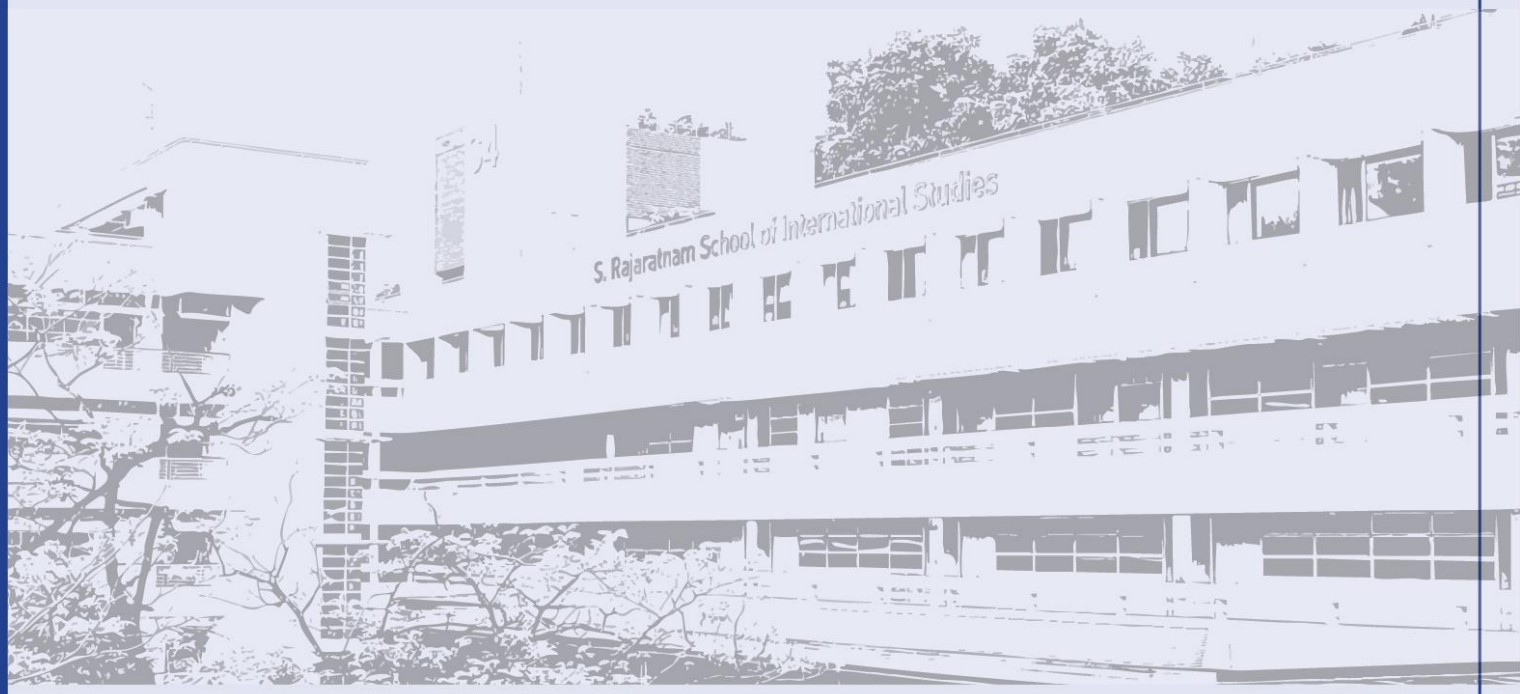
WORKING PAPER

MARCH 2025

Public-Private Partnerships in Outer Space: Implications for the Defence and Security Sector

Wichuta Teeratanabodee

WP344



RSiS S. RAJARATNAM SCHOOL OF INTERNATIONAL STUDIES
Nanyang Technological University, Singapore

Ponder the Improbable since 1996

Abstract

The outer space domain has experienced profound changes since the Cold War, marked by increasing participation from nations and private enterprises. The commercialisation of space has intensified competition, reducing the cost of space technologies and enabling governments to expand their space capabilities through public-private partnerships (PPPs). This paper investigates the PPP models of prominent spacefaring nations – including the United States, the United Kingdom, Russia, Japan, India, and China – examining their implementation in civilian and military contexts and their alignment with international legal frameworks. Despite the global adoption of space PPPs, significant variations exist in their characteristics and application. Western nations like the US and the UK, with extensive experience in PPPs, tend to have more established frameworks for public-private collaboration, while China, Japan, and India are still fine-tuning their approaches. Beyond the characteristics of PPPs, the development of domestic regulations governing space PPPs varies across countries, but overall progress remains slow, raising concerns about governance amidst the growing role of private entities. Although discussions on space safety and sustainability are progressing, they are inadequately reflected in national regulatory frameworks, highlighting the need for stronger governance mechanisms to address the challenges of the evolving space industry.

Introduction

The 21st century is regarded as the "new space" era, driven by the growing presence of private companies in the domain. However, despite the emergence of private companies, space norms and governance frameworks remain largely rooted in the 1960s-1970s space competition and have not sufficiently accounted for the unique challenges and opportunities presented by these actors. Furthermore, in their current form, these frameworks are not directly applicable to space companies, whose numbers have grown substantially, especially in the last decade.

This means that space companies are governed either by industrial standards or by domestic regulations enforced by states. Although domestic legislation often draws from existing outer space treaties, variations arise depending on national contexts, economic conditions, and market structures. Furthermore, industrial standards often ignore political and strategic considerations, which limits their applicability due to the dual-use nature of space technologies. Since space companies have directly (and will likely become more) engaged in conflicts, this creates a regulatory and governance gap from the perspective of defence and international security.

This paper addresses this research gap by exploring the trends and characteristics of relationships between the public sector – governments, militaries, and relevant defence establishments – and space companies in key spacefaring nations, notably the United States, the United Kingdom, Russia, Japan, India, and China. The paper includes three emerging Asian space powers which are growing in significance, but remain relatively under-researched compared to their Western counterparts. The paper will highlight the characteristics of public-private partnerships (PPPs) in each country, the relevant actors involved, as well as domestic regulations governing space companies. It will also identify implications of public-private partnerships for the defence and security sector.

Key questions that inform the research for this report are:

- What are the core characteristics of public-private partnerships of key spacefaring countries, including the US, the UK, Russia, Japan, India, and China, as seen through national and defence policies on outer space and domestic regulations?
- To what extent are the different national space policies consistent with the outer space treaties and other soft laws?
- What are some areas of cooperation between government, military, and private actors (e.g., defence and national security, debris mitigation, or other non-traditional security issues), and what are their implications on the defence and security field at both the national and international levels?
- How do different governments balance supporting companies for technological innovation and following/enforcing international space norms and standards (through national laws and policies)?

By answering these questions, the paper aims to explore current trends of PPPs in the outer space domain in terms of broader national policies, cooperation, regulations, and limitations; compare them against international norms and laws of outer space and

determine the gaps and implications from the perspectives of defence and international security; categorise the characteristics of PPPs through a comparative perspective, and shed some light on key space companies and their (often huge) influence on the outer space domain.

The paper in structured as follows: it will first introduce the concept of PPP and how they have been applied to the outer space domain. The report will then explore various case studies, including the US, the UK, Russia, Japan, India, and China, to determine the trends of PPPs in those countries and their regulatory developments. The comparison will be presented primarily from the perspective of the public sector. This will be followed by an analysis and discussion of the differences in these trends, and what that might tell us about the future of PPPs in outer space, particularly in terms of implications for the defence and security sector. The report will conclude with policy recommendations.

Public-Private Partnerships in Outer Space

The exploration and utilisation of outer space have long been primarily associated with government agencies, particularly in the realm of military activities. During the Cold War, space was a domain of competition, and space technologies were an indicator of economic and military power. However, space innovation continued to advance even after the Cold War, and increased affordability of certain space technologies created an environment that encouraged the participation of more space actors, including private companies, in the industry. While certain technologies have become more affordable, space technologies have also grown more complex, making other aspects of space exploration more costly. Furthermore, innovation is happening rapidly. These factors have led to a paradigm shift in the space industry from a domain monopolised by governments towards more collaboration between public and private entities to save costs, keep up with the pace of technological developments, and remain at the forefront of international competition.

A PPP refers to a "long-term agreement between the government and a private partner whereby the private partner delivers and funds public services using a capital asset, sharing the associated risks".[1] A similar definition is also put forward in various academic literature, highlighting long-term contractual agreements between public and private entities as a key characteristic.[2] It is a prominent and dynamic strategy for addressing complex societal challenges and delivering public services (more) efficiently, allowing both governments and companies to tap on each other's expertise, strengths, and benefits, as well as share responsibilities and risks.

