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The Future of U.S.-India Private Sector Space Collaboration

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Abstract

India and the United States have dramatically deepened their cooperation on space exploration and technology in recent years. The two countries have codified their collaboration in the space domain through bilateral and multilateral agreements, including the U.S.-India initiative on Critical and Emerging Technology (iCET) and the Artemis Accords. At the same time, private companies are playing an increasingly prominent role in each country's civilian, military, and commercial space ambitions. While accounting for the differences in maturity and growth between each country's private space sector, this paper examines the barriers and incentives to collaboration between the Indian and American private space sectors. This paper's recommendations aim to guide policymakers from both countries in bridging their respective private sectors to advance mutual objectives.

Keywords: Space Policy, Innovation, Critical and Emerging Technologies, Commercial Space, Defence Cooperation, US-India Relations

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Introduction

Current US-India space collaboration marks a significant shift from their historical geopolitical dynamics, moving away from Cold War-era tensions. Over the past 25 years, their relationship has strengthened, driven by security interests, geopolitical imperatives, and technological advancements. Today, they collaborate on various fronts, including joint technological projects, defence, critical minerals, and space exploration. During Prime Minister Modi's June 2023 visit to the US, several joint initiatives were launched, and a vision for enhanced technology cooperation was outlined.

India's decision to join the Artemis Accords highlighted a significant departure from its traditional stance of strategic non-alignment. In a September 2023 joint statement, President Biden and Prime Minister Modi declared their intention to "forge ahead into new frontiers across all sectors of space cooperation," laying the groundwork for deeper collaboration in this strategic domain.

Advancing US-Indian cooperation in space requires further integrating the US and Indian commercial space sectors. Non-governmental actors, ranging from legacy companies to newly-formed startups, are increasingly shaping the trajectories of the Indian (and US) space sectors. When India initiated significant economic reforms in the early 1990s, it laid the preliminary groundwork for private sector involvement in the space sector. However, it wasn't until the last five years that a fundamental shift towards actual private sector participation in the space sector took place.

Once the country's first space startup emerged, the industry grew exponentially. According to Deloitte India and the Confederation of Indian Industry in their report, "NewSpace: India Perspective" (September 2023), India's space sector grew from one startup in 2014 to more than 190 startups in 2023. ISRO has reluctantly but obediently ceded to the private sector, opening new avenues for collaboration, both within and outside India, enabling US-India partnerships ranging from satellite development to space exploration missions.

However, joint innovation in space technology between the United States and India faces various challenges. The United States and Indian governments enforce strict export controls and maintain complex bureaucratic processes, which significantly impacts private-sector space collaboration. These controls restrict technology transfer and create substantial red tape, which, in turn, decreases the ease of conducting business in both countries' space sectors. This complex regulatory environment limits opportunities for cross-border investment and complicates the sharing of technology and expertise.

Additionally, the mature US space industry contrasts with India's developing space sector, posing challenges to effective collaboration. Lingering historical distrust and concerns over the other country's reliability on critical security and trade issues further compound these issues. For the US-India space partnership to become a significant space exploration and technology force, both nations would have to make concerted efforts to address these regulatory and trust-related challenges.

The core aim of our research is to address the following question: *How can the United States and Indian governments design incentives and reduce barriers to further integrate their space ecosystems, with a particular focus on their burgeoning private sectors?*

Using primary and secondary analysis and in-depth interviews with experts, we assess how each country's government and industry are approaching the prospect of collaboration in space technology. We also use field interviews and site visits with key industry stakeholders in Delhi and Bangalore to further understand the rapid growth of India's burgeoning private space sector and what this growth implies for the United States-India space relationship.

We divide our research and findings into four parts:

Part I contextualizes where US-India cooperation on defence and commercial space activities fits within the broader trajectory of the bilateral relationship. It traces the historical evolution and recent developments that have shaped this strategic partnership, setting the stage for deeper exploration of their collaborative efforts in space.

Part II offers an assessment of each country's space ecosystem, and maps their respective space value chains, highlighting their respective comparative advantages and identifying growth opportunities. This detailed examination underscores the significance of innovation and private sector participation in driving the future of space exploration and technology.

Part III discusses the institutional and regulatory barriers that hinder deeper space collaboration and ecosystem integration.

Part IV proposes policy recommendations for the US and Indian governments to further collaboration in the space sector. It discusses the mechanisms through which both governments can offer practical incentives for their private sectors to pursue joint ventures and collaborations. The section emphasizes the importance of navigating regulatory challenges, fostering technological exchanges, and cultivating a supportive ecosystem for collaborative innovation.

