002 and his opposition to proposed space

2 For more details on this period, see James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, 3rd ed. (Stanford: Stanford University Press, 2019), 240–43.

arms control measures, Russia announced in 2004 a no-first-deployment pledge in regard to space-based weapons, challenging the United States and others to join it. Moscow then joined with Beijing in a major 2008 diplomatic initiative proposing the Treaty on the Prevention of the Placement of Weapons in Space (PPWT). The PPWT called for countries to refrain from orbiting devoted space weapons and making threats of force against space objects. But the treaty offered no specific verification mechanism to ensure that such systems were not launched into orbit and allowed continued testing of ground-based systems against space objects. Many countries that had initially welcomed the PPWT eventually soured on the proposal due to these loopholes.

Russia hoped to boost its international credentials in the field of space science with a much publicized cooperative mission (Phobos-Grunt) to the Mars moon Phobos in 2011, which carried experiments from China and other countries as well. However, the project failed embarrassingly shortly after launch when faulty equipment (likely the result of poor-quality components) caused the satellite to become unresponsive in low-earth orbit before it could even direct itself toward Mars. The dead spacecraft suffered a humiliating uncontrolled re-entry and burn-up in January 2012, leading to finger-pointing within the Russian space program.

By the start of Putin's third presidential term in March 2012 (after Medvedev's short interregnum as president), the Russian government began looking to broaden expansion of the country's civil space program over the next decade. The $70 billion ten-year plan outlined a range of new launchers, a human landing on the Moon, and an ambitious program of deep-space scientific research. Foreign reports predicted a new golden age of Russian space dominance, with new commercial and heavy-lift launchers, extensive lunar research and manned missions, and a full range of deep-space probes. But it was not to be. Falling oil and gas prices sapped the Russian state budget, the success of the U.S. start-up launch company SpaceX in developing a low-cost heavy-lift booster (the *Falcon 9*), and Western sanctions on Russia after its intervention in Crimea and eastern Ukraine started a slow devolution of the country's position in space. While in 2013 Russia still held nearly 50% of the global commercial space launch market, by 2018 it had dropped to just 10%.[3] In 2019, Russia conducted only 2 commercial launches out of 22 total;

3 Eric Berger, "Russia Appears to Have Surrendered to SpaceX in the Global Launch Market," Ars Technica, April 18, 2018 ~ https://arstechnica.com/science/2018/04/russia-appears-to-have-surrendered-to-spacex-in-the-global-launch-market.

45 launches had been promised by prior government plans.[4] Moreover, while Russia continued to benefit from operating the sole means of accessing the International Space Station (the Soyuz spacecraft) after the end of the U.S. shuttle program in 2011, the U.S. commercial crew program's plan to begin launches in 2020 with two different systems (operated by Boeing and SpaceX) meant that the $70 million fee for each foreign astronaut brought to the station would soon disappear.

At home, Putin had devoted major funding to construct the Vostochny Cosmodrome in the Russian Far East—aimed at establishing Russia's independence from its Soviet-era launch site (the Baikonur Cosmodrome) now located in Kazakhstan and operated by Russia under a $115 million yearly lease. Putin insisted that the first launch would take place by 2014 and promised routine human spaceflight launches by 2020. But serious problems related to the embezzlement of state funds, a lack of workers, and poor management saw the deadline come and go. In the face of several Proton launch failures from Baikonur and widespread problems of poor quality and corruption in the space sector, Putin decided in early 2016 to create the state space corporation Roscosmos with the aim of bringing the commercial practices to the space sector. Roscosmos finally had its first launch from Vostochny in 2016, but problems continued.

Russia's break with the West and NATO stimulated the Russian Space Forces to engage in a number of threatening counterspace maneuvers, including resumption of work on its Nudol direct-ascent, anti-satellite interceptor and a series of proximity operations near Western satellites.[5] At the UN Committee on the Peaceful Uses of Space (COPUOS) in 2015, Russia disrupted progress toward a set of long-term sustainability guidelines—promoting international cooperation in space situational awareness, orbital debris mitigation, and space weather forecasting—by blocking the release of the first set of agreements and proposing a whole new set of concepts for consideration, irritating many Western and also nonaligned countries. In the summer of 2015, Russia also played a major spoiler role (along with China and Brazil) in halting negotiations at the United Nations for an international code of conduct for outer space activities that was backed by the European Union and the United States.

4 Svetlana Sukhova, "'Angara' problem: Pochemu novaya raketa-nositel' do sikh por ne letaet" [The "Angara" Problem: Why the New Booster Rocket Has Still Not Flown], *Kommersant*, January 13, 2020 ~ https://www.kommersant.ru/doc/4214792.

5 For more specific details on these programs, see "Russian Federation," in *Global Counterspace Capabilities: An Open Source Assessment*, ed. Brian Weeden and Victoria Samson (Washington, D.C.: Secure World Foundation, 2018), 2-1–2-35.

Instead, it continued to insist on the Russo-Chinese PPWT. Still, after a year of bad publicity at COPUOS, Russia backed down and allowed the first set of long-term sustainability guidelines to be released in 2016.

In the absence of any clear progress toward improving the Russian civil space sector by former Roscosmos general director Vladimir Popovkin, Putin took the highly unusual step of appointing his deputy prime minister Dmitry Rogozin to lead the space agency in May 2018. Yet economic weaknesses and low energy prices forced the Putin administration to downgrade its decadal space plan from $70 billion to just $20 billion, meaning drastic cuts for the Roscosmos budget.

The Current Status of Russia's Space Sector

The combined effects of Western sanctions, falling oil and gas prices, and the failure of Putin's highly bureaucratized Roscosmos to deliver new technologies have left Russia's space program in a troubled condition. With the recent rise of foreign (especially U.S.) launch competitors, Russia's main space income-generator is at risk. Thus, space is becoming a loss leader rather than a source of revenue, and Russia's threatening military space program depends on an aging technological base. In a strikingly blunt interview with space leaders in early 2019, Prime Minister Medvedev scolded Rogozin and his Roscosmos team: "We need to quit projecting future plans, stop talking about where our missions will land in 2030, get to work, and do more." With just one commercial launch conducted in 2017, he warned that Roscosmos must be "more active in commercializing our space industry and increase Russia's international market share of commercial launches."[6] However, this is easier said than done.

Several problems undergird the challenges Russia faces. First, Russia's current stable of rockets uses old technology and lacks the capability to land and reuse spent rocket stages, a technique that SpaceX has pioneered and that has allowed it to engage in dramatic price cuts. Second, many of the new technologies that are driving the global market in space services are coming from small commercial start-up companies. Yet Russia lacks a viable private venture capital market, requires would-be space entrepreneurs to register with the Federal Security Service, and lacks a legal regime

6 Eric Berger, "Russian Space Chief Told to Drop Grandiose Talk, Get More Done," Ars Technica, January 24, 2019 ~ https://arstechnica.com/science/2019/01/russian-prime-minister-blasts-space-chief-talk-less-do-more.

to support intellectual property protection.[7] Moreover, Roscosmos sees start-ups as potential competitors for state funds and actively blocks their development. Instead, its highly centralized bureaucracy and top-down management processes stifle innovation and push out timelines while fostering corruption. In 2018 alone, 27 people were convicted of crimes in the space sector, and government statistics stated that as much as 10% of funds at Vostochny had been embezzled.[8] Finally, a third factor in Russia's decline relates to the specific implications of Western sanctions on space production. Before 2014, Russian space enterprises routinely purchased high-quality Western-made components for their satellites, creating a relationship of dependency. Putin's decision to invade Crimea and eastern Ukraine ended that relationship and forced Roscosmos to either develop alternative suppliers or reconstitute Russian production lines, both costly and time-consuming efforts that have so far been unsuccessful.

The Russian Space Forces continue to benefit from generous state funding. Putin has developed a large sovereign wealth fund and can dip into it for critical projects. However, counterspace weapons do not generate income, posing a dilemma for Russia's long-term sustainability in space. Russia's post-1991 business model has depended on launch-generated revenues (for Western commercial satellites and astronauts), which have supported Roscosmos and its enterprises and allowed the space program to remain active in human spaceflight and, to a lesser degree, space science. But Russia has staked its future on the long-awaited Angara booster that is being built by Khrunichev, which is now years behind schedule. No pad even exists for its planned launches from Vostochny. Indeed, the project's prospects are so poor that Roscosmos is now proposing more rapid development of a Soyuz-5 rocket, even though it is based on 40-year-old technology and, if completed, will not be capable of returning stages to the launch pad for reuse, making it uncompetitive with SpaceX.

Russia's strategy at the United Nations and elsewhere seems to be aimed mostly at blocking and discrediting the growing U.S. commercial and military role in space by building a coalition of like-minded nations behind a set of vague and unverifiable initiatives allegedly intended to prevent the weaponization of space. Since many countries are without space programs,

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7 For more on this situation, see James Clay Moltz, "The Changing Dynamics of Twenty-First-Century Space Power," *Strategic Studies Quarterly* 13, no. 1 (2019): 66–94.

8 Matthew Bodner, "The Long Road to Vostochny: Inside Russia's Newest Launch Facility," SpaceNews, January 30, 2019 ~ https://spacenews.com/the-long-road-to-vostochny-inside-russias-newest-launch-facility.

or are friendly with frequent co-sponsor China, the PPWT and Russia's resolution on no first placement of weapons in space continue to receive widespread support. But they have few prospects of becoming international law in their current form, which raises questions about their real value. Meanwhile, the Russian Space Forces continue to develop a range of ground- and space-based anti-satellite systems that are repeatedly called out in international discussions by the United States and the United Kingdom.[9] Equally problematic is the lack of meaningful Russian leadership in civil space, where even Roscosmos director Rogozin now downplays previous and unfulfilled plans to land Russians on the Moon, in part because of his organization's failure to develop a new heavy-lift rocket.