---

[1] OECD, "OECD Principles for Public Governance of Public-Private Partnerships", accessed 12 February 2024, www.oecd.org/gov/budgeting/oecd-principles-for-public-governance-of-public-private-partnerships.htm#:~:text=Public%2DPrivate%20Partnerships%20(PPPs),asset%2C%20sharing%20the%20associated%20risks.

[2] See, for example,„Darrin Grimsey, and Mervyn Lewis, "Public Private Partnerships and Public Procurement", *Agenda: A Journal of Policy Analysis and Reform* 14, no.2 (2007): 171-188, https://press.anu.edu.au/publications/journals/agenda/agenda-journal-policy-analysis-and-reform-volume-14-number-2-2007.

The emergence and rapid growth of private space companies in the past few decades have ushered in a new era of space exploration. These companies have brought a fresh perspective, more cost-efficient methods, and an entrepreneurial spirit to the space sector. Unlike the public sector, whose budgets are often centralised and bureaucratically distributed, private companies have more freedom in their spending and investments. They also have more leeway to take risks and explore innovative paths to achieve technological goals or introduce novel innovations. Simultaneously, with the rise of space companies in the market, competition has intensified, compelling them to seek the most cost-efficient methods to produce their products or deliver their services. This environment has fostered rapid innovation while driving solutions to reduce costs, such as lowering satellite launch expenses.

The commercialisation and privatisation of outer space have also challenged the traditional monopoly held by government agencies in space exploration. While states remain significant actors in outer space, their approach has evolved over the decades to become more reliant on private companies through PPPs. PPPs are increasingly common in outer space activities which have traditionally been costly and resource intensive. Through PPPs, the public sector can rely on commercial efficiencies and innovation for better outcomes. The private sector, in return, has capitalised on an opportunity to enter a lucrative market that was previously inaccessible to them. Both sides can share costs, risks, and responsibilities for their projects.[3] In other words, PPPs offer a pragmatic approach to harness the strength of both sectors, foster innovation and cost-effectiveness, and enhance capabilities in the final frontier.

Contemporary PPP models in the outer space sector are adapted from ground infrastructure and utilities sectors (e.g., roads, bridges, and energy) with decades of experience in such partnerships. Yet despite adopting models from other types of infrastructure, outer space PPPs are distinct due to the unique characteristics of the domain.[4] For instance, space programmes often involve the design and development of new technologies, but focus much less on repairs, modifications, and touch-ups once launched due to the domain's limited accessibility.[5] In other infrastructure sectors, repairs and modifications are often addressed under the notion of responsibility, and this differs from the complexities of what responsibility means in outer space PPPs. These factors have also made the design and development process much more risk-averse, leading to a higher degree of public sector involvement in outer space PPPs.[6]

Some of the functions that outer space PPPs can serve include: mission support – to advance science, space exploration, or national security and defence; functional support – when the private sector provides functional services to the public sector,

---

[3] Karen L. Jones, "Public-Private Partnerships: Stimulating Innovation in the Space Sector", Center for Space Policy and Strategy, 2018, accessed 1 March 2024, https://aerospace.org/sites/default/files/2018-06/Partnerships_Rev_5-4-18.pdf.

[4] Notably, in other infrastructure sectors, the public or the people can directly interact with and use them in their daily lives, while they do not get to use space assets directly although benefit from it. See Moon J. Kim, "Coherence to Choices Informing Decisions on Public-Private Partnerships in the Space Sector" (PhD diss., RAND Pardee Rand Graduate School, 2023).

[5] Kim 2023, p. 49

[6] Ibid.

such as communications, Earth observation, and space logistics, which could also contribute to mission support; technological advancement, such as prototyping or collaboratively developing new technologies; and providing a space industrial base – to promote a competitive and robust commercial space sector (often within that country).[7] In serving those functions, PPPs have been utilised by various governments for services and missions such as space transportation (e.g., reusable rockets, mass-scale 3D-printed rockets, logistic services, and deep space exploration and mining), in-space manufacturing, bioproduction, space agriculture, satellite services and servicing, satellite communications, navigation, and Earth monitoring.[8]

PPPs are cost-effective for both sides. Through project sponsorship, governments do not have to bear the full financial responsibility for space activities. In return, private entities, which are usually more agile and cost-effective, also benefit from inflows of public sector funding to further innovation and growth. Furthermore, the competitive nature of the private sector can also expedite the development and deployment of military space technologies. This acceleration is crucial for maintaining a technological edge in an environment where advancements are rapid and critical for national security. Finally, collaborating with private entities allows the public sector to share the risks and responsibilities associated with space activities. Private companies bring their own investments and expertise, reducing the need for the government to have capabilities to mitigate all the risks arising from outer space activities and ensuring a more distributed risk profile.

While PPPs in outer space offer numerous benefits, they also pose several challenges and potential risks to both public and private actors, as well as the broader international community. Two key challenges brought about by PPPs in outer space are the balance between innovation and national security, and the issues of responsibility and liability.[9]

The first important challenge arising from outer space PPPs is the intricate balance between innovation and national security. The outer space domain, as well as its related technologies, are inherently dual-use for civil and military operations. This means that they can be used for both civilian and military purposes, and the line between the two is not always clear. Satellite launchers, for example, can launch both military and commercial rockets. Another example being during the Cold War, American space shuttles were perceived by the Soviet Union as potential weapons that could destroy the Soviet satellites.[10] Given the inherent link between space systems and national security, space PPP programmes typically require greater public sector oversight throughout their life cycle than any other infrastructure.[11] This also means

[7] See Jones 2018
[8] See Gordon Rausser, Elliot Choi, and Alexandre Bayen, “Public-private partnerships in fostering outer space innovations”, *PNAS Perspective* 120, no. 43 (2023): 1–10, https://doi.org/10.1073/pnas.2222013120.; and Jones 2018
[9] Natalia Puspita and Natasha Boydston, "Framing the Responsibility of Public-Private Partnerships (PPPs) on Space Technology in International Law", *Padjadjaran Journal of International Law* 7, no. 2 (2023): 174, https://doi.org/10.23920/pjil.v7i2.1352.
[10] Jakub Pražák, “Dual-use conundrum: Towards the weaponization of outer space?”, *Acta Astronautica* 187: 391-405.
[11] Kim 2023, p. 49

that space companies involved in a nation's PPPs face a higher risk of being targetted by adversaries, making them vulnerable to external risks both during peacetime and during conflict.

Furthermore, private companies are driven by profit motives and may prioritise commercial interests over national security concerns that are the priority of their public sector partner. For instance, Elon Musk has expressed his aspiration to use SpaceX to start a human colony on Mars, while Aerospace and Axiom Space Plan are planning on developing their own space stations.[12] Differences in priorities may create tension between both sectors, and striking a balance is crucial for the success of PPPs in military space technologies, a task that is ultimately challenging.

The integration of private entities into military space endeavours raises concerns about the security of sensitive information and technologies. While companies usually collaborate with the government where they are based, international collaboration within the outer space industry is not unheard of. India, for example, recently announced that it would utilise SpaceX launchers for satellite deployment. While India and the US are security partners, the sharing of sensitive information, even between allies, carries inherent risks. Furthermore, with more companies collaborating with governments, adversaries might target these firms to disrupt or attempt to access sensitive information, as seen in the case of Russia and SpaceX after the former's February 2022 invasion of Ukraine.[13] Establishing clear boundaries within the PPP model and implementing robust regulations with independent oversight mechanisms, while difficult, are essential to mitigate these risks.

Another common challenge for space PPPs concerns liability and responsibility, stemming from the fact that outer space is difficult to govern due to it being a global common, and thus activities related to outer space are governed under international laws. However, international laws, both in the general sense and those that are specifically applied to space, are not always strong tools. The 1967 Outer Space Treaty, as well as other related treaties including the 1968 Space Rescue Agreement, the 1979 Moon Agreement, the 1972 Liability Convention, and the 1975 Registration Convention, have not been updated since the Cold War era, when the nature of international politics was very different and, more importantly, when there was minimal commercialisation of space. This creates an increasingly large gap in the governance of outer space activities.