Part I: Historical Context and Changing Dynamics

1.1 Historical Context (1947-2013)

Since India's independence, the US-India relationship has evolved significantly. Prime Minister Nehru, India's first prime minister, aimed to keep India impartial during the Cold War. Despite initial challenges, India's non-alignment proved beneficial, as it received aid from both the US and the USSR. According to Arup Dasgupta's article "Charting Indo-US Space Cooperation" (2023), in 1969, ISRO collaborated with NASA on the SITE program, using a NASA satellite to broadcast educational programs to remote Indian villages.

India's non-aligned position was undermined by regional conflicts and shifting alliances. The United States' decision to support Pakistan during the Indo-Pakistani War of 1971, in its effort to counter the Soviet Union, strained the US-India relationship and fuelled mutual distrust. The US also opposed India's growing cooperation with the Soviet Union, including its purchase of Soviet weapons and extensive Soviet support for India's space program. In 1975, India launched its first satellite using a Soviet rocket (Weinraub 1975).

In 1998, India's Pokhran nuclear tests caused a significant strain in the US-India relationship (that had begun to improve after the Cold War). The Clinton administration imposed sanctions on India, which also affected its space program. This period marked a low point in bilateral relations. However, efforts to repair the relationship began in 2000, when President Clinton visited India, and continued under President Bush through diplomatic initiatives. Over time, sustained engagement, the lifting of sanctions, and growing mutual trust resulted in the 2005 US–India Civil Nuclear Agreement. This agreement paved the way for expanded cooperation, including in space. Following the nuclear deal, collaboration between the US and India increased, leading to joint projects in satellite technology, remote sensing, and space exploration.

In 2005, the countries also established the US-India Civil Space Joint Working Group (CSJWG), whose initial remit included areas from satellites to collaboration on Chandrayaan-1, India's first lunar probe mission (Embassy of India 2005, Department of State 2007). Chandrayaan-1 launched in 2008, and carried NASA's Moon Mineralogy Mapper; this was the first of many modern-era direct NASA and ISRO collaborations. Over the next five years, the US-India relationship and space collaboration improved, with regular CSJWG meetings and joint climate mapping from space. NASA also provided technical support for ISRO's 2013 Mangalyaan mission, India's first interplanetary mission.

1.2 Changing Dynamics and Recent Milestones (2014-Present)

The current era of US-India space collaboration began around 2014, coinciding with India's progress in space capabilities and the election of current Prime Minister Narendra Modi, who sought to deepen ties with the United States. Both countries saw China as a strategic adversary, leading to increased cooperation on sensitive technologies, including space and defence.

In 2014, the United States and India established the NASA-ISRO Mars Joint Working Group, and announced joint space initiatives. India's Mangalyaan Mars Orbiter Mission was a significant technological achievement, showcasing its rapidly advancing space capabilities. In 2020, the United States and India signalled interest in integrating their space sectors more comprehensively in their space policy objectives. Since 2021, the US and India have built and defined a shared vision for collaboration in space, elevating their partnership to a new height. Four initiatives mark essential steps forward in this collaboration: the Artemis Accords (common norms for space), INDUS-X (defence collaboration), Initiative on Critical and Emerging Technology (iCET) (critical technologies), and an enhanced NASA-ISRO relationship/CSJWG (increased traditional government-to-government space collaboration). In addition, deregulation has allowed private companies to develop advanced space technologies, altering the roles of governments.

The iCET and Artemis Accords are key pillars of US-India space collaboration. Launched in 2022, the iCET focuses on strategic technology partnerships, including innovation, defence tech, semiconductor supply chains, and space cooperation. It prioritizes human spaceflight, commercial

ventures, and talent exchanges in space science (The White House 2023a). The Artemis Accords, which India joined in 2023, set principles for peaceful, transparent, and responsible space exploration, emphasizing interoperability, emergency assistance, data sharing, and resource protection. India's alignment with Artemis Accords marks a significant shift in its space policy, a striking testament to how much the US-India space relationship has evolved since the Indian-Soviet space collaboration in the 1970s.

Bolstered by the foundations established by iCET and the Artemis accords, the India-US Defense Acceleration Ecosystem (INDUS-X) and upgraded NASA-ISRO/CSJWG collaboration could provide vehicles for both civilian and military space ecosystem integration. Launched in 2023 following the inaugural Defense Space Dialogue in 2022, INDUS-X operationalizes iCET's "Defence Innovation Bridge" (Press Information Bureau 2023). INDUS-X seeks to bring together government, the private sector, and academia into a single, more interconnected defence ecosystem through initiatives including mentor-protégé partnerships, standardizing certifications for technology companies, and easing regulations for cross-border development (Department of Defense 2023).

NASA-ISRO/CSJWG collaboration also contains a wide variety of new initiatives, including the creation of a sub-working group under CSJWG dedicated to commercial space collaboration and the NASA-ISRO Synthetic Aperture Radar (NISAR) mission, the first space hardware collaboration between NASA and ISRO on an Earth-observing mission (The White House 2023b, 2023c). The NISAR mission, set to launch in 2024, marks an important shift from consultative cooperation to concrete collaboration.