Given these conditions, it is hard to see how Russia can expect to restore its previously leading role in international space activity. While its counterspace technologies will continue to pose a serious threat to Western space systems, overall trends indicate a slow but steady decline. Even in the military sector, problems are beginning to emerge. Vice Premier Yuri Borisov described a "very tough, serious discussion" he conducted in December 2019 with top military officials about ongoing "delays in the development of domestic satellite constellations serving Russian military purposes."[10] Russian officials admit that achieving an independent capability to manufacture the full range of electronic components needed for these satellites will now take until 2030. The best chance for Russia's return to space power would be a dramatic reform of its space sector and a reintegration with foreign companies, along with a decentralization of state management and controls. However, given political trends in Russia and the possibility of two additional terms in office for President Putin, this direction seems highly unlikely.

Instead, Russia seems intent on persevering with a neo-Soviet model of state-led space development, despite its unsustainability over the long haul. Support for a realistic settlement of the Ukrainian crisis, a fortuitous rise in oil and gas prices (unlikely in the wake of the global coronavirus recession), or a loosening of political and economic controls to spur domestic space entrepreneurs might alleviate the Russian space program's woes. But, in the context of Putin's Russia, such changes appear to be much like Communism once was during the Soviet period: only a distant vision on the horizon. ◈

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9 Robert A. Wood, "The Threats Posed by Russia and China to Security of the Outer Space Environment," statement before the Conference on Disarmament Plenary Meeting on Agenda Item Three, Geneva, August 14, 2019 ~ https://geneva.usmission.gov/2019/08/14/statement-by-ambassador-wood-the-threats-posed-by-russia-and-china-to-security-of-the-outer-space-environment.

10 Vladimir Mykhin, "Rossiiskogo kosmosa v galaktike pochti ne ostaloc" [Russia's Space Program Is Hardly in the Galaxy Anymore], *Nezavisimaya Gazeta*, January 1, 2020.

Japan's Space Power

Saadia M. Pekkanen

Japan derives its space power from three distinct components, which make it possible to assess and gauge the country's capacity for independent space statecraft on multiple fronts. First, Japan has cutting-edge technologies that stretch across the civilian, commercial, and military domains. Second, it has developed legal and policy structures that normalize the country's positions and interpretations to be consistent with international space law. Finally, Tokyo has prioritized space diplomacy and governance in its foreign relations portfolio. Together, these hard and soft competencies are valuable for Japanese statecraft in an unpredictable and changing world order, positioning Japan to shape the flow of international engagements, activities, and events in line with its national interests. They also provide a way to understand the potential substance and trajectory of Japan's statecraft beyond the commonly used and narrow prism of the U.S.-Japan alliance.

Technological Foundations

Space technologies are dual-use, allowing countries to amass significant military capabilities under the guise of civilian and commercial enterprises.[1] In Japan's case, constitutional and pacifist constraints in the early postwar period served to focus policy attention on the country's scientific and exploratory space programs.[2] This programmatic emphasis was further reinforced by the presence of the U.S.-Japan alliance, which drew attention away from the military aspects of the space program. The result is that during the postwar period, and without any significant blowback, Japan was able to amass in plain sight an impressive suite of

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NOTE ~ The author thanks the Center for Global Partnership for financial support on this project.

1 Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), 6–7.

2 Unless otherwise indicated, information on Japan's space technologies, agreements, laws, and so forth is from the official website of the Japan Aerospace Exploration Agency (JAXA) ~ http://www.jaxa.jp.

space technologies that today can be transposed for military purposes if and when the country so chooses.[3]

Rockets. Japan has indigenous and highly sophisticated capabilities in both liquid- and solid-fuel rockets. Among liquid-fuel variants, the H-IIA rocket is Japan's flagship rocket and has launched almost all of the country's major satellites, including those for meteorology, observation, and reconnaissance. From its debut test flight in August 2001 to its 41st launch in February 2020, the H-IIA boasts a near-perfect launch record of 98% and has, to date, enjoyed an unbroken string of 35 successful launches.[4] Its more powerful version, the H-IIB, ferries a cargo transporter to the International Space Station. Both the H-IIA and H-IIB are scheduled to be replaced by the H-III rocket in 2020, allowing Japan to send heavier payloads much deeper into space.[5]

Japan also has a long and excellent history in solid-propellant rockets. Its operational rocket on this front is the three-stage Epsilon, which debuted in 2013. Along with using H-IIA solid-fuel rocket boosters for the first stage, the Epsilon's upper stages are built on earlier rocket technology, namely the sophisticated multistage M-V that caught the attention of the United States for its comparability to the MX Peacekeeper intercontinental ballistic missile before being discontinued in 2006.[6] The Epsilon has a perfect launch record, but to date it has only had four launches. It is billed as an advanced next-generation rocket capable of speedier launches, as it incorporates artificial intelligence for automatic and autonomous pre-flight inspection and mobile control through laptop computers.

Satellites and spacecraft. Japan has made remarkable strides since the launch of its first satellite, *Ohsumi*, in 1970. In the last 50 years, Japan has amassed full-spectrum and cutting-edge capabilities across a range of satellites and spacecraft, including those for lunar and planetary exploration, astronomy, meteorology, communication, observation, navigation, and reconnaissance. Japan has emphasized the importance of these technologies for pragmatic policy purposes—such as disaster management, environmental monitoring, industrial development, and

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3 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).

4 Maiko Kobayashi, "H2A roketto uchiage seiko" [Successful Launch of H2A Rocket], *Asahi shimbun*, February 9, 2020 ~ https://www.asahi.com/articles/ASN2930P8N1QULBJ00P.html.

5 "Mitsubishi Heavy Looking to Develop More Powerful H3 Rocket for Lunar Missions," *Japan Times*, November 12, 2019 ~ https://www.japantimes.co.jp/news/2019/11/12/national/science-health/mitsubishi-heavy-h3-rocket-space-moon/#.Xk7z7yhKiUk.

6 Pekkanen and Kallender-Umezu, *In Defense of Japan*, 111–13, 178–80.

national defense—and continues to seek independent technology pathways. It has kept pace, for example, with the worldwide shift to small satellites. In late 2019, Japan's super low altitude test satellite (SLATS) *Tsubame* set a Guinness world record for being the lowest-altitude Earth observation satellite in orbit.[7] In addition, it has sent sample-return missions to asteroids billions of miles away, the most notable being those of the *Hayabusa* spacecraft. Furthermore, Japan has launched the Quasi-Zenith Satellite System (QZSS), which is designed to be compatible with the United States' GPS system but that, over time, will allow Japan to have autonomous positioning information for safety and security reasons.

NewSpace. Japanese entrepreneurs are also endeavoring to keep abreast of "NewSpace" developments. NewSpace loosely refers to a wide range of emerging companies with innovative space technologies that aim to profit in a space economy projected to rise from over $400 billion today to around $1 trillion by 2040.[8] In Japan, a number of such private companies have risen to the fore with products and services that traverse both the market and military domains. Axelspace, for example, is working to revolutionize physical and social views of the planet by advancing microsatellite technologies; Astroscale projects that space debris removal will become a routine service industry as satellite megaconstellations are launched; ispace bills itself as a lunar exploration company with an eye on the Moon's water resources to spearhead a lunar space economy; and Synspective proposes to advance synthetic-aperture radar satellite data solutions across a wide range of industries such as urban planning, finance and investment, disaster mitigation, mineral and energy development, and infrastructure development. All these firms are part of the worldwide vanguard of private industry into space.

Domestic Legal and Policy Frameworks

Japan has come a long way from the Diet's 1969 "peaceful purposes" resolution, which sought to unequivocally signal the country's commitment to peaceful and nonmilitary activities in outer space. This resolution

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7 For more information, see "Super Low Altitude Test Satellite (SLATS) 'Tsubame' Has Set a Guinness World Record," JAXA, Press Release, December 24, 2019 ~ https://global.jaxa.jp/press/2019/12/20191224a.html.

8 John Holst and Becki Yukman, "Q1—The Space Report 2019," Space Foundation, January 2019 ~ https://promo.spacefoundation.org/tsr/quarterly-reports/TheSpaceReport19Q1.pdf; and "Space: Investing in the Final Frontier," Morgan Stanley, July 2, 2019 ~ https://www.morganstanley.com/ideas/investing-in-space.

reflected Japan's interpretation of the 1967 Outer Space Treaty. Japan set a high—and given the dual-use nature of space technologies, unrealistic—bar for itself by interpreting peaceful use strictly as "nonmilitary" as opposed to the more widely used "nonaggressive" interpretation.[9]

Legal changes. In 2008, as the prospects for NewSpace reality and the geopolitical situation surrounding Japan changed, the Diet passed its first ever Basic Space Law. Among other things, this law led to the establishment of the Strategic Headquarters for National Space Policy and mandated the 2009 Basic Space Plan that continues to be revised frequently. The legal importance of the 2008 Basic Space Law was that it finally aligned Japan's interpretation of peaceful use of outer space as nonaggressive in accordance with accepted international interpretations, paving the way for space industry developments in the security and military domains. Also notable are two more recent pieces of legislation that recognize the expanding role of commercial and private entities in outer space activities. Japan set up the Space Activities Act in 2016 to license launch and satellite operations and to clarify liability and indemnification for damages. It also established the Remote Sensing Act in 2016, which licenses remote-sensing devices and certifies remote-sensing data distributors.