One such gap can be seen in the 1972 Liability Convention. According to the Convention, which is a part of the larger space legal regime, the responsibility for space activities falls on the launching states.[14] There are two categories of state

---

[12] Brianna Rauenzahn et al., "Regulating Commercial Space Activity," *The Regulatory Review*, 2020.
[13] See Elizabeth Howell,"Elon Musk says Russia is ramping up cyberattacks on SpaceX's Starlink systems in Ukraine", *Space.com*, 14 October 2022, www.space.com/starlink-russian-cyberattacks-ramp-up-efforts-elon-musk.
[14] UNOOSA, "Convention on International Liability for Damage Caused by Space Objects", accessed 13 March 2024, www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introliability-convention.html#:~:text=Elaborating%20on%20Article%207%20of,to%20its%20faults%20in%20space.

responsibility: direct and indirect. Direct state responsibility arises when a state commits an intentionally wrongful act either through its own actions or omissions that disobey an international treaty, customary international law, or both.[15] On the other hand, indirect state responsibility takes place when a state is held responsible for wrongful actions of non-state actors or entities within its jurisdiction. This may include situations where a state fails to prevent or punish the actions of private individuals or companies whose conduct violates international law.[16] Applying this aspect of liability in international law to PPPs in outer space, states or the public sector remain primarily responsible for space activities conducted under their jurisdiction, including those undertaken by private companies.[17]

Regulatory frameworks for space activities are slowly evolving to account for the growing role of private companies in space. However, the process of regulatory development itself faces several challenges, including the need to balance the interests of various stakeholders and address national security concerns without hindering innovation. At present, there have not been many substantial updates to the space legal regime. Despite efforts to develop and implement "soft laws" or norms and governance through international and regional organisations (e.g., the United Nations Committee on the Peaceful Uses of Outer Space, the European Union Code of Conduct, the EU Code of Conduct-inspired International Code of Conduct for Outer Space Activities), as well as industry standards, progress has been limited due to the non-binding nature of these instruments.

Consequently, states remain primarily responsible for safety and sustainability in space. Its responsibility is a crucial mechanism for promoting compliance with international laws and ensuring that space actors are held accountable for their actions.[18] As international space law dictates that all commercial activities in space must obtain authorisation and ongoing supervision of a state, states exercise their responsibility through the use of domestic policies and regulations – often in the form of a license.[19] For example, American space companies are beholden to their country's space policies and regulations, which are subject to change based on shifting government priorities.[20] Thus, the notion of "shared responsibility" between the public and private sectors is different for outer space compared to that of PPPs in other infrastructure sectors.

It is also important to note that legal and regulatory frameworks specific to PPPs are lacking. PPPs, in theory, should be governed by a well-defined set of regulatory framework to ensure compliance, accountability, and responsibility. However, in Alyssa Goessler's study on regulatory frameworks and their potential implications for PPPs in outer space in the US, she concluded based on interviews with employees of US space

[15] Puspita and Boydston 2023, p. 179
[16] Ibid
[17] Puspita and Boydston 2023.
[18] Puspita and Boydston 2023, p. 179
[19] Alyssa Goessler, "The Private Sector's Assessment of U.S. Space Policy and Law", Aerospace Security, 25 July 2022, https://aerospace.csis.org/the-private-sectors-assessment-of-u-s-space-policy-and-law/.
[20] Goessler 2022, p. 1

companies regarding their companies' regulatory and policy preferences that public sector policies are incapable of moving fast enough to stay in front of, or even catch up with, where investments are guiding the behaviour of the private sector.[21]

This is clearly exemplified in space sustainability. Increasing PPP activities around the world, while providing more benefits and profits for space companies, may incentivise more start-ups and new space firms to enter the industry. On the one hand, this could promote healthy competition leading to further innovation and a reduction of costs for outer space activities. On the other hand, however, this can lead to an increasing number of space actors, potentially challenging established norms – which are already lagging in terms of effectiveness – and creating complexities for the public sector in managing space activities.

The overwhelming proliferation of satellites and space activities, including those driven by private companies, also contributes to the issue of space debris. Sustainable practices and responsible behaviour in space are becoming essential considerations for international security to prevent collisions and preserve the long-term usability of Earth's orbits. Currently, there is no binding legal framework regulating the reduction or removal of debris – whether at the international or national levels.

Given that public sector regulatory development typically lags behind private sector technological advancement, the growing trend of space PPPs poses challenges. It is therefore important to examine how different spacefaring nations are managing space PPPs and the scope of their current policies and regulations to pre-empt and handle potential challenges of PPPs to maintain the safety and accessibility of outer space.

Case Studies

This section examines how the US, the UK, Russia, Japan, India, and China engage in PPPs to advance their capabilities and interests in the space domain. It focuses particularly on the characteristics of PPPs in each country, as well as key public and private actors involved. It will also explore recent regulatory developments in the space sector at the domestic level, where relevant, to highlight priority issues/areas for each country's space ecosystem.

The United States

The US boasts the largest number of space companies, with more than half of the global total headquartered within its borders.[22] Consequently, the US also has an extensive and sophisticated array of outer space PPPs. This emphasis on PPPs traces back to the Reagan administration which introduced regulatory measures under a National Space

[21] Ibid.
[22] Information as of 2021. See John Koetsier, "Space Inc: 10,000 Companies, $4T Value ... And 52% American", *Forbes*, 22 May 2021, www.forbes.com/sites/johnkoetsier/2021/05/22/space-inc-10000-companies-4t-value--and-52-american/.

Policy in 1982 aimed at enabling the US commercial space sector to take off.[23] While space PPPs in the US initially leaned towards civilian applications, particularly in support of initiatives by the National Aeronautics and Space Administration (NASA), a similar trend is emerging within the military space domain.

NASA, America's civilian space agency, has historically been the cornerstone of US space exploration efforts. It engages in various space activities across missions spanning science in outer space, human space activities, aeronautics, and technologies for space exploration. Through these different missions, NASA works extensively with private companies using PPPs. One notable effort is the Commercial Crew Program launched in 2010 with the objective of partnering with American space firms to deliver safe, reliable, and cost-effective transportation of astronauts to and from the International Space Station (ISS) and Earth.[24] Some of its partners under this initiative include Boeing, Blue Origin, Paragon Space Development Corporation, Sierra Nevada Corporation, and SpaceX. Several of these companies have successfully developed their own spacecraft for the transportation of astronauts to and from the ISS.[25]

Within specific domains of space activities such as the low Earth orbit (LEO) satellite sector, NASA has gradually been leaving the sector to private industry and shifting its focus towards the deeper space domain. Currently, SpaceX stands out as a dominant player in the LEO satellite field.[26] Looking ahead, NASA will likely leverage these commercial partnerships to pursue more ambitious goals, including returning to the Moon and sending astronauts to Mars.[27] While NASA primarily focuses on civilian applications of outer space, it is noteworthy that most of the spacecraft involved in the Commercial Crew Program possess dual-use capabilities. For instance, spacecraft like SpaceX's Crew Dragon (launched with NASA in 2020)[28] and Boeing's CST-100 Starliner (tested with NASA in 2023)[29] have the potential for military applications alongside their civilian roles.

---

[23] Some of the pro-private industry laws are the Commercial Space Launch Act and the Land Remote-Sensing Commercialisation Act. These have led to the emergence and rise of space commercialisation in the US. See further: Goessler 2022, p. 1-2.

[24] See NASA, www.nasa.gov/humans-in-space/commercial-space/commercial-crew-program/ - :~:text=NASA's Commercial Crew Program is,partnership with American private industry; see also NASA, "Commercial Crew Program American Rockets American Spacecraft American Soil", accessed 15 March 2024, www.nasa.gov/wp-content/uploads/2015/10/commercial_crew_press_kit_2.pdf; NASA, "Commercial Crew Program", accessed 23 February 2024, www.nasa.gov/humans-in-space/commercial-space/commercial-crew-program/

[25] New Space Economy, "Public-Private Partnerships: A Catalyst for the Space Economy", accessed 23 January 2024, https://newspaceeconomy.ca/2023/05/26/public-private-partnerships-a-catalyst-for-the-space-economy/; see also NASA 2022.

[26] Allen Hsieh, "How can the Chinese commercial space sector close the gap with the US", *Digitimes Asia*, 20 February 2024, www.digitimes.com/news/a20240220PD209/china-aerospace-chang-guang-satellite.html#:~:text=The%20Chinese%20commercial%20space%20industry%20chain%20has%20covered%20various%20segments,navigation%2C%20and%20remote%20sensing%20applications.

[27] Rauenzahn et al., 2020.

[28] Rachel Cohen, "For Clues About Space Force's Future, Look to Crew Dragon", *Air and Space Forces Magazine*. 27 May 2020, www.airandspaceforces.com/for-clues-about-space-forces-future-look-to-crew-dragon/.

[29] Jason Costa. "NASA, Boeing Provide Update on First Crewed Starliner Flight Test", NASA,17 February 2023, https://blogs.nasa.gov/commercialcrew/tag/cst-100-starliner/.

In these PPP arrangements, NASA acknowledges its responsibility and priority to maintain crew safety and survival. It thus requires all commercial systems associated with NASA through PPPs to adhere to stringent safety and performance standards in order to obtain certification for the transport of American and international partner astronauts to the ISS.[30] These systems undergo rigorous testing to validate their ability to ensure crew safety and survival. This is an example of how a public institution is liable and accountable for its PPP activities through domestic policies and regulations.