The United States and India have started the four aforementioned initiatives to build the foundation for stronger space cooperation. As the CSJWG has grown and matured since 2005, so will these new institutions, fuelling the current momentum behind U.S.-India space collaboration.

1.3 Private Sector's Rise in Space Innovation

In contrast to prominent government-led space programs of the twentieth century, the private sector has taken a leading role in space activities due to liberalization measures by major spacefaring nations like the US and India. As more private firms enter the space market, they focus on operational efficiency, reducing launch costs, and fostering rapid innovation. The dual-use nature of space assets means this growth has significant strategic and economic implications for spacefaring nations.

Moreover, the commercial sector has required less R&D investment as many technologies, particularly for satellite launches, have become standard. Present-day launch costs are 40 times lower than they were in the 1980s, and recent analysis by Citibank approximates that they will fall an additional 95% by 2040 due to reusability, scale, lower input costs, and cost-efficient production methods (Citi GPS 2022). As firms master efficiency in the space value chain, they will play a key role in innovating dual-use space assets, which are of strategic interest to countries like the US and India.

In the subsequent section, we will contextualize the role of private firms in the US and Indian space sectors. Then, we will assess how space market deregulation has impacted India's private space sector. Finally, we will highlight current and projected advantages within the Indian private space sector that US stakeholders should explore further.

Part II. Space Value Chain

2.1 Defining the Space Value Chain

The space value chain encompasses the complete spectrum of activities and services in the space industry. We divide the space value chain into three core segments: upstream, midstream, and downstream. Each of these segments has distinct roles and functions in the overall value-creation process:

- **Upstream activities** in the space industry focus on creating space equipment, such as satellites and spacecraft. This phase includes satellite manufacturing, which is essential for Earth observation and communication applications.
- **Midstream activities** in the space sector connect the manufacturing of spacecraft and satellites to their use in space. This category includes ground station operations for satellite launches, satellite operations, and managing space-based assets from Earth.
- **Downstream activities** focus on using data procured from space for terrestrial applications. This phase involves managing and processing data for end-uses like weather forecasting, agricultural monitoring, and disaster management.

Table 1: Comparative Matrix of Prominent US and Indian Firms Along the Space Value Chain

	United States	India
Upstream	**Blue Origin:** Human spaceflight services **Boeing:** Satellites, space vehicles **Lockheed Martin:** Aerospace, satellite launches **Northrop Grumman:** Aerospace, defence tech **Rocket Lab:** Commercial satellite launches **SpaceX:** Rocket and Space Launches	**AADYAH Aerospace:** Aerospace components, propulsion **Agnikul Cosmos:** On-demand satellite launches **Azitaa BST Aerospace:** Satellite tech services **Bellatrix Aerospace:** In-space propulsion, satellites **Dhruva Space:** On-demand satellite launches

		Skyroot Aerospace: Cost-effective launch vehicles **Multiple startups:** Small satellite design
Midstream	**Blue Origin:** Human spaceflight services **Globalstar, Inc:** Promotes, exploits space products **Iridium Communications:** Global satellite communications **OneWeb:** Broadband internet satellites **SpaceX Starlink:** High-speed internet satellites	**ISRO:** Ground station capabilities **New Space India Limited (NSIL):** Manages the production, assembly, and integration of launch vehicles with industry consortium
Downstream	**Google Earth:** Mapping with satellite imagery **GPS Navigation Systems:** Satellite nav. services **Virgin Galactic:** Space Tourism	**Astrogate Labs:** Optical satellite communication **Digantara:** Space situational awareness (SSA) **GalaxEye:** Space-based observation **Pixxel:** Hyperspectral earth observation satellites **Multiple startups:** Space data analysis and processing services

2.2 Key Players in The United States and India's Space Ecosystems

This section outlines the key institutional players that make up the United States and India's respective space ecosystems. We briefly summarize the evolution of each country's government, military, and private sector involvement in space activities until the present day and situate these actors in each country's present-day space value chains.

United States

Since the 1980s, private industry has played a key role in shaping the United States' space program. Large aerospace companies have traditionally been involved in government space missions; for instance, Boeing, Lockheed Martin, General Dynamics, and LTV have traditionally played vital roles in government space missions. Now, however, startups and small to medium-sized enterprises are also contributing significantly to the space economy by creating new market opportunities, and enhancing the supply chain in specific sectors such as satellite manufacturing, space tourism, and commercial launch services.

The United States leads in government space spending globally. Even so, in 2021, over 80% of the US space industry was made up of commercial entities, highlighting the substantial role of private enterprise (Zagorsky 2023). SpaceX, in particular, has made significant strides in reducing orbit costs with reusable rocket technology, making space missions more economical, and capturing a significant share of the global launch market (Weinzierl, Lucas, and Sarang 2020).