Political support. Perhaps most important, Japan's space developments are boosted by high-level support from the government under Prime Minister Shinzo Abe. Space is marked as a critical domain under his doctrine of "proactive pacifism" and has been elevated in the context of defense cooperation in the U.S.-Japan alliance.[10] With an eye on both commercial prospects and national security, the government has accelerated efforts to support space businesses in a globally competitive environment, committing approximately 100 billion yen ($1 billion) to foster growth in public-private partnerships.[11]

Law, Governance, and Diplomacy

Japan has also amplified its space capabilities by harnessing the powers of law and diplomacy through international and regional venues.

9 Setsuko Aoki, "Current Status and Recent Developments in Japan's National Space Law and Its Relevance to Pacific Rim Space Law and Activities," *Journal of Space Law* 35, no. 2 (2009): 363–438.

10 Ministry of Defense (Japan) and U.S. Department of Defense, "The Guidelines for Japan-U.S. Defense Cooperation," April 27, 2015, chap. VI ~ https://www.mofa.go.jp/files/000078188.pdf.

11 "Dai san kai uchu kaihatsu riyo taisho hyoshoshiki, shusho kantei" [Awards Ceremony for the Third Space Exploitation Prize], Prime Minister's Office of Japan, March 20, 2018 ~ https://www.kantei.go.jp/jp/98_abe/actions/201803/20uchuu.html.

International space law. Like other spacefaring countries, Japan has long been embedded in the international space law regime. It is a party to four of the five treaties that form the core of international space law, namely the foundational 1967 Outer Space Treaty, the 1968 Rescue Agreement, the 1972 Liability Convention, and the 1975 Registration Convention; it is not a party to the 1979 Moon Agreement. Japan recognizes the set of five principles adopted as UN General Assembly resolutions on outer space, and is fully cognizant of the complex web of other related resolutions, along with domestic space law, memoranda of understanding, informal structures and arrangements, customs, and soft laws that make up the international space law regime.[12]

However, there are looming differences in interpretations of some of the foundational principles of the 1967 Outer Space Treaty, such as whether space resources can be appropriated at all by a state or commercial entity,[13] or even more fundamentally whether outer space is a global commons. It remains to be seen how Japan will use its position to shape such governance debates in the years ahead. It is more than likely that if Japanese commercial enterprises make credible strides toward space resource extraction on celestial bodies, Japan will seek to clarify and protect their ownership rights much in the same way that the United States and Luxembourg have done through national legislation. In the meantime, at a more pragmatic and immediate level, the transnational structure of the space regime allows Japan to engage diplomatically with other players and structure agreements and outcomes in line with its own interests. One of its most notable space relationships, for example, is with the United Arab Emirates (UAE), a space leader in the Arab world, which has remarkable ambitions backed credibly by significant political and financial resources. Japan and the UAE signed a space activities agreement for the use of outer space for peaceful purposes in 2016.

Asia-Pacific Regional Space Agency Forum. Japan has also taken steps to shape regional space governance, most notably through spearheading the creation of the Asia-Pacific Regional Space Agency Forum (APRSAF), which dates back to 1993.[14] Today the main Japanese representatives in APRSAF are the Ministry of Education, Culture, Sports, Science and Technology (MEXT)

12 Francis Lyall and Paul B. Larsen, *Space Law: A Treatise* (London: Routledge, 2018), 27–48.

13 Tanja Masson-Zwaan and Mahulena Hofmann, *Introduction to Space Law*, 4th ed. (Alphen aan den Rijn: Wolters Kluwer, 2019), 99–100.

14 Information on APRSAF is from the "About APRSAF" tab on the official English website available at https://www.aprsaf.org.

and the Japan Aerospace Exploration Agency (JAXA). After 26 annual conferences rotated among participant countries—but always historically co-hosted by Japanese agencies, morphing into MEXT and JAXA since 2004—APRSAF has become a useful platform for Japan to engage other space aspirants in the region and elsewhere who seek to advance their own socioeconomic development.[15] The forum remains an open and flexible regional cooperative framework, stressing voluntary and cooperative activities and seeking concrete cooperative activities to solve regional issues. Its four working groups—space applications, space technology, space environment utilization, and space education—provide a rubric for international projects, such as those related to disaster management and environmental protection. These offer concrete pathways to set up collaborative joint project teams of interest to APRSAF participants, such as Sentinel Asia, which was initiated in 2005 to focus on natural disasters in the Asia-Pacific region.

Japan's Position in the New Space Race

In the swirls of a new space race characterized by democratization, commercialization, and militarization, Japan is in a critical position to deploy its hard and soft competencies.[16] It is a space power to watch.

Through its solid foundation in technology, Japan can credibly partner with both advanced and emerging space powers around the world on complex science and engineering missions ranging from designing and launching satellites to those aiming for the Moon and beyond. Such projects can involve the analytics of small satellites and big data refocusing our attention on human activities on Earth, or they can aim for imaging and prospecting celestial bodies with a new hybrid of autonomous spacecraft and robots.

Through the reorientation of its domestic legal and policy frameworks, Japan has elevated its status in the U.S.-Japan alliance. Today, Japan continues to echo themes of minimizing risks, building resilience, and deterring threats with great force. Yet it is no mere junior partner to the

15 For background and comparative perspectives on APRSAF, see James Clay Moltz, "Asian Space Rivalry and Cooperative Institutions: Mind the Gap," in *Asian Designs: Governance in the Contemporary World Order*, ed. Saadia M. Pekkanen (Ithaca: Cornell University Press, 2016), 116–34; and Ram S. Jakhu and Joseph N. Pelton, eds., *Global Space Governance: An International Study* (New York: Springer, 2017), 65–86.

16 Saadia M. Pekkanen, "Governing the New Space Race," *American Journal of International Law Unbound* 113 (2019): 92–97.

United States and is charting independent technological pathways that may, step by step, become more consequential for the durability of the security alliance. One trend to watch is whether Japan will also extend a limited version of collective self-defense—which underpins military operations with the United States—to the protection of space assets.[17]

Finally, by enmeshing itself with others in the processes of law, diplomacy, and governance, Japan is demonstrating its pragmatic understanding that reliance on space technology and solutions alone is insufficient. Public, private, and hybrid partnerships operating on norms, principles, and rules across new borders—in orbit, on asteroids, near and on the Moon, and even beyond Mars—are going to be critical in the years ahead. Through its engagements in international and regional venues, Japan has subtly positioned itself to influence the policy positions of other countries on the principles governing outer space activities and the types of collaborative frameworks necessary for advancing peaceful governance. In the long game of such processes, Japan has also effectively built up an important constituency for its dual-use space interests in the fierce global competition. ◈

17 Saadia M. Pekkanen, "U.S.-Japan Military Space Alliance Promises to Grow in 'New Ways,'" *Forbes*, October 27, 2015 ~ https://www.forbes.com/sites/saadiampekkanen/2015/10/27/u-s-japan-military-space-alliance-promises-to-grow-in-new-ways/#2a06a6dd7d5d.

South Korea's Space Program: Activities and Ambitions

Hyoung Joon An

Among spacefaring nations, the Republic of Korea (ROK) is a relatively young player. Despite establishing some infrastructure necessary for space-related activity in the 30 years after the launch of *Sputnik*, the country truly committed to such activity only in the 1990s. Since then, South Korea's space program has developed rapidly to become a significant presence. In 1992 the launch of KITsat-1 (Korean Institute of Technology Satellite), the first ROK satellite, marked the program's first major achievement, after which the country built up its technological capabilities for space exploration relatively quickly. It has launched 37 satellites into orbit to date and in 2013 developed its first space launch vehicle, the KSLV-1 (also called *Naro-1*).[1] At present, South Korea aims to launch the first wholly Korean-made launch rocket, the KSLV-2 (also called *Nuri*), by 2021, which will later be used to launch a lunar orbiter and lander as well.

This essay examines how South Korea's national framework for space development and scientific and technological activities in the space sector have evolved in recent decades. To understand the country's space-oriented ambitions, the essay reviews the ROK's "Third Basic Plan for the Promotion of Space Development, 2018–2022," which marks the nation's latest comprehensive space policy and includes space launch vehicles, satellites, the Korea Lunar Exploration Program, and the Korean Positioning System (KPS).

Historical Background and Institutional Framework

The vision of developing space for economic security has provided a strong boost to various ROK space projects since the 1980s. Although the country did not have an adequate infrastructure network for such development, in the 1970s it began outlining a new economic rationale for entering the field of space technology based on developing high-tech

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[1] For further background on Korean satellites, see "Online Index of Objects Launched into Outer Space," UN Office for Outer Space Affairs ~ https://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id.

infrastructure and skilled workers trained in the nation's growing defense industry. Because the majority of the country's industries utilized low-cost labor and only became competitive in world markets in the 1980s, the government emphasized space development as a way to reinforce the country's economic security.[2] Space development was expected to afford South Korea the opportunity to catch up with advanced industrial nations and withstand fierce international competition in new technologies.

In 1985 the government announced the "Long-Term Plan for the Development of Science and Technology toward the 2000s," which emphasized space development as a way to reinforce industrial competitiveness. Furthermore, in 1987 it passed the Aerospace Industry Development and Promotion Act, which provided the first significant funding for a national space program. Both strategies focused on developing satellites and sounding rockets for space launch vehicles expected to follow.[3] With the establishment of the Korea Aerospace Research Institute (KARI) in 1989—which would become the principal actor in South Korea's civilian space program—SaTReC (Satellite Research Center) at the Korea Advanced Institute of Science and Technology and Korea Telecom emerged as central actors. Although initially relying on technology imported from other countries, South Korea aspired to attain indigenous capabilities for space development.