Another significant programme spearheaded by NASA is the Artemis Program. While primarily a NASA initiative, the programme involves collaboration between the public and private sectors. This includes, for instance, collaboration with companies like Blue Origin, which aims to facilitate human missions to the Moon. Like the Commercial Crew Program, the systems being developed for these missions are designed with dual-use capabilities, making them suitable for both civilian and military applications.

Apart from NASA, another significant entity is the US Space Force (USSF). Established in 2019 under the Trump administration, USSF operates under the purview of the US Department of Defense (DoD) which oversees space missions in support of defence and military operations.[31] The USSF is tasked with securing national interests in, from, and to space.[32] Despite being a relatively young entity, the USSF has swiftly followed the PPP trend in the civilian space sector, seeking to collaborate with American private companies to advance national security interests in space.

In February 2020, Colonel Eric Felt, Head of the Air Force Research Laboratory's (AFRL's) Space Vehicles Directorate, articulated the USSF's intention to forge partnerships with private entities by following the NASA playbook.[33] Recognising the potential of commercial capabilities to meet military needs, the USSF aims to leverage partnerships with space companies to enhance its strategic capabilities while minimising costs.

For instance, AFRL has been experimenting with integrating data from over 260 commercial remote sensing satellites with national satellites "to create a capacity that is much more robust and resilient than just any one piece of that all by itself."[34] This collaboration approach mirrors NASA's partnerships with companies like SpaceX and Boeing through initiatives such as the Commercial Crew Program. AFRL has already applied a similar PPP model to that practised by NASA, but on a smaller scale.[35] The Space Systems Command, the USSF's procurement arm, calls this initiative the Commercial Augmentation Space Reserves (CASR). Apart from the NASA playbook, the

---

[30] NASA 2022.
[31] Anastasia Silvker, "Global Outer Space Guide: United States", *Norton Rose Fulbright*, accessed 12 March 2024, www.nortonrosefulbright.com/nl-nl/knowledge/publications/08a2c80a/global-outer-space-guide-us.
[32] See USSF. n.d. https://www.spaceforce.mil/About-Us/About-Space-Force/
[33] Sandra Erwin, "Space Force thinking about NASA-style partnerships with private companies", *Space News*, 4 June 2020, https://spacenews.com/space-force-thinking-about-nasa-style-partnerships-with-private-companies/.
[34] Ibid.
[35] Ibid.

PPP framework behind CASR has also drawn on the DoD's experience with the Civil Reserve Air Fleet.[36]

Through initiatives like CASR, the USSF aims to capitalise on the expertise and resources of the private sector to enhance its capabilities in space operations. By aligning with successful models established by NASA and the DoD, the USSF seeks to maximise efficiency and effectiveness in fulfilling its mission to safeguard national interests in the space domain.

Within five years of its founding, the USSF has already established significant partnerships with numerous space companies. Notably, SpaceX has been actively involved in launching military satellites for the USSF using its Falcon 9 and Falcon Heavy launch vehicles.[37] This illustrates how PPPs could provide the public sector with an opportunity to grow and thrive fast, sparing it the need to independently own, design, or develop space assets. Beyond the evident time efficiency and cost benefits, the USSF emphasises that fostering such partnerships during peacetime ensures its access to commercial capabilities during times of crisis and conflict.[38]

This strategic approach is particularly salient considering the ongoing conflict in Ukraine, which underscores the integral role of the private sector in bolstering military capabilities. More precisely, a representative from the Space Systems Command noted that "the fight is not going to be only with military space capabilities. It is going to be a joint fight with our commercial partners, and with our international allies."[39]

When it comes to regulatory frameworks to guide their space activities, the US possesses one of the most advanced and comprehensive systems globally. Based on the USSF's plan to model its PPP arrangements after public entities such as NASA and DoD, it can be said that American public entities will likely remain the main responsibility bearer for outer space activities, primarily by imposing safety requirements and regulations. Apart from these, there have also been recent regulatory developments in the US concerning space activities. For example, the Senate recently passed the Orbits Act, which addresses the critical issue of reducing space debris and the promotion of safe space activities.[40] If enacted, the bill would help direct the Department of Commerce's Office of Space Commerce to identify and publish a list of orbital debris posing the greatest risk to humans and space assets. This initiative could

---

[36] Sandra Erwin, "Space Force considers public-private partnerships to respond to crises" *Space News*, 20 February 2023, https://spacenews.com/space-force-considers-public-private-partnerships-to-respond-to-crises/.

[37] See, for example, Secretary of the Air Force Public Affairs, "United States Space Force launches seventh X-37B mission", United States Space Force, 29 December 2023, www.spaceforce.mil/News/Article-Display/Article/3628417/united-states-space-force-launches-seventh-x-37b-mission/; Sandra Erwin, "SpaceX launches U.S. military spaceplane on Falcon Heavy rocket", *Space News*, 28 December 2023, https://spacenews.com/spacex-launches-u-s-military-spaceplane-on-falcon-heavy-rocket/.

[38] Erwin 2023a.

[39] Ibid.

[40] It is noteworthy that a similar bill was previously introduced but was unsuccessful in the House.

arguably pave the way for NASA to develop and implement a debris removal programme.[41]

The House is also considering the Commercial Space Act that would designate the Department of Commerce's Office of Space Commerce as the single authority for regulating new space missions involving private companies.[42] The objectives of this bill include streamlining regulatory processes for commercial space activities, promoting industry growth by centralising the authorisation and licensing processes and reducing administrative hurdles, and ensuring compliance with international obligations.[43]

The United Kingdom

The UK is another prominent commercial actor in outer space, possessing the second largest number of space companies worldwide, after the US (as of 2021). Despite having a much smaller market size than the US, and a smaller budget for military space activities than its peers, space PPPs in the UK have been thriving.[44] PPPs between the commercial space sector and the British government have mostly been with the UK Space Agency and the Ministry of Defence.[45]

The UK Space Agency focuses primarily on the country's civil space activities. Like the US, there has been an increasing emphasis on growing the commercial space sector and its potential for innovation. For example, the UK government invested in OneWeb to support the completion of its first generation constellation, making it the world's first operator to complete a LEO broadband constellation. Recently, the UK Space Agency also announced an initial of over £6 million (approximately US$7.5 million) in funding to local space companies for projects such as satellite-based quantum communication technologies and thermal imaging technologies.[46] The UK has also aimed to lead the global effort to make space more sustainable by funding demonstrator missions for debris removal, which shows its responsibility and commitment to making space more sustainable.[47] The UK Space Agency also works closely with the Ministry of Defence, acting as the coordinator between the commercial

---

[41] Hayley Blyth, "Space and satellite wrap up – Legal and regulatory developments in 2023", *Bird & Bird*, 14 December 2023, www.twobirds.com/en/insights/2023/global/space-and-satellite-wrap-up-legal-and-regulatory-developments-in-2023.

[42] (Apart from spectrum and launch which would remain with the Federal Communications Commission and Federal Aviation Administration respectively). Blyth 2023.

[43] John Goehring, "The Commercial Space Act of 2023 is Bad for National Security", *Just Security*, 19 December 2023, www.justsecurity.org/90567/the-commercial-space-act-of-2023-is-bad-for-national-security/#:~:text=The%20Commercial%20Space%20Act%20of%202023%2C%20introduced%20in%20the%20U.S.,U.S.%20leadership%20in%20space%20activities.

[44] The UK government's expenditure on space-related programmes is remarkedly low, especially compared to other countries with similarly sized economies and populations. See Lucia Retter, James Black, and Theodora Ogden, *Realising the Ambitions of the UK's Defence Space Strategy* (RAND Europe, 2022), accessed 10 February 2024.

[45] Retter et al., 2022.

[46] UK Space Agency, "Policy paper National Space Strategy in Action", accessed 10 March 2024, www.gov.uk/government/publications/national-space-strategy-in-action/national-space-strategy-in-action.

[47] UK Space Agency 2023.

sector and the Ministry by indicating "to industry, well ahead of any future tenders, the space-specific technologies which the Ministry of Defence is likely to require […]".[48]

On the defence and security side, the key player is the Ministry of Defence. PPPs by the Ministry can be traced back to the 1990s. In 1997, the British government initiated a plan to replace the Ministry of Defence's existing Skynet 4 satellites with a new military satellite communications system. This plan adopted a PPP approach, which aimed to save approximately £500 million (approximately €740 million) over the contract's lifespan. Under the agreement, private company Paradigm Secure Communications would deliver core military satellite communications to the UK armed forces, with the possibility of commercialising excess capacity to third parties.[49] This, again, demonstrates the dual-use aspect of outer space PPPs.

The British Ministry of Defence has shown its willingness to contribute to the continued growth of the UK's space economy with headline investment of more than £5 billion (over US$6.3 million) over the next decade (2023-2033).[50] In turn, it aims to leverage the commercial space sector to enhance its Defence Space Portfolio by providing clear guidance to space companies regarding the technologies and industrial capabilities required by the military.[51] It will also leverage the dual-use benefit of space technologies "as a vehicle to shape commercial space development for [the Ministry of] Defence needs and generate additional return on the investment."[52]

All public sector institutions in the UK have designed their space-related policies and regulations in line with the overarching National Space Strategy set out by the National Space Council.[53] Recent regulatory developments include the conclusion of public consultations on changes to orbital liabilities and an insurance framework for space activities involving the UK. These changes aim to reduce regulatory barriers for private space companies operating in the UK.[54]

The main proposals include: (i) a variable liability limit for orbital operations based on the activity, orbit, and sustainability aspects of each mission; (ii) alternative insurance models for third-party liability cover, such as a mutual or a collective policy; and (iii) a refund of license fees for companies that commit to sustainable practices.[55] The refund of license fees for companies with sustainable space practices takes an

[48] See further: UK Space Agency 2023.
[49] Xavier Bertran and Alexis Vidal, "The Implementation of a Public-Private Partnership for Galileo: Comparison of Galileo and Skynet 5 with Other Projects", *Online Journal of Space Communication* 5, no. 9 (2006): 390–99, 393.
[50] British Ministry of Defence, "Defence Space Strategy: Operationalising the Space Domain", accessed 2 March 2024, https://assets.publishing.service.gov.uk/media/61f8fae7d3bf7f78e0ff669b/20220120-UK_Defence_Space_Strategy_Feb_22.pdf.
[51] Ibid.
[52] Ibid.
[53] British Ministry of Defence 2022, p. 33.
[54] UK Space Agency, "Consultation on Orbital Liabilities, Insurance, Charging and Space Sustainability", 5 March 2024, www.gov.uk/government/consultations/consultation-on-orbital-liabilities-insurance-charging-and-space-sustainability/consultation-on-orbital-liabilities-insurance-charging-and-space-sustainability.
[55] Blyth 2023.

incentive-based approach to promoting sustainability in outer space. Nevertheless, despite the UK's efforts to pioneer orbital debris removal missions, there are no enforced regulatory developments as yet.[56]

Russia

Russia was formerly a leading spacefaring power alongside the US during the Cold War. However, it has since lost its prominent position in the international competition among countries to build capabilities in outer space.[57] Since the collapse of the Soviet Union in the early 1990s, Russia has deliberately chosen not to cultivate a competitive commercial space sector.[58] From 2013 to 2016, the Russian space ecosystem even went through a process of re-nationalisation with the reestablishment of the Roscosmos State Corporation in 2015.[59] Roscosmos, which can be characterised as a quasi-civil space agency, was founded to accelerate the reformation and transformation of Russia's space sector, including its military dimension. However, given global financial pressure on Russia since its annexation of Crimea in 2014, as well as corruption more generally, the Russian space ecosystem has been facing an unstable flow of funding.[60]

This has consequently led to the private space sector in Russia being marginal and lacking in potential, especially compared to that of the US and China.[61] The situation has worsened following the outbreak of the Russia-Ukraine War in February 2022 due to the economic sanctions the US and several other Western countries had imposed on Russia. These sanctions primarily targeted Russia's space and technology sectors, along with its key financial institutions, affecting all Russian launch providers in the process.[62] Despite President Vladimir Putin's recent expression of interest in engaging private companies in the Russian space ecosystem, there has been no clear direction on how the government is planning to do so, especially amidst the current situation.[63] All of the private space companies involved in the ongoing Russia-Ukraine War are US companies providing support to Ukraine, but there are none on the Russian

---

[56] UK Space Agency, "UK builds leadership in space debris removal and in-orbit manufacturing with national mission and funding boost", 26 September 2022, www.gov.uk/government/news/uk-builds-leadership-in-space-debris-removal-and-in-orbit-manufacturing-with-national-mission-and-funding-boost.

[57] FlorianVidal, "Russia's Space Policy: The Path of Decline?", The French Institute of International Relations, 2021, www.ifri.org/sites/default/files/atoms/files/vidal_russia_space_policy_2021_.pdf.

[58] Bruce McClintock, "The Russian Space Sector: Adaptation, Retrenchment, and Stagnation", *Space & Defense* 10, no. 1 (2017): 3–8, www.rand.org/content/dam/rand/pubs/external_publications/EP60000/EP67235/RAND_EP67235.pdf.

[59] Pawel Bernat, "Russia's Strategic Shift in Space Policy Moscow Turns to China", *Per Concordiam*, 6 December 2021,.https://perconcordiam.com/russias-strategic-shift-in-space-policy/.

[60] Vidal 2021.

[61] Pawel 2021.

[62] Jeremy Grunert, "Sanctions and Satellites: The Space Industry After the Russo-Ukrainian War", *War on Rocks*, 10 June 2022, https://warontherocks.com/2022/06/sanctions-and-satellites-the-space-industry-after-the-russo-ukrainian-war/.

[63] TASS, "Russia interested in engaging private companies in space sphere — Putin", 27 October 2023, https://tass.com/science/1697569.

side, which demonstrates the visible disparity in the growth and development of commercial space sectors between the two countries.[64]

Japan

Japan is another key spacefaring country. It has traditionally maintained a strong government-led space programme through the Japan Aerospace Exploration Agency (JAXA), which focuses on civilian space activities. With the evolving global landscape of the space industry, there have been indications of increased involvement of private companies in space-related activities in Japan as well. The country has been following the global trend of engaging in more space PPPs by increasingly exploring collaborations and partnerships, but primarily for the civilian space sector. Compared to its Western counterparts, particularly the US and the UK, space PPPs involving the defence sector and military in Japan are not as extensive largely due to how space PPPs have been developed in Japan vis-à-vis the civilian domain.

In 2015, JAXA established the Space Exploration Innovation Hub Center to facilitate research projects through partnerships with various fields, including the private sector. The Center partnered with private companies on approximately 20 projects to foster a sustainable and thriving commercial space sector for the future.[65] In 2018, the Japanese government set up a US$940 million fund for space start-ups to further this initiative, with the goal of doubling its space industry market size by 2030.[66] This was followed by another ten-year fund worth US$6.7 billion issued by the government for JAXA from November 2024 onwards to support the development, demonstration, and commercialisation of advanced space technologies in three key areas: satellites, space exploration, and space transportation.[67] These efforts contribute towards Japan's ambitions, detailed in the 2020 Space Basic Plan, to achieve superiority and bolster its space autonomy amidst heightening tensions in the Indo-Pacific region.[68]

However, Japan's outer space PPPs, especially when comparing the roles of civilian and military space agencies, are quite different from other countries. One key difference is that despite JAXA playing a prominent role in civilian space activities, it is not as involved in the defence and security sector – the accumulation of technical knowledge related to military space activities and technology applications primarily lies

---

[64] See Marko Höyhtyä and Sari Uusipaavalniemi, "The Space Domain and the Russo-Ukrainian War: Actors, Tools, and Impact", *Hybrid CoE Working Paper* 21 (2023), accessed 9 March 2024, www.hybridcoe.fi/wp-content/uploads/2023/01/20230109-Hybrid-CoE-Working-Paper-21-Space-and-the-Ukraine-war-WEB.pdf.

[65] JAXA, "About 20 Projects Are Currently in Progress JAXA and Private Businesses Are Co-Creating the Space Business," accessed 2 March 2024, https://global.jaxa.jp/activity/pr/jaxas/no077/08.html.

[66] Michael Sheetz, "Japanese government launches $940 million fund for space start-ups", *CNBC*, 20 March 2018, www.cnbc.com/2018/03/20/japan-offers-940-million-to-boost-nations-space-startups.html.

[67] Andrew Jones, "Japan creates multibillion-dollar space strategic fund to boost space industry", *Space News*, 12 March 2024, https://spacenews.com/japan-creates-multibillion-dollar-space-strategic-fund-to-boost-space-industry/.

[68] Japan Cabinet Office, "Outline of the Basic Plan on Space Policy (Provisional Translation)", 30 June 2020, https://www8.cao.go.jp/space/english/basicplan/2020/abstract_0825.pdf.

with private companies rather than the Ministry of Defence or the Japanese Self-Defense Force (JSDF). This is partly due to domestic political sensitivity in Japan on the issue of maintaining and strengthening its military, which is rooted in its constitution.