In 1996 the government announced the "First Basic Plan on Mid-to-Long-Term National Space Development." The chief objectives were to join the top ten countries in the space industry and, by 2010, to launch the KSLV-1 from a local launch site with an independently developed satellite. This plan was ultimately replaced by the "Basic Plan for the Promotion of Space Development" in 2007. In addition, the government passed the Space Development Promotion Act in 2005, which stipulates that it must draft a basic plan every five years to address emerging objectives and strategies for national space development.

Announced in February 2018, the current "Third Basic Plan for 2018–2022" set the ultimate objective of "improving public safety and quality of life by implementing challenging but reliable space development." To achieve that objective, it identifies four strategies: harmonizing challenges and practicalities, selecting and focusing on strategic sectors, creating new

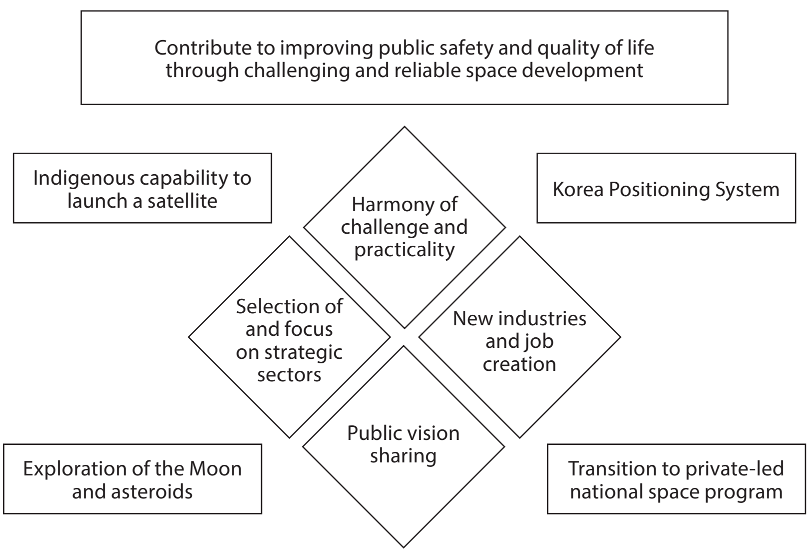
2 Denis Fred Simon and Changrok Soh, "Korea's Technological Development," *Pacific Review* 7, no. 1 (1994): 90.

3 Sounding rockets are research rockets designed to take measurements.

industries and jobs, and sharing the public vision (**Figure 1**). These four strategies are accompanied by four goals. First, to establish an indigenous space launch vehicle, South Korea is concentrating on developing the KSLV-2 to place a 1.5-ton satellite into low-earth orbit (i.e., 600–800 kilometers from Earth's surface) and advance the nation's satellite application service and development. Second, it plans to complete a lunar exploration project by 2020 and land an indigenous spaceship on the Moon by 2030. Third, South Korea plans to establish its own satellite navigation system, the KPS, which will encompass the Korean Peninsula and surrounding areas. The goal is to start the service in 2035 as a means to obtain more stable location information. Fourth and last, it expects to transition from government-led space development to private-sector-led activities in an effort to establish an environment favorable to space innovation.

FIGURE 1

Objectives of the "Third Basic Plan for the Promotion of Space Development, 2018–2022"



Space Launch Vehicles

South Korea initiated the Korean Sounding Rocket (KSR) project for scientific purposes in the 1990s. In the years that followed, KARI successfully launched the solid-fuel sounding rockets KSR-1 in 1993 and KSR-2 in 1998, as well as the liquid-fuel KSR-3 in 2002. The indigenous propulsion, control, and guidance technologies used in the KSR series would later be utilized for the first space launcher.[4] However, national security concerns soon intervened to renew the ROK's emphasis on developing space capabilities. In August 1998, North Korea's Taepodong-1 missile test and attempted satellite launch shocked South Korea and laid bare the democratic country's fundamental reliance on the United States for space-derived intelligence about its northern neighbor. In response, the government moved the timeline for its independent launch of the KSLV-1 forward by five years from 2010 to 2005.

To meet the approaching deadline, South Korea dropped its commitment to independence in technological development by deciding to purchase equipment from Russia. Moscow agreed to provide the standard booster from its Angara project to serve as the first stage of the South Korean launch vehicle, while the ROK planned to develop its own solid-fuel kick motor for the second stage. Nevertheless, the successful launch of the KSLV-1 was delayed for eight years due to lengthy negotiations on technology transfer between the two countries, technical problems, and two failed launch attempts in 2009 and 2010. At last, in January 2013, South Korea succeeded in joining the world's elite "space club" when the KSLV-1 blasted off and placed a satellite into orbit.

Taking the KSLV-1 as a stepping stone, South Korea started the next phase of the project—a rocket entirely made at home, the KSLV-2—in 2010. This rocket is designed to launch a 1.5-ton utility satellite into low-earth orbit. The three-stage launch vehicle uses a cluster of four 75-ton thrust liquid-fuel rockets in the first stage, a 75-ton liquid engine in the second stage, and a 7-ton liquid engine in the third. On November 28, 2018, a test launch vehicle that consisted of only the 75-ton liquid engine was successfully launched from the Naro Space Center.

The KSLV program has proved crucial to establishing South Korea as a new entrant in the space community, contributing to the nation's prestige and boosting its national image abroad. KARI currently plans to cultivate a

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4 Gwang-Rae Cho et al., "The Korean Sounding Rocket Program," *Acta Astronautica* 62, no. 12 (2008): 706–14 .

launch service ecosystem based on the KSLV-2, as well as to link and expand that ecosystem in the future.

Satellites

Although initially focused on purchasing foreign technology, South Korea has made major efforts in the last decade to develop independent capabilities for the production and orbiting of satellites using its own launcher. During the 1990s the country initiated a space program with KITsat-1 and KITsat-2, an endeavor aided by the University of Surrey in the United Kingdom, and with the Korea Multi-Purpose Satellite (KOMP) series. KOMPsat-1, initially launched in 1999, involved cooperation with foreign manufacturers including TRW (now merged with Northrop Grumman), Astrium, ELOP, and Thales Alenia.[5]

In the 21st century, South Korea has increased its technological capabilities with dozens of successful satellite projects, including KITsat-4 and the Science and Technology satellite known as STsat-1 in 2003, KOMPsat-2 and KOREAsat-5 in 2006, KOREAsat-6 and COMS-1 in 2010, KOMPsat-3 in 2012, STsat-2c along with KOMPsat-5 and STsat-3 in 2013, KOMPsat-3A in 2015, CAS500-1 in 2017, GEO-KOMPsat-2A in 2018, and GEO-KOMPsat-2B in 2020.

Among those achievements, the KOMPsat series has comprised low-earth orbit observation satellites with optical and imaging radar as well as infrared observation capabilities. The series enables South Korea to monitor the ground, ocean, and general environment with high accuracy and strengthen the nation's security and international competitiveness in space technology. Satellites in the STsat series, by contrast, are devoted to preliminary research and experiments in space, whereas the COMS (the Communication, Ocean, and Meteorological Satellite) series serves the needs of meteorological observation, monitoring, and the development of next-generation geostationary satellite communications. Beyond that, the GEO-KOMPsat-2 program is designed to develop two geostationary orbit satellites sharing the same satellite bus. In that series, GEO-KOMPsat-2A

5 Martin N. Sweeting, "Space at Surrey: Micro-Mini Satellites for Affordable Access to Space," *Air and Space Europe* 2, no. 1 (2000): 38–52; and Choi Joon-Min, "Perspective on Korean Space Technology Development Programs," in *Space Technology Development: Effects on National Security and International Stability*, ed. Park Jiyoung (Seoul: Asan Institute for Policy Studies, 2014), 67–97.

is for meteorological and space weather monitoring missions, whereas GEO-KOMPsat-2B is for monitoring the ocean.[6]

Having made remarkable achievements in satellite development over the past 30 years, South Korea is now concentrating on converting its government-led satellite projects into a system led by the private sector. As part of that plan, the CAS500 program is intended to meet the demand for satellites in the public sector and expand the foundation for the domestic satellite industry. The CAS500 series includes the 500-kilogram-class compact advanced satellite, an Earth-observation model using the Advanced Earth Imaging Sensor System with a ground resolution of a half meter in panchromatic mode and two meters in color mode. KARI and the industry plan to jointly develop CAS500-1, and in the process KARI will transfer the core technologies to private industry. For CAS500-2, the industry will be responsible for overall development, while KARI will perform technical audits and provide technical support. CAS500-1 is expected to enter into orbit in late 2020.

The Korean Lunar Exploration Program

Since the turn of the century, competition has skyrocketed among Asian countries, including China, Japan, and India, to explore space and the Moon.[7] A capacity for lunar exploration is both an indicator of national power and a proxy for a country's scientific and technological power. The Korean Lunar Exploration Program, South Korea's first foray into deep space exploration, is symbolic of the nation's capacity to advance its space technology and, in turn, boost national pride. The program was initiated as part of the "First Basic Plan for the Promotion of Space Development" in 2007 and specified a two-phase strategy in the "Second Basic Plan" in 2011.

In the first phase, the development of the Korean Pathfinder Lunar Orbiter will be carried out in collaboration with NASA. The phase will involve securing core technology for space exploration, establishing a deep space telecommunications network, and developing technology payloads. In the second phase, an unmanned lunar orbiter and lunar lander will be developed and launched as an ROK-made launch vehicle in 2030.