Historically, the JSDF has relied primarily on the US-Japan security alliance as well as communication satellites and other strategic assets such as a regional positioning satellite system operated by private companies to deliver necessary space technologies and services.[69] In other words, while the JSDF has long engaged in PPP arrangements for outer space activities to advance Japan's national security and defence interests, its role is primarily that of a purchaser or client, not as an owner or operator. For example, Japan does not own any satellites operated solely for military purposes, and it was not until 2012 that JAXA's mandate was expanded to cover the development of dual-use technologies and provision of expertise to the Ministry of Defense, following the adoption of the 2008 Basic Space Law.[70] Due to its history of civil-military relations and the nature of existing space PPPs, Japan's Ministry of Defense is not as autonomous in defining and designing its own space system architecture.[71]

Furthermore, there remains a gap between the public and private sectors in Japan's space PPP model, in that the former provides support primarily in the form of investment and funding, while the latter focuses solely on innovation. With the growing trend of outer space PPPs, several concerns arise. On the private sector side, Japan's space industry may struggle to achieve rapid growth without substantial government support. Meanwhile, public institutions like JAXA and the Ministry of Defense lack the necessary experience and capabilities to quickly develop their own systems for space activities. As a result, they would often have to rely on private companies for these advancements.[72]

Nevertheless, PPPs involving dual-use activities are becoming formalised in Japan. For instance, Mitsubishi and ispace have made strides in satellite launches and lunar exploration through collaboration with JAXA. Mitsubishi Heavy Industries' H-IIA and H-IIB rockets have also been used for a range of satellite launches containing both civilian and military payloads, and the satellites serve both Japan's national defence and civil natural disaster monitoring.[73] Despite ispace's failure to land on the moon in May 2023,[74] the company is planning for its Hakuto-R Mission 2 and 3 to re-attempt a moon

---

[69] Suzuki Kazuto, "Space Security in Japan's New Strategy Documents", Center for Strategic and International Studies. 21 June 2023, www.csis.org/analysis/space-security-japans-new-strategy-documents.

[70] Lionel Fatton, "Japan's Space Program Shifting Away from "Non-Offensive" Purposes?", *The Institut Françaus des relations internationales*, accessed 2 February 2024, www.ifri.org/sites/default/files/atoms/files/fatton_japan_space_program_2020.pdf.

[71] See Kazuto 2023.

[72] Jones 2024.

[73] Juan I. Volosin, "IGS Optical 8 | H-IIA 202", *Everyday Astronaut*, 5 January 2024, https://everydayastronaut.com/igs-optical-8-h-iia-202/.

[74] Reuters, "Japan startup's failed moon landing caused by altitude miscalculation, company says", *Reuters*, 26 May 2023, www.reuters.com/business/aerospace-defense/japans-ispace-says-altitude-miscalculation-caused-moon-landing-failure-2023-05-26/.

landing in 2024 and 2025 respectively.[75] Mitsubishi Electric has also agreed to collaborate with Astroscale – a private space company developing solutions for on-orbit servicing, notably for debris removal – to jointly develop and manufacture sustainably designed satellite buses to be used for national security purposes.[76]

Japan's domestic space regulatory framework primarily comprises the 2008 Basic Space Law and a 2016 framework for spacecraft launch and control.[77] Currently, most commercial space activities are regulated by the Cabinet Office, which is responsible for the management and administration of related licenses.[78] Despite the country's recent focus on debris removal missions, especially through various collaborations between JAXA and Astroscale, there is no specific law in Japan that expressly requires the removal of orbital debris. Nevertheless, the government established guidelines for private space companies seeking licenses under Japanese law, stipulating that license holders take all measures necessary to limit debris released during operations, although there are no legal implications arising from non-compliance for now.[79]

India

India's space programme is led by its national space agency, the Indian Space Research Organisation (ISRO). The country's recent moon landing, which made it the fourth country in the world to accomplish this feat, demonstrates its burgeoning and formidable space capabilities. These successes can be partly attributed to the growing private space industry in India on both the civilian and military fronts.

On the civilian side, India has strived to foster space PPPs. Prime Minister Narendra Modi stated in 2021 that the Indian government would serve as an enabler for the private sector's innovation.[80] Fostering effective collaboration with the private sector was also mentioned in India's first National Space Policy launched in 2023. The growing success of India's space PPP's can be seen in the country's successful moon landing in August 2023, which was made possible by collaboration between ISRO and several private companies including Ananth Technologies, an Indian aerospace manufacturer founded in 1992, and Hindustan Aeronautics.[81]

---

[75] Alexandre Bans, "Japan's Race for Space Exploration: Challenges and Opportunities", *Asia Power Watch*, 15 November 2023,.https://asiapowerwatch.com/japans-race-for-space-exploration-challenges-and-opportunities/.

[76] George Gibson and Akihito Takamatsu, "Global Outer Space Guide: Japan", *Norton Rose Fulbright*, accessed 12 March 2024, www.nortonrosefulbright.com/nl-nl/knowledge/publications/b95ef154/global-outer-space-guide-japan.

[77] Daiki Ishikawa, Hiroko Yotsumoto, and Tetsuji Odan, "In Review: Space Law, Regulation, and Policy in Japan", *Lexology*. 5 January 2023, www.lexology.com/library/detail.aspx?g=f0a661ce-b787-4bb5-95ab-d07fd4159fe6.

[78] Gibson and Takamatsu 2023.

[79] Ibid.

[80] Namrata Goswami, "Indian Space Program and its Drivers: Possible Implications for the Global Space Market", IFRI, accessed 3 November 2023, https://www.ifri.org/sites/default/files/atoms/files/goswami_indian_space_program_2022_.pdf.

[81] The Hans India, "Chandrayaan-3: An example of PPP working to India's advantage", *The Hans India*, accessed 2 March 2024, https://www.thehansindia.com/technology/tech-news/nasa-backed-private-us-firms-lander-finally-launches-to-moon-858735?infinitescroll=1.

In 2021, Prime Minister Modi launched the Indian Space Association (ISpA), which aims to transform the country into a global leader in the new space economy and harness private sector talent and resources through PPPs modelled on the US approach.[82] With the proliferation of new space companies in India including NewSpace India Limited, Larsen & Toubro, Antrix (the commercial arm of ISRO), and Bellatrix Aerospace, ISpA will likely serve as the coordinator between the public sector and these companies by helping them navigate India's regulatory environment.[83] The Indian government, in turn, leverages their different areas of expertise. For instance, Bellatrix Aerospace, which specialises in the development of in-space propulsion systems and orbital launch vehicles, was offered a contract by ISRO to develop a rocket propulsion system.[84]

India has also shown interest and openness to partner with the private sector in other countries as well for the development of its domestic space sector. For example, NewSpace India Limited, the commercial arm of ISRO, recently announced that it will use SpaceX's Falcon 9 to launch a communication satellite later this year.[85]

On the defence and security side, the Indian Air Force (IAF) is undergoing a transformation to become the Indian Air and Space Force (IASF), highlighting the importance of the outer space domain for India's national security interests.[86] Chief of Defence Staff of the Indian Armed Forces Anil Chauhan noted that the military has inked five contracts with private companies, with four more being drafted.[87] This is partly driven by the Indian military striving to become independent from foreign constellations that have thus far enabled its significant defence capabilities, including for positioning, navigation, and timing requirements. Furthermore, the government also plans for more investment in the private space sector in the next few years.[88]

Regarding regulatory frameworks, India has signed the Artemis Accords, a US-led set of principles to guide space exploration and cooperation.[89] While this is an example of India's progress at the international level, its domestic regulatory framework remains underdeveloped despite the public sector's efforts to facilitate

---

[82] Goswami 2023, p. 9.
[83] Goswami 2023, p. 18-20
[84] Society for Innovation and Development, "Bellatrix Aerospace Pvt Ltd", accessed 2 March 2024, https://sid.iisc.ac.in/bellatrix/.
[85] Jeff Foust, "India Selects Falcon 9 for Communications Satellite Launch", *Space News*, 2 January 2024, https://spacenews.com/india-selects-falcon-9-for-communications-satellite-launch/.
[86] Economic Times, "Military Satellites, Space Fighters: How IAF Plans to Transform into a Superpower in Space", *Economic Times*, 15 December 2023, https://economictimes.indiatimes.com/news/defence/military-satellites-space-fighters-how-iaf-plans-to-transform-into-a-space-superpower/articleshow/105893651.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.
[87] The names of the companies were not identified.
[88] Gordon Arthur, "India plans to spend $3 billion on space. Can it catch up to China?", *Defense News*, 7 March. 2024, www.defensenews.com/space/2024/03/06/india-plans-to-spend-3-billion-on-space-can-it-catch-up-to-china/.
[89] Blyth 2023.

PPPs. This regulatory gap, some experts suggest, is hampering the growth of India's space ecosystem, particularly when compared to other spacefaring countries.[90]

China

China has garnered attention as one of the world's top three space powers in terms of capabilities and space assets, alongside the US and Russia. Historically, space activities in China have been monopolised by the government, with significant emphasis placed on the military aspect. Although private space companies have existed for some time, all of them were state-owned enterprises.[91] However, in recent years, Chinese policy discourse has increasingly emphasisd the importance and effectiveness of PPPs, reshaping the country's space ecosystem.

China has been actively advancing its space capabilities and exploring collaborations in the space domain. While the Chinese space programme is primarily led by government agencies, there are indications of an evolving landscape that includes partnerships with private entities, particularly after the government opened up the space sector to private capital in 2014.[92] This led to the emergence of new private space companies in the past few years, expanding the private space industry beyond two state-owned companies: China Aerospace Science and Technology Corporation, and China Aerospace Science and Industry Corporation.

In its 2016 White Paper on outer space activities, China advocated for policies that encourage "social forces" (including non-governmental space entities) to participate in space development. Beijing has also shown interest in space exploration, including lunar and Mars missions, and the openness to PPPs is perceived to realise this ambition. China's aim to land astronauts on the moon by 2030 is being supported by a collaboration between the government, universities, automotive enterprises, and research institutions, who are currently engaged in design work.[93] In the next five years, according to a report published by China's State Council in 2022, the country plans to develop advanced technologies for outer space activities, including conducting in-orbit activities such as debris cleaning.[94]

These efforts underscore China's commitment to prioritising domestic production in its space industry to achieve self-reliance in space technologies and supply chains. With China's military-civil fusion (MCF) strategy, these developments

---

[90] Ajey Lele, "Indian Space Force: A Strategic Inevitability", *Space Policy* 65 (2023): 1–14.
[91] Mingyan Nie, "The Growth of China's Non-governmental Space Sector in the Context of Government Support for Public-Private Partnerships: An Assessment of Major Legal Challenges", *Space Policy* 59 (2022): 1–10.
[92] Masaaki Yatsuzuka, "The Complex Impact of China's Military-Civil Fusion in Space", *Think China*, 4 July 2022,.www.thinkchina.sg/complex-impact-chinas-military-civil-fusion-space.
[93] Andrew Jones, "China's Commercial Launch Firms Get Space Station Cargo Boost", *Space News*, 25 October 2023, https://spacenews.com/chinas-commercial-launch-firms-get-space-station-cargo-boost/#:~:text=The%20Chinese%20government%20opened%20up,emergence%20of%20SpaceX%20and%20Planet.
[94] PRC The State Council, "China's Space Program: A 2021 Perspective", 28 January 2022,. https://english.www.gov.cn/archive/whitepaper/202201/28/content_WS61f35b3dc6d09c94e48a467a.html.

will certainly support its military space power in the future.[95] Additionally, while the line between the civil and military uses of space technologies is generally difficult to distinguish, it is particularly ambiguous in the Chinese space ecosystem given the historical ties between the space sector and the Chinese military.[96]

Examples of private companies involved in space PPPs in China include iSpace and LandSpace – both have had successful profiles in supporting public sector space activities. LandSpace, for example, successfully entered orbit using a rocket fuelled by liquid methane – a cheaper, safer, and more efficiently combusted alternative to the widely used liquid hydrogen and liquid oxygen rocket fuels.[97] These efforts were supported by the Chinese military and state-owned enterprises.

However, the commercial space industry in China nevertheless faces certain challenges. In contrast to Japan, where the accumulation of technical know-how is mainly in private companies, Chinese space companies have relatively limited capacity to conduct research, manufacture, and launch space vehicles and satellites.[98] Despite China's ongoing attempts to implement the MCF strategy, including in the outer space domain and creation of a platform for the private sector to actively participate in the Chinese space ecosystem, commercial space activities in China remain underdeveloped due to strict legal measures and close supervision by the government.[99]

There is a clear gap in China's domestic regulatory frameworks for outer space activities, especially when it comes to PPPs.[100] Its domestic framework has been described as being at an "infant stage" with regulations only addressing the issues of launching and registration of space objects.[101] However, according to China's State Council Information Office, the country is planning to speed up the formulation of a national space law to promote law-based governance of its space industry.[102]

---

[95] Yatsuzuka 2022.
[96] Neel V. Patel, "China's Surging Private Space Industry Is Out to Challenge the US", *MIT Technology Review*, 21 January 2021,.www.technologyreview.com/2021/01/21/1016513/china-private-commercial-space-industry-dominance/.
[97] Daisuke Kawase, "Rapidly Improving Private-sector Tech Fueling China's Space Strategy", *The Japan News*, 4 September 2023, https://japannews.yomiuri.co.jp/politics/defense-security/20230904-134357/.
[98] Nie 2022
[99] Mingyan Nie, "Space Privatization in China's National Strategy of Military-Civilian Integration: An Appraisal of Critical Legal Challenges", *Space Policy* 52 (2020): 1–8.
[100] Nie 2022
[101] Fabio Tronchetti, "Space Law and China", *Planetary Science*, 25 February 2019, https://oxfordre.com/planetaryscience/display/10.1093/acrefore/9780190647926.001.0001/acrefore-9780190647926-e-66.
[102] PRC The State Council 2022.

Discussion and Key Takeaways

This section discusses some general takeaways, with more specific policy recommendations detailed in the section that follows.

Space PPPs are a growing trend

Collaboration and partnerships between the public and private sectors in the outer space domain are on the rise. This is due to several factors. Since the late 1990s and more prominently in the early 2000s, there has been an emergence of private space companies. With the innovation they have brought to the space industry, the technologies for outer space activities have therefore become more affordable, which, in turn, has attracted more new companies and start-ups. On the other hand, while some technologies for outer space activities have become cheaper, private companies supporting military capabilities require a high level of technical know-how, as well as the ability to meet more stringent requirements. In other words, robust military capabilities in space have not necessarily been more affordable despite certain technologies becoming more cost-effective.

Furthermore, there has been more pressure on the public sector in several countries to either maintain or reduce their military spending. PPPs thus serve as a powerful way to minimise public sector spending on developing space technologies and manufacturing systems for use in outer space. In return, the commercialisation of the space industry has also created a competitive environment in which companies have to strive to innovate and reduce their costs, resulting in the availability of more cost-effective options for the public sector. In other words, PPPs benefit both the public and the private sectors. Because of this, its prominence in the space domain will likely increase going forward.

Space PPPs for military purposes are also rising but their extent and arrangements differ

The rising trend of space PPPs is not only confined to the civilian side of space activities but also extends to the military. All the countries examined in this report have taken advantage of the dual-use nature of space technologies, and utilised space PPPs to support their defence and military missions. Furthermore, a growing number of defence establishments are formalising relationships with the private sector for outer space activities.

The bureaucratic and institutional histories of each country or how they have formulated space PPPs in the past significantly affect the patterns of their PPPs today. Western countries, particularly the US and the UK, seem to have a more balanced relationship between the public and private sectors, while China, Japan, and India are still working out their preferred model, and are therefore constantly reorganising their PPP models. This has also affected PPPs with a defence and security focus. While there is enthusiasm for space PPPs in the defence and security sector among China, Japan, and India, their space sectors were previously heavily dominated by either the public

or private sector. Without an extended experience of working together, one side or the other might lag.

For example, in Japan, the private sector has typically dominated the space domain, especially for technological innovation. This resulted in the Japanese defence establishment having limited technical knowledge compared to the private sector. On the other hand, the space sector in China has primarily been dominated by the government. Thus, even though their space industry is now more open to the private sector, most technical know-how has been accumulated by the public sector.

The development of domestic regulatory frameworks differs among spacefaring countries; overall progress remains slow

As PPPs serve both civilian and military functions, outer space is a difficult domain to govern. On the one hand, this is understandable because whenever there is a national security dimension at stake, it is generally difficult to reach consensus at the international level, particularly within multilateral fora such as the UN. On the other hand, the issue is an important one and needs to be urgently addressed.

The rising trend of PPPs means that there has been a significant increase in the number of space actors, especially the private sector who are not directly responsible, such as for potential damanges to other space objects, under the Liability Convention. Despite this, the development of domestic regulations for the space industry in many spacefaring countries has made slow progress. Many countries still lack space regulations beyond licensing and registration. This raises concerns about how the private sector will be held accountable to international laws.

This also undermines the capacity to effectively govern the safety and sustainability of outer space. While solutions to orbital debris have been on the agendas of many spacefaring countries and there have been more space companies aiming to solve this problem, the increasing number of private actors in the loosely regulated domain of outer space is a source of the problem. The lack of regulatory frameworks to address the scope of responsibility and liability of private space companies is therefore an ongoing concern.

Space companies have gained more power, and simultaneously faced higher security risks

As space is central to national and international security, private space companies face increasing risks. The Russia-Ukraine war provides clear evidence demonstrating how a private company – in this case, SpaceX – can be involved in a conflict. As defence establishments increasingly rely on private companies' space systems, more space companies – intentionally or not – are likely to become key players in future conflicts.