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6 "Korea's Cutting-Edge Satellites for Observing the Earth," Korea Aerospace Research Institute ~ https://www.kari.re.kr/eng/sub03_02.do.

7 Brian Harvey, Henk H.F. Smid, and Theo Pirard, *Emerging Space Powers: The New Space Programs of Asia, the Middle East and South America* (London: Springer, 2009).

The program is currently completing the detailed design of the orbiter and six scientific payloads for the first phase.

However, the launch of the Korean Pathfinder Lunar Orbiter has been delayed from December 2020 until July 2022 after the mission encountered technical issues in development.[8] The weight of the planned orbiter continued to increase as development progressed and failed to meet the 550-kilogram limit. Consequently, KARI, in consultation with NASA, has changed the lunar orbital transference from the existing phasing loop transfer method to the ballistic lunar transfer and weak stability boundary method, which uses the gravity of the Earth, the Moon, and the Sun to enter the Moon's orbit.

Korean Positioning System

The KPS is another key space program that advances South Korea's ambitions in space technology and aims to improve the quality of life for its people. The goal is to provide citizens within a thousand-kilometer radius of Seoul an ultraprecise location data service at meter, sub-meter, and centimeter resolutions. The implementation of the KPS will benefit citizens by providing stability without depending on foreign systems such as GPS. It is also expected to accelerate the fourth industrial revolution, including technology such as self-driving automobiles and the country's burgeoning drone industry, by transmitting accurate location information.[9] Designed to be a system fully compatible with and complementary to GPS, the KPS is expected to improve the performance of positioning, navigation, and timing on the peninsula as well as joint U.S.-ROK response capabilities should GPS problems arise. Building the system also has the advantage of improving the accuracy of GPS in general. By 2035, when the KPS is expected to consist of seven satellites, the error range of GPS in South Korea, currently at ten meters, will be reduced to less than one.

Since the KPS plan was unveiled in the "Third Basic Plan" in 2018, a preliminary steering committee for the project has been organized. Currently, the committee has overseen planning for a preliminary feasibility study to define the system's service and system requirements.

8 Choi Ha-yan, "Plans for Korea's Lunar Orbiter Were Unrealistic and Poorly Conceived from the Start," *Hankyoreh*, December 1, 2019 ~ http://english.hani.co.kr/arti/english_edition/e_national/919133.html.

9 Michael Herh, "S. Korea to Build 'Korean Positioning System' by Putting Up Seven GPS Satellites," *Business Korea*, January 30, 2018 ~ http://www.businesskorea.co.kr/news/articleView.html?idxno=20414.

Ultimately, the KPS will be a regional navigation satellite system consisting of three geostationary navigation satellites, four oblique navigation satellites, and a vast series of terrestrial systems. Constructing the entire system is projected to cost approximately 3 trillion won ($259 million).[10]

Conclusions

South Korea's space program has been primarily driven by a nationalistic rationale implicit in the argument that space development serves self-defense, economic security, and national prestige. The country's aspirations in space have evolved as it has pursued national development, allowing it to attain indigenous abilities. Space development has proceeded with the support of a strong industrial policy similar to the pattern of South Korea's entry as a late developer in other sectors, including heavy and chemical industries, shipbuilding, automobiles, electronics, and telecommunications.[11] Space development has become one of the largest-scale R&D programs for achieving national science and technology aspirations and has been viewed as a way to reinforce South Korea's industrial competitiveness. A close review of the major space-related activities in which the ROK has participated reveals that its ambitions are expected to not only improve the management of national resources and responses to social problems but also greatly enhance the country's influence on the global space order.

Concerning the "Third Basic Plan for the Promotion of Space Development 2018–2022," two recommendations can be proposed to better fulfill the strategies therein. First, it is necessary to review the need to revamp current space development governance and to establish a dedicated space agency at the national level. South Korea's space development programs have been planned and committed to by the Ministry of Science and ICT. However, amid rapid changes in global space development in terms of technology, industry, security, and diplomacy, the participation of government ministries has expanded to include, for example, the Korea Meteorological Administration; the Ministry of Oceans and Fisheries; the Ministry of Land, Infrastructure and Transport; the Ministry of Foreign Affairs; and the Ministry of National Defense. Therefore, a space agency

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10 Jung Min-hee, "KARI to Work on Basic Design of Personal Air Vehicle This Year," *Business Korea*, January 3, 2020 ~ http://www.businesskorea.co.kr/news/articleView.html?idxno=39807.

11 Juan Felipe Lopez-Aymes, "Automobile, Information and Communication Technology and Space Industries as Icons of South Korean Economic Nationalism," *Pacific Focus* 25, no. 2 (2010): 289–312.

dedicated to development, representation, and coordination needs to be established to afford a higher level of governance.

Second, South Korea should be a more active participant in developing an international legal framework for space activity. Thus far, the ROK is a signatory to four of the UN space treaties: the Outer Space Treaty, the Rescue Agreement, the Liability Convention, and the Registration Convention. In addition, the country is a member of international space institutions and conventions, including the UN Committee on the Peaceful Uses of Outer Space, the Agreement Relating to the International Telecommunications Satellite Organization, the Convention on the International Mobile Satellite Organization, and the International Telecommunication Constitution and Convention. Participation in these activities helps maintain close networks with foreign space development agencies and enables cooperation between space diplomacy–related ministries, and South Korea complies with most of their guidelines. Nevertheless, a network of specialists is urgently needed to review and propose space laws and protocols related to emerging issues such as utilizing outer space resources and space debris. As a reliable member of the international space community, South Korea should establish a group of experts to support the pursuit of appropriate activities. ◈

India's Space Program, Ambitions, and Activities

Namrata Goswami

The Indian space program is one of the most advanced among Asian spacefaring nations. India's demonstrated space capacities, both civilian and military, include missions to the Moon and Mars, Earth observation and navigation, anti-satellite (ASAT) weapons capability, and the ability to launch satellites into multiple orbits simultaneously. India came very close to landing near the lunar south pole with its *Chandrayaan-2* mission in September 2019, but its *Vikram* lander malfunctioned at the last minute.[1] On December 2, 2019, NASA's Lunar Reconnaissance Orbiter Camera released details of the impact site and the associated debris field from the lander, just 2.1 kilometers short of its intended target.[2] India has future missions planned for the Sun in 2021, the first Indian astronaut to low-earth orbit in 2022, a *Chandrayaan-3* lunar mission in 2022–24 in collaboration with Japan, Mars in 2023, and Venus in 2023.[3] Recently, India tested ASAT capabilities and has instituted changes in its military space institutions. The country is currently drafting a space activities bill to better regulate the space environment.

It is important to understand that India's grand strategy informs its space behavior. I define grand strategy as an ideational construct based on what states perceive as threats and opportunities in their strategic environment, and accordingly what means they devise to either defend or take advantage of these threats and opportunities. The country's grand strategy framework has changed since independence from British colonial rule in 1947: India has gone from being a state keenly aware of building its international reputation, upholding and crafting norms, joining international institutions, and resisting overt military broadcasting

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1 Meghan Bartels and Hanneke Weitering, "India Loses Contact with Vikram Lander during Historic Moon Landing Attempt," Space.com, September 6, 2019 ⁓ https://www.space.com/india-loses-contact-with-vikram-moon-lander-chandrayaan-2.html.

2 NASA, "Vikram Lander Found," December 2, 2019 ⁓ https://www.nasa.gov/image-feature/goddard/2019/vikram-lander-found.

3 Siddharth Chauhan, "ISRO to Launch Chandrayaan-3 Moon Mission by November 2020: Report," Techradar, November 14, 2019 ⁓ https://www.techradar.com/in/news/isro-to-launch-chandrayaan-3-moon-mission-by-november-2020-report.

of power to one that is an assertive economic and military power at the turn of the 21st century.[4] Its military and political assertiveness was glimpsed when it tested nuclear weapons under Prime Minister Atal Bihari Vajpayee's National Democratic Alliance government in 1998, as well as in the constitutional change to Kashmir's status last year under a Bharatiya Janata Party (BJP) government led by the current prime minister Narendra Modi.[5] On both occasions, twenty years apart, a BJP-led India defied international outcry and defined its actions as being in the national interest.[6] India's space activities and ambitions reflect both grand strategic continuity and change over decades. Given that, its investments in outer space serve two clear purposes: first, space capacities enhance national development goals; and, second, they showcase its technological capabilities and ambitions as a great power.

This essay analyzes India's space capacities (both civilian and military), the development of a new space sector, the growing conversation on space resources, and the need for space regulation. It also highlights changes in India's space policy and strategy over the years.

India's Space Capacity

Civilian and commercial. India's civilian space activities are steered by the Indian Space Research Organisation (ISRO), formed in August 1969. The country launched its first satellite, the *Aryabhata*, into orbit in 1975. It now operates 57 satellites, and in 2019 accounted for 6% of successful global launches (7 of 111) behind only China (38), the United States (29), and Russia (19), and the same number as Europe.[7] The star of its launch vehicles is the Polar Satellite Launch Vehicle, followed by the

4 Namrata Goswami, ed., *India's Approach to Asia: Strategy, Geopolitics and Responsibility* (New Delhi: Pentagon Press, 2016); Kanti Bajpai, Saira Basit, and V. Krishnappa, eds., *India's Grand Strategy: History, Theory, Cases* (New Delhi: Routledge India, 2014); and Ashok Kapur, *India—From Regional to World Power* (New York: Routledge, 2004).