Most, if not all, governments around the world have been increasingly relying on the technologies and services from the private sector, reflecting a global shift in the public-private power dynamic. Furthermore, with substantial investment in the space industry and a steady pipeline of contracts from governments, space companies have

become more powerful. Private companies are therefore likely to exert greater influence on public sector decision-making processes during future conflicts, potentially even influencing the direction of conflicts by selectively supporting certain actors with their technologies.

Conclusion and Policy Implications/Recommendations

The exploration of PPPs in the outer space domain reveals a dynamic landscape shaped by the convergence of technological advancements, commercial interests, and national security imperatives. This report has delved into the state of PPPs in both civilian and military domains of the US, the UK, Russia, Japan, India, and China, scrutinised their functions and implications, and highlighted the challenges they pose to the defence and security sector.

Throughout the analysis, it is evident that PPPs have become a cornerstone of space activities, offering a pathway for governments to leverage the agility and innovation of private entities while sharing costs, risks, and responsibilities. This collaborative approach has fostered rapid advancements in space technologies, driving innovation and cost-efficiency, and expanding the space industrial base.

Among the case studies, the US presents the most dynamic and developed arrangement of outer space PPPs as it has been among the world's top space actors with a long history of space technological development. Through decades of collaborating with private companies, public sector entities that deal with the outer space domain, including NASA and the DoD, have established a solid relationship with the private sector. Although the Soviet Union was in competition with the US during the Cold War, Russia's space PPPs today are far less developed than that of the US, which partly explains why Russia's space programme has fallen behind in the present. This illustrates the important role of the private sector in the present for advancing a country's space industry and ecosystem.

The UK is another country with a robust and growing presence in the commercial space sector, characterised by strategic partnerships between government entities and private companies. The UK has fostered a thriving environment for PPPs in outer space. However, with a substantially smaller market size than that of the US, the UK government often directly communicates with the private sector regarding the technologies they hope to procure for the defence sector. Following the path of the US and the UK are Japan, China, and India, who are continuously enhancing their space PPPs. The latter three countries are constantly adjusting the institutional and administrative arrangements for communication and management between the public and private sectors regarding outer space activities.

The development of regulatory frameworks remains an urgent task for these spacefaring countries. This is not only to fill the gap between domestic legislation and international laws on outer space, but also to address long term issues of safety and sustainability in space. This paper puts forward two broad policy recommendations for spacefaring countries, especially small and middle powers, who are seeking to enhance its space activities to navigate PPPs and enhance their space ecosystem.

First, the private sector is essential to advancing a country's space capabilities, and every spacefaring country should account for this aspect when designing space policies. As discussed, outer space PPPs are rising, and this trend will likely persist in the coming decade. As seen in the case of Russia, which did not invest in and place as much emphasis on PPPs as the US and others, its space ecosystem is not as developed today (although it is also true that the lack of extensive PPPs is only one of several reasons behind Russia's slower progress in outer space development at present). As private space companies can offer innovative and affordable technologies to the public sector, they are important actors in the future development of the space domain. This not only applies to major spacefaring countries but also to small and middle powers, who might be faced with limited resources and thus must be more strategic about investing in their commercial space sector.

Considering the private sector's important roles in the space industry goes beyond how the public sector should interact with space companies but also involves understanding the institutional structure and the development of space PPPs in a manner relevant to the domestic context of that country. Understanding the opportunities and challenges arising from their own institutional arrangements will help countries move forward quicker when trying to facilitate collaboration between the public and private sectors, which is a significant governance capacity in a fast-moving domain like outer space. For example, the public sector in Japan, including the military, is facing challenges as it lacks technical expertise. Thus, when managing collaborative projects with private companies, the public sector has more gaps to fill because it also needs to invest in providing technical training for its staff. This partly resulted in Japan's PPP structure progressing slower than other countries despite the country having long been an important space power.

Furthermore, the public sector also needs a thorough understanding of the market within their respective countries to inform their communication strategies with space companies. For example, with a much smaller market than the US, the UK and Chinese governments often directly communicate with private space companies when it comes to technologies that are of interest to their defence establishments or those that their militaries might require in the future. This is different from the US model, where, thanks to a much larger market, the public sector can afford to give private companies autonomy when developing technologies to support space missions. The government and military can then choose products that suit their needs rather than needing to invest resources to decide what they want upfront. Most small and middle powers would likely have to follow a path like the UK and China.

Apart from direct communication with the private sector, smaller spacefaring countries would likely have to rely on the private sector in other countries for relevant technologies as the size of their domestic markets might not be sufficient to meet all their defence and security needs. This raises a potential challenge for the public sector in smaller spacefaring countries as how communication takes place with foreign companies will likely be different compared to their domestic private sector. Small and middle space powers should therefore have plans and strategies ready to guide how they partner with different types of private sector entities.

Second, the development of domestic regulatory frameworks should become a priority, especially on the aspect of space sustainability. Given the generally slow progress in regulatory framework development at the domestic level, spacefaring countries should prioritise the development of comprehensive regulatory frameworks that address the dual-use nature of space technologies and ensure compliance with international laws and norms. These frameworks should go beyond licensing and registration, accounting also for liability, responsibility, safety, and sustainability measures to effectively govern space activities conducted by both public and private entities. Furthermore, as many spacefaring countries, especially small and middle powers, rely on foreign space companies, their regulatory frameworks should also consider PPPs with enterprises that are not entirely under its jurisdiction.

A comprehensive domestic regulatory framework will not only allow spacefaring nations to promote the safety and sustainability of outer space, which is an increasingly significant aspect, but also ensure safe and sustainable operations by space companies, especially those that have PPP arrangements for military needs and hence are involved in missions supporting national security. Such companies face higher security risks and might be involved in future conflicts. An effective set of regulatory framework would be able to help ensure these companies know how to manage their involvement in national security matters in both peacetime and during a conflict, making the space industry resilient and thus creating a conducive environment for more private space companies to participate.

Acknowledgement

I would like to sincerely thank the Military Transformations Programme at RSIS, especially Manoj Harjani and Dr Michael Raska, for their support throughout the project. I am also grateful for the editorial team for their help with copyediting and sharpening the piece.

About the Author

Wichuta Teeratanabodee was a Senior Analyst at the Military Transformations Programme at RSIS, where she researched norms and governance for military technologies. She is currently pursuing a PhD at the University of Cambridge's Department of Politics and International Studies. She obtained her MSc in Strategic Studies from RSIS.

About the S. Rajaratnam School of International Studies

The **S. Rajaratnam School of International Studies (RSIS)** is a global think tank and professional graduate school of international affairs at the Nanyang Technological University, Singapore. An autonomous school, RSIS' mission is to be a leading research and graduate teaching institution in strategic and international affairs in the Asia Pacific. With the core functions of research, graduate education, and networking, it produces research on Asia Pacific Security, Multilateralism and Regionalism, Conflict Studies, Non-traditional Security, Cybersecurity, Maritime Security and Terrorism Studies.

For more details, please visit www.rsis.edu.sg. Join us at our social media channels at www.rsis.edu.sg/rsis-social-media-channels or scan the QR code.

RSIS Working Paper Series

344	Public-Private Partnerships in Outer Space: Implications for the Defence and Security Sector *Wichuta Teeratanabodee*	2025
343	How Will Prime Minister Anwar Ibrahim Advance Malaysia's Belt and Road Cooperation with China? *Ngeow Chow Bing*	2025
342	Anwar Ibrahim in Power: A Historical Locating of the Limits for Change in Malaysia *Ooi Kee Beng*	2024
341	Institutional Challenges for China's Chip Industry *Manoj Harjani*	2024
340	How Doctrinal Differences Among Distinct Islamist Strands of Thought Influence Malay-Muslim Political Actors and Political Outcomes in Malaysia *Ahmad Fauzi Abdul Hamid and Che Hamdan Che Mohd Razali*	2023
339	Malaysia's Changed Electoral Landscape *Meredith L. Weiss*	2023
338	From Competition to Cooperation: The Global Palm Oil "'Sustainability Turn" as a Turning Point for the Malaysia-Indonesia "Special Relationship" *Helena Varkkey*	2022
337	Can Youth Save Malaysia's Democracy? *Meredith L. Weiss*	2022
336	Malaysia Policies and Interests in the South China Sea *Johan Saravanamuttu*	2021
335	Late Malaysian Politics: From Single Party Dominance to Multi Party Mayhem *William Case*	2021
334	Sabah's Unrelenting Exclusionary and Inclusionary Politics *Vilashini Somiah and Jose Ricardo Sto. Domingo*	2021
333	Measures of Economic Vulnerability and Inter-dependency in the Global Economy *Jikon Lai and Amalina Anuar*	2021

To access the full list of past RSIS Working Papers, click here.