5 John F. Burns, "India Sets 3 Nuclear Blasts, Defying a Worldwide Ban; Tests Bring a Sharp Outcry," *New York Times*, May 12, 1998 ~ https://www.nytimes.com/1998/05/12/world/india-sets-3-nuclear-blasts-defying-a-worldwide-ban-tests-bring-a-sharp-outcry.html; Nikhil Kumar et al., "India's Parliament Votes to Change Kashmir's Status and Give New Delhi More Control over Contested Region," CNN, August 7, 2019 ~ https://www.cnn.com/2019/08/06/asia/india-kashmir-union-territory-intl-hnk/index.html; and "The UN Can't Ignore Kashmir Anymore," *New York Times*, October 2, 2019 ~ https://www.nytimes.com/2019/10/02/opinion/editorials/kashmir-india-pakistan-un.html.

6 Tarun Vijay, *India Battles to Win* (New Delhi: Rupa Publications, 2009).

7 Union of Concerned Scientists, "UCS Satellite Database," March 31, 2019 ~ https://www.ucsusa.org/nuclear-weapons/space-weapons/satellite-database; and Ed Kyle, "Space Launch Report: 2018 Launch Vehicle/Site Statistics," December 29, 2018 ~ http://www.spacelaunchreport.com/log2018.html.

Geosynchronous Satellite Launch Vehicle. For India, its edge in space capabilities comes from its low-cost missions,[8] with ISRO chairperson Kailasavadivoo Sivan asserting that "our USP [unique selling proposition] is our cost-effectiveness."[9] India can launch multiple payloads, including a record-breaking 104 satellites in a single launch in 2017 and another record of 29 satellites into three different orbits in 2019.[10] In 2019, the country spent around $1.9 billion on its space program,[11] with a relatively high return on investments based on the cost of manufacturing, logistics, and scientists' salaries compared to other national space programs. In contrast, the overall budget of NASA was $21.5 billion in 2019.[12] A comparison of scientists' salaries at ISRO and NASA offers further insight. While an entry-level NASA scientist makes around $90,000 annually and directors earn a starting annual salary of around $180,000, ISRO senior scientists make approximately $12,000 annually.[13] One has to calculate such differences in overhead costs when comparing space programs.

The focus of ISRO is robotic explorations, concentrated on lunar and Mars missions. In 2008, India launched its first lunar probe, *Chandrayaan-1*, which confirmed the presence of water ice on the lunar poles.[14] In 2014, India successfully sent its Mars orbiter, *Mangalyaan*, for the low cost of $74 million, compared to the $651 million cost of NASA's Mars orbiter, *Maven*, the same year.[15] Being the first Asian spacefaring

8 Samanth Subramanian, "India's Frugal Mission to Mars," *New Yorker*, November 7, 2013 ~ https://www.newyorker.com/tech/elements/indias-frugal-mission-to-mars.

9 M. Somasekhar, "ISRO: Harnessing Space Tech for Public Good," *Hindu Business Line*, March 9, 2020 ~ https://www.thehindubusinessline.com/blchangemakers/harnessing-space-tech-for-public-good/article31020925.ece#.

10 Ellen Barry, "India Launches 104 Satellites from a Single Rocket, Ramping Up a Space Race," *New York Times*, February 15, 2017 ~ https://www.nytimes.com/2017/02/15/world/asia/india-satellites-rocket.html; and Amitabh Sinha, "Explained: What Makes PSLV-C45 Special," *Indian Express*, April 2, 2019 ~ https://indianexpress.com/article/explained/pslv-c45-rocket-launch-indian-space-research-organisation-isroc-5653610.

11 Andrew Jones, "India Outlines Launch Plans, Progress in Human Spaceflight and Space Transportation," SpaceNews, February 27, 2020 ~ https://spacenews.com/india-outlines-launch-plans-progress-in-human-spaceflight-and-space-transportation.

12 Jeff Foust, "House Spending Bill Offers $21.5 Billion for NASA in 2019," SpaceNews, May 8, 2018 ~ https://spacenews.com/house-spending-bill-offers-21-5-billion-for-nasa-in-2019.

13 Manavi Kapur, "ISRO May Have Reached the Moon but Its Salary Allotments for Staffers Are Yet to Take Off," Scroll.in, September 11, 2019 ~ https://scroll.in/article/936855/isro-may-have-reached-the-moon-but-its-salary-allotments-for-staffers-are-yet-to-take-off.

14 Frank Tavares, "Ice Confirmed at the Moon's Poles," NASA, August 20, 2018 ~ https://www.nasa.gov/feature/ames/ice-confirmed-at-the-moon-s-poles.

15 Ipsita Agarwal, "These Scientists Sent a Rocket to Mars for Less Than It Cost to Make 'The Martian,'" *Wired*, March 17, 2017 ~ https://www.wired.com/2017/03/these-scientists-sent-a-rocket-to-mars-for-less-than-it-cost-to-make-the-martian; and Sanjay Kumar, "India Joins Elite Mars Club," *Nature*, September 24, 2014 ~ https://www.nature.com/news/india-joins-elite-mars-club-1.15997.

nation to obtain Mars orbit—on its first attempt—raised the status of the Indian space program.[16] Although in September 2019 India failed with its lunar lander, its *Chandrayaan-2* lunar orbiter succeeded in entering lunar orbit in August 2019.[17] India's ambitions to scale up its activities in outer space were evidenced in 2018 when Prime Minister Modi announced that the country would send a man or woman into low-earth orbit by 2022 in a mission called Gaganyaan.[18] Consequently, four Indian astronauts have started their year-long training in Russia's Yuri Gagarin Cosmonaut Training Center.[19] ISRO also takes great pride in contributing to India's national development, including but not limited to utilizing space technology to identify potential fishing zones for the Indian National Centre for Ocean Information Services, innovating a telemedicine program for remote areas, creating tele-education networks, improving the accuracy of weather forecasts, and virtually connecting India's vast financial sector.[20]

As with other space sectors where the private space industry plays a critical role in developing key technologies, such as reusability in Blue Origin, SpaceX, and ispace's 2021 reusable rocket tests,[21] India's private space sector has also taken off. Companies like Bellatrix work on rocket propulsion; R-beam on wireless transmission; Blue Sky Analytics on space-based intelligence, surveillance, and reconnaissance for pollution monitoring; Dhruva Space on small satellites; Satsure on mapping supply chain infrastructure; and TeamIndus on building spacecraft and lunar landers. Another company, Exseed Space, is the first private Indian space startup to succeed in building and launching its own satellite using SpaceX

16 "Mangalyaan India's Mission to Mars," *National Geographic*, November 24, 2016, available at YouTube ~ https://www.youtube.com/watch?v=Lv-4fiVadVk; and Ajey Lele, *Mission Mars: India's Quest for the Red Planet* (New Delhi: Springer India, 2014).

17 Jason Davis, "Chandrayaan-2 Enters Lunar Orbit," Planetary Society, August 20, 2019 ~ http://www.planetary.org/blogs/jason-davis/chandrayaan-2-successful-loi.html.

18 "Gaganyaan, India's First Manned Mission, Set to Be a Reality by 2022," *Mint*, August 15, 2018 ~ https://www.livemint.com/Politics/glFe56EP0V2EkF25mQshXO/Narendra-Modi-announces-Gaganyaan-in-Independence-Day-speech.html.

19 "Star City Adventure: Take a Sneak Peek into India's First Space Crew Training in Russia," RT, February 17, 2020 ~ https://www.rt.com/news/480892-india-first-space-crew-russia.

20 Indian Space Research Organisation, "Vision and Mission Statements" ~ https://www.isro.gov.in/about-isro/vision-and-mission-statements.

21 Ryan Woo, "Chinese Space Startup Revs Up for Reusable Rocket Race," Reuters, August 10, 2019 ~ https://www.reuters.com/article/space-exploration-china-linkspace/chinese-space-startup-revs-up-for-reusable-rocket-race-idUSL4N25603B.

Falcon 9's international commercial launch.[22] In light of this, in 2019 the Department of Space funded the public enterprise NewSpace India Limited, which aspires to commercialize and privatize India's space capacities.[23] This is no different from the outer space trajectory in the United States, where a federally funded agency (NASA) dominated the space domain from 1958 until 2015, when Blue Origin's *New Shepard* (sub-orbital) and SpaceX's *Falcon 9* (orbital) reusable rockets burst into the skies and then vertically landed, forever changing how humanity views space travel.[24]

Military space. Historically, under the tutelage of Vikram Sarabhai, the father of the Indian space program, India's space activities were squarely focused on national development goals, mainly utilizing space to improve the lives of its people. However, since the 1999 Kargil War, when intelligence fell short in identifying infiltrators across the border with Pakistan, India has recognized the military importance of space capabilities, especially in augmenting intelligence and mapping. The first such experiment was the 2001 launch of the Technology Control Satellite, followed by the establishment of the National Technical Research Organisation in 2004. After China's ASAT test in 2007, India's defense establishment—led by the Defence Research and Development Organisation (DRDO)—recognized that increasing India's space defense capacities had to be expedited. This led to the establishment of the Integrated Space Cell within the Integrated Defence Services in 2008, and the Space Security Coordination Group in 2010. The first dedicated military satellites were the RISAT-2 in 2008 and the GSAT-7 in 2013.[25] An interesting recent development has been the inclusion of India's NavIC global navigation satellite system as an allied system within the 2020 U.S. National Defense Authorization Act under section 1601, "Space Activities." During President Donald Trump's February 2020 visit to India, the United States and India signed a joint statement in which

22 Surendra Singh and Srinivas Laxman, "India's First Private Satellite Launched," *Times of India*, December 5, 2018 ~ https://timesofindia.indiatimes.com/india/space-x-launches-indias-first-privately-built-satellite-exceedsat-1/articleshow/66937238.cms.

23 "New Space India Limited," Department of Space (India), Press Release, July 24, 2019 ~ https://pib.gov.in/newsite/PrintRelease.aspx?relid=192201; and "Sitharaman Launches New Space India Limited, ISRO's Commercial Arm to Market, Sell Products," News18, July 5, 2019 ~ https://www.news18.com/news/business/sitharaman-launches-new-space-india-limited-isros-commercial-arm-to-market-sell-products-2219263.html.

24 Christian Davenport, "Elon Musk's SpaceX Returns to Flight and Pulls Off Dramatic, Historic Landing," *Washington Post*, December 21, 2015 ~ https://www.washingtonpost.com/news/the-switch/wp/2015/12/21/elon-musks-spacex-pulls-off-dramatic-historic-landing.

25 "RISAT-2 (Radar Imaging Satellite-2)," Earth Observation Portal ~ https://earth.esa.int/web/eoportal/satellite-missions/r/risat-2; and Rajat Pandit, "India's First Military Satellite Successfully Launched," *Times of India*, August 30, 2013 ~ https://timesofindia.indiatimes.com/india/Indias-first-military-satellite-successfully-launched/articleshow/22168268.cms.

space exploration and space domain awareness were highlighted as critical components of their partnership.[26]

A strategically significant development in 2019 was the Mission Shakti ASAT test against India's own Microsat-R satellite.[27] The ASAT test demonstrated the capability to hit adversarial objects in space, a capability the DRDO has possessed since 2012 but only just showcased. This was the first time that the DRDO was visibly involved in a space mission, which is normally the exclusive domain of the civilian ISRO. Following the test, Prime Minister Modi directed his national security adviser Ajit Doval to work on a space power doctrine and set up the contours of the new Defence Space Agency and Defence Space Research Organisation.

A Strategic Shift

It is important to understand India's grand strategic policy shift. From being a country critically concerned about how other nations view it, India is emerging as an assertive country under the current BJP-led government. This was seen in its nonchalant response to international criticisms after its 2019 ASAT test creating space debris.[28] Modi asserted that investing in military space capabilities was in India's national interest given its dependence on space assets to survive as a nation.

Besides ambitions in robotic exploration and space science, India has taken greater interest in and started to encourage global discourse on space resources. This is demonstrated, for example, in ISRO's focus on finding helium-3 on the lunar surface. Former senior space officials like Sivathanu Pillai, former chief of BrahMos Aerospace, have stipulated that "there are plans to mine helium-3-rich lunar dust, generate energy and transport it back to Earth."[29] Such perspectives are supported by Srikumar Banerjee,

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26 "Joint Statement: Vision and Principles for the United States–India Comprehensive Global Strategic Partnership," White House, Press Release, February 25, 2020 ~ https://www.whitehouse.gov/briefings-statements/joint-statement-vision-principles-united-states-india-comprehensive-global-strategic-partnership.

27 Loren Grush, "India Shows It Can Destroy Satellites in Space, Worrying Experts about Space Debris," Verge, March 27, 2019 ~ https://www.theverge.com/2019/3/27/18283730/india-anti-satellite-demonstration-asat-test-microsat-r-space-debris.

28 Brian Weeden and Victoria Samson, "India's ASAT Test Is a Wake-Up Call for Norms of Behavior in Space," SpaceNews, April 8, 2019 ~ https://spacenews.com/op-ed-indias-asat-test-is-wake-up-call-for-norms-of-behavior-in-space; and Marco Langbroek, "Why India's ASAT Test Was Reckless," *Diplomat*, April 30, 2019 ~ https://thediplomat.com/2019/05/why-indias-asat-test-was-reckless.

29 Dipanjan Roy Chaudhury, "India Needs Dedicated Military Space Programme: Lt. Gen PM Bali," *Economic Times*, July 11, 2018 ~ https://economictimes.indiatimes.com/news/defence/india-needs-dedicated-military-space-programme-lt-gen-pm-bali/articleshow/57225348.cms.

former director of Bhabha Atomic Research Centre,[30] who asserts that the country's future is in mining minerals in space. India's societal and policy discourse on space resources will grow stronger as states focus more competitively on the lunar poles for resources and space-based mining.[31] With growing concerns that space may become further militarized with the establishment of space forces in countries such as China, the United States, France, and Japan, India will likely play a larger role in global space governance mechanisms, given that it is one of the most advanced spacefaring nations. The newly competitive global space environment has motivated India to consider better regulation of its commercial space activities, with its parliament considering a draft space activities bill.[32]

India's proven capabilities to travel to the Moon and Mars, its ambitions for human spaceflight in low-earth orbit and a second Mars mission, and its plans for an independently owned space station by 2030[33] imply that space will play a critical role in shaping the country's grand strategy. More importantly, India has learned valuable strategic lessons about the global preference to include only those with demonstrated capabilities in regime-making, such as was the case in the Nuclear Non-Proliferation Treaty, which did not include India at its creation in 1968 because the country had not yet tested nuclear weapons. Consequently, with its ASAT test, India ensured that it will be included in any future space governance regime. With a globally competitive economy, a youth bulge, and an ever-growing space science community, India will continue to play an important role in the realm of outer space. ◈

30 "Mining in Space Can Be India's Next Milestone, Suggest Scientists," NDTV, July 28, 2016 ~ https://www.ndtv.com/india-news/mining-in-space-can-be-indias-next-milestone-suggests-scientists-1437519.

31 Ibid.

32 "Space Activities Bill, 2017," Insights IAS, January 1, 2019 ~ https://www.insightsonindia.com/2019/01/01/space-activities-bill-2017.

33 "India Planning to Launch Own Space Station by 2030, ISRO Chief Says," *Wire* (India), June 13, 2019 ~ https://science.thewire.in/space/isro-space-station-gaganyaan-chandrayaan-2.

Europe in Space: Partner, Competitor, and Model for Asia

Kai-Uwe Schrogl and Christina Giannopapa

Europe regards itself as the second-greatest global space power after the United States, possessing all space capabilities except human space transportation. Investments in autonomous access and other operations demonstrate recognition of the strategic importance of space for European policy, economy, security, and society. This standing consequently leads to a large spectrum of interrelations and interactions with other space powers internationally. In this context, Asia is the region of highest interest. Its key space powers—Japan, China, and India—for decades have been associated with Europe through cooperation, competition, and conflict. While cooperation has so far prevailed, competition is growing, and conflict could easily turn from rare and punctual to severe and dominant.

This essay describes Europe's ambitions in light of its achievements in space. In addition, it provides a special focus on Europe's contributions to international regulatory efforts in this field, since the status of outer space as a global common requires international interaction, with European and Asian states playing important roles. This is followed by a close look at the direct interactions between the two regions. Finally, the essay presents a comparison between the efforts in Europe and Asia to establish possible regional cooperative mechanisms to coordinate and integrate their space efforts, providing more opportunities for Europe to serve as a partner, competitor, and model for Asia in space.

The Achievements and Ambitions of Europe

In 2016, Europe manifested its ambition toward space. This was done through a joint statement by the European Union and the European Space Agency (ESA), which had previously been approved by 30 member states

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NOTE ~ The views expressed in this essay are those of the authors and do not represent the views of organizations with which they are affiliated.

in total. The document "Joint Statement on Shared Vision and Goals for the Future of European Space" develops three pillars of strategic relevance for Europe:

> (1) to maximize the integration of space into European society and economy, by increasing the use of space technologies and applications to support public policies, providing effective solutions to the big societal challenges faced by Europe and the world, strengthening synergies between civilian and security activities in the fields of navigation, communication and observation, including through monitoring borders, land and maritime security conditions; (2) to foster a globally competitive European space sector, by supporting research, innovation, entrepreneurship for growth and jobs across all Member States, and seizing larger shares of global markets; and (3) to ensure European autonomy in accessing and using space in a safe and secure environment, and in particular consolidate and protect its infrastructures, including against cyber threats.[1]

One of the most prominent keywords in this strategic outline is "autonomy." Since starting its joint efforts in the 1960s, Europe has been striving to reach autonomy in almost all aspects of space activity. These are access to space (with the Ariane and Vega rockets), satellite telecommunications (Eutelsat operations), meteorology (Eumetsat meteorological satellites), navigation and positioning (Galileo navigation system), and operational Earth observation (through data provided by the Copernicus Programme). The next step is reaching autonomy in the Space Situational Awareness Programme and its Space Surveillance and Tracking segment.[2] Europe is also advancing in the field of military and security applications both on the national level and in coordination among member states.[3] It is notable among Europe's achievements that the region collectively has a long tradition in space science and human spaceflight (albeit decidedly not with the objective of autonomous human access to space). Many firsts, such as the landings on Saturn's moon Titan and on the comet Churyumov-Gerasimenko, are prestigious examples.

The European setup in space governance is characterized by four elements: (1) national programs by the member states of the EU

1 For the full text, see "Joint Statement on Shared Vision and Goals for the Future of Europe in Space by the EU and ESA," European Space Agency, October 26, 2016 ~ https://www.esa.int/About_Us/Corporate_news/Joint_statement_on_shared_vision_and_goals_for_the_future_of_Europe_in_space_by_the_EU_and_ESA.

2 Ntorina Antoni et al., "Re-affirming Europe's Ambitions in Space: Past, Present and Future Perspectives," *Acta Astronautica* 151 (2018): 772–78.

3 Christina Giannopapa et al., "Elements of ESA's Policy on Space and Security," *Acta Astronautica* 147 (2018): 346–49. For the respective articles, see Kai-Uwe Schrogl et al., eds., *Handbook of Space Security* (New York: Springer, 2015).

and the ESA, (2) the multilateral cooperation of the ESA's 22 members,[4] (3) the supranational cooperation of the EU's 27 member states, and (4) a space industry that matches traditionally complex but globally competitive large-system integrators with agile small and medium-sized enterprises and start-ups to compete in an ever-growing sector. These four elements have always been dynamic in their relationships and developments. However, the European states have usually managed to find a balance between the elements, which further aligns their efforts. While coordination and negotiation take continuous time and effort, achieving consensus usually leads to the reliable and successful implementation of programs and policies.

Europe's Contributions to International Space Law and Regulation

Europe is an unwavering supporter of both outer space's status as part of the global commons and the rule of law governing space activities. These conditions are laid down in space treaties developed by the UN Committee on the Peaceful Uses of Outer Space (COPUOS), as well as in the provisions developed in the International Telecommunication Union. In particular, the basics are the freedom of use and the prohibition of national appropriation of space, as well as an obligation to use space for only peaceful purposes. European states have been active and constructive in all forms of space law development in all relevant forums. Often, they have built bridges between opposing positions, such as during the Cold War between the United States and the Soviet Union, as well as between the global North and South during the 1980s and 1990s. Today, the ability to bridge disparate perspectives is even more salient in a multipolar world with different views of how space should be governed.

Furthermore, European states have been at the forefront of numerous initiatives to improve the application of existing laws and develop new laws in space. The leading role of European states in reaching an agreement in COPUOS on the mitigation of space debris in 2007 goes back to the early 1990s, and states have led UN General Assembly resolutions to clarify concepts relevant to the liability regime and improve the implementation of the registration regime.[5] The initiative establishing an International Code

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4 Maarten Adriaensen et al., "Priorities in National Space Strategies and Governance of the Member States of the European Space Agency," *Acta Astronautica* 117 (2015): 356–67.

5 For the legal texts negotiated in COPUOS, see "Space Law Treaties and Principles," UN Office for Outer Space Affairs ~ https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html.

of Conduct on Outer Space Activities in 2007 was particularly important. Though this initiative was terminated in 2015, it set the stage for establishing an agenda item for the COPUOS Legal Subcommittee on Space Traffic Management in 2016.[6]

The novelty of these initiatives is that space law has now turned to the question of how to regulate behavior in space, moving beyond merely addressing the status of outer space and its users with the existing space law. The new importance of behavior in space can also be seen in states' interests to maintain security in outer space and to build transparency and confidence as well as rule-based behavior. The necessity of this approach was highlighted in the Chinese and subsequent Indian anti-satellite tests in 2007 and 2019, respectively. Regardless of such incidents, however, which caused considerable diplomatic concern at the time, Europe today works constructively with Asian states to further the development of space law.

Europe's Cooperation and Competition with Asia

Independent space powers coexist in Asia and have cooperated with the ESA mainly in the field of space science, especially Japan, India, China, and South Korea. Beyond this, bilateral cooperation also takes place. The Japan Aerospace Exploration Agency is the most prominent partner and has engaged in cooperation with France, Germany, Italy, Norway, and the Netherlands in the fields of space science and exploration, earth observation, space transportation, ground station operations, satellite communications, and research and development.[7] Japan has also been a long-standing partner of the International Space Station and will be part of the Lunar Gateway Space Station Program, whereas China has not been invited by the United States to join. South Korea, through its Korea Aerospace Research Institute, has collaborated with France, Germany, Denmark, and Romania.[8] China has been eager to develop bilateral cooperation with the main European space actors, and in 2019 it strengthened a partnership with France in space science as well as on a joint development project for high-speed broadband telecommunication satellites. In the fields of earth observation and global navigation satellite

6 Kai-Uwe Schrogl et al., eds., *Space Traffic Management: Towards a Roadmap for Implementation* (Paris: International Academy of Astronautics, 2018).

7 For updates on Japanese bilateral cooperation, see "International Cooperation," Japan Aerospace Exploration Agency ~ https://global.jaxa.jp/press/int.

8 For a list of South Korea's cooperation partners, see "Bilateral Cooperation," Korea Aerospace Research Institute ~ https://www.kari.re.kr/eng/sub06_02.do.

systems, there is coordination among states via international forums like the Committee on Earth Observation Satellites and the International Committee on Global Navigation Satellite Systems, respectively.

Asia is also a market for European space-related exports. Imports to Europe from Asia, however, are scarce. In the commercial field there is very little cooperation, with the exception of an attempt for Japan's H2 rocket and Europe's Ariane 5 rocket to serve as backup for each other. In 2014 the liberalization of China's space industry started and opened up a greater degree of private investment and new opportunities. Since 2016, China has been actively engaged in the Space Information Corridor project through its Belt and Road Initiative, which aims to boost trade links and infrastructure investment from China and Asia to Europe and Africa.[9] The Space Information Corridor project strives to provide space information services and enable cooperation in satellite and ground applications and systems, as well as the development of other products. On the one hand, the emerging rise and engagement of China in the commercial market will increase competition among other Asian states as well as with European ones. Trade agreements like the recent EU-Vietnam Agreement could, on the other hand, open doors for partnerships between Asian countries and Europe in space applications and products.

Europe as a Model for Governing Regional Cooperation in Asia

Intergovernmental cooperation in Europe and through the ESA has been observed by other regions hoping to build greater unity, in particular, Latin America, parts of Africa, and Asia. A critical element for regional cooperation is whether it is established as a balance between the participants or whether it is organized under a single leader. In Europe, the major states (France, Germany, the United Kingdom, and Italy) opted for a balanced governance even though manifest leadership by France would also have been feasible. In Latin America, however, the competition between the two potential leaders—Brazil and Argentina—has so far made a solution impossible. In Africa, only ad hoc cooperation, like with telecommunications in Western Africa, has been implemented, but political fragmentation has limited further steps.[10] Efforts were made by the African Union in 2018 to create an

9 Li Yang, "China Willing to Share Space Successes with B&R Countries: Official," Belt and Road Portal, November 2, 2017 ~ https://eng.yidaiyilu.gov.cn/qwyw/rdxw/32744.htm.

10 Christina Giannopapa, "Improving Africa's Benefit from Space Applications: The European-African Partnership," *Space Policy* 27, no. 2 (2011): 99–106.

African Space Agency, inspired by the ESA, but the organization still waits for actual implementation.[11]

As in Europe and Latin America, in Asia the situation is also characterized by potential leaders: Japan or China, with a less active role played by India. Not by chance, both Japan and China have been trying to set up regional cooperation under their respective leadership, resulting in two different formats for governance. Japan established the Asia-Pacific Regional Space Agency Forum (APRSAF) in 1993, whereas China founded the Asia-Pacific Space Cooperation Organization (APSCO) in 2008. Membership is somewhat overlapping, with institutions from 40 states (including non-Asian states) participating in APRSAF, and 8 formal member states in APSCO. This indicates the basic difference between the two: APRSAF is a coordination mechanism of institutions (such as space agencies, research establishments, and space applications users), while APSCO is an intergovernmental organization.[12] APSCO, therefore, much more resembles the ESA, although it has not yet been enabled to develop technologies and satellite projects as part of its model.[13] Both formats, however, share the common understanding, which was first manifested in the ESA, that space activities are an evident field for pooling resources among neighboring, like-minded states.

The two different ways Japan and China organize their influence is unsurprising, given the divergent nature of the two states. Japan follows a more informal path, while China prefers the binding arrangement found in partnerships. The two leaders invest considerably in organizing their respective groupings. In this way, they pass benefits to participating states and organizations. However, so far no "winner" has emerged from this development. But the pure existence, or coexistence, of these two groupings demonstrates how space is used in Asia as a strategic diplomatic tool by the leading states. Although Europe has so far been reluctant to cooperate with these two institutions, it has shown some preference for APRSAF due to its looser and less binding mechanisms. Nonetheless, it still prefers to focus on bilateral cooperation with individual states within Asia for specifically defined concrete projects.

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11 For the draft statutes, see "State of the African Space Agency" ~ https://au.int/sites/default/files/treaties/36198-treaty-statute_african_space_agency_e.pdf.

12 For more on the Asia-Pacific Regional Space Agency Forum, see http://www.aprsaf.org; and for the Asia-Pacific Space Cooperation Organization, see http://www.aspco.int.

13 Mingyan Nie, "Asian Space Cooperation and Asia-Pacific Space Cooperation Organisation: An Appraisal of Critical Legal Challenges in the Belt and Road Space Initiative Context," *Space Policy* 47 (2019): 224–31.

Challenges Ahead

The biggest challenge for Europe vis-à-vis Asia for the 2020s is to find and maintain the balance between partnership and competition. Both are intensifying, but competition in commercial space activities should not hinder partnership in science and exploration, just as partnership should not open doors for nonreciprocal commercial exchanges. To achieve this balance, further internal coordination in Europe is necessary. No comprehensive Asia strategy so far exists beyond coordinated understanding. During the second half of 2020, the European Union will discuss, upon the initiative of the German EU Council presidency, the issue of establishing key principles for the global space economy, which will focus on such questions of equilibrium.

Furthermore, it is difficult to assess from the European side the development of the "Asian geometry in space" with two big space powers, Japan and China, and their respective groupings plus India as the third major actor. The top question, however, is whether developments in Asia will lead to concerns regarding not only economic competition but also stability and security interests in space. As is evident, anti-satellite tests have alarmed the whole international community interested in and dependent on using space. Europe focuses all of its bilateral as well as multilateral diplomatic efforts to reduce such security risks in order to maintain outer space as part of the global commons for use by all states in the future. ◈