India

India's space aspirations, while following a different trajectory and pace, mirror the US goal of leveraging the private sector for commercial and strategic aims. Initially focused on national development, India's space efforts, led by ISRO, have recently shifted towards privatization and global integration with reforms like New Space India Limited (NSIL) and IN-SPACe. This shift aligns with global space commercialization trends, though ISRO remains a dominant player.

The Indian Government's Role in its Domestic Space Sector

India's space sector remained highly regulated until the late 2010s, leaving the private space sector with no room to flourish. For decades, the private sector in India's space economy consisted primarily of ISRO's Tier-2 and Tier-3 suppliers. ISRO had thus cultivated an expansive vendor ecosystem, with about 400 private companies operating in clusters near cities such as Bangalore, Hyderabad, and Pune. Such vendors tend to specialize in space-specific products like screws and sealants, and up to one hundred can collaborate on a single ISRO launch (Travelli 2023). Thus, India's private space sector could not evolve beyond ISRO's fragmented private vendor ecosystem until recently.

In 2019, under Prime Minister Modi, India's space sector saw a major shift, with privatization and new objectives guided by the Aatmanirbhar Bharat strategy promoting self-reliance. This policy aims to strengthen both commercial and defence capabilities. However, as representatives from an Indian space industry trade group pointed out, the pro-indigenization policy sends a confusing message to foreign investors that Indian firms are trying to attract. Ultimately, India still depends on foreign investment for many subsystems, components, and materials.

Table 2: Summary of Indian Space Sector Reforms (2019-Present)

Year enacted	Measure/Reform
2019	New Space India Limited (NSIL) established a new public sector undertaking company to steer the commercial exploitation of space products, services, and technologies by facilitating industry participation and technology transfers from ISRO to the commercial sector. *The establishment of NSIL has contributed to technology transfers from ISRO that have benefited firms involved in upstream activities in the space value chain.*
2020	The Indian National Space Promotion and Authorisation Centre (IN-SPACe) is a "single window nodal agency" to boost the commercialization of Indian space activities. IN-SPACe's mandate is to authorize space activities, promote industry clusters and incubation centres, and ensure equitable access to space infrastructure. *IN-SPACe's mandate as an industry regulatory and promoter impacts private firms participating in all segments of the space value chain.*
2022	The Department of Space announced India's National Geospatial Policy, liberalizing geospatial data acquisition, processing, and dissemination. The policy focuses on achieving Sustainable Development Goals (SDGs) and promoting India's self-reliance on geospatial data. It also invites the Indian private sector to participate in commercializing geospatial services. *The National Geospatial Policy encourages domestic geospatial entrepreneurship to meet its objectives. While this would stimulate all parts of the space value chain, it would particularly benefit firms involved in midstream and downstream geospatial activities.*
2023	The Indian Space Policy 2023 outlines key stakeholders' roles in space activities. The scope of ISRO, DoS, In-SPACe, and NSIL reflected in this policy are as follows: ISRO is set to transition from contributing to space technology manufacturing to focusing on R&D in advanced technology that meets national objectives, including long-term projects like Chandrayaan and Gaganyaan. The policy tasks ISRO with sharing technology and best practices with other government and non-government companies. The Department of Space is now the nodal department for implementing space technologies and coordinating international cooperation and global space governance and programs, in consultation with the Ministry of External Affairs. DoS must also provide overall policy guidelines to regulating entities and create a dispute settlement mechanism for space activities.

	IN-SPACe is designated as the private space industry's sole regulator, and must create a stable regulatory framework to ensure a level playing field for non-governmental entities. NSIL will continue facilitating the commercialization of space technologies and platforms created through public expenditure. *The Indian Space Policy 2023 clearly states that private entities may engage in a range of space activities at all levels of the space value chain, from launching and operating space assets to operating ground services to establishing space situational awareness (SSA) assets.*
2024	India has recently finalized a new foreign direct investment (FDI) policy for the space sector, which liberalizes rules for foreign ownership to help attract foreign investment in areas including satellite manufacturing, ground segment, launch vehicles, subsystems, and more (Jones 2023). *India's novel space sector FDI rules allow for 100% foreign investments in satellite manufacturing without government approval needed, and eased investment policies on launch vehicles.*

Since 2019, the Modi government has enhanced the private sector's role in India's space economy, and repositioned ISRO as a key facilitator. New entities like NSIL and IN-SPACe support private sector growth. ISRO and IN-SPACe have successfully engaged with startups, exemplified by Skyroot Aerospace's launch of India's first privately developed rocket, Vikram-S, in 2022, with substantial support from both agencies (Rajagopalan 2022).

The release of the Indian Space Policy 2023, which outlines the Indian government's vision for building up its space capacity through leveraging the private sector, has done even more to prioritize private participation in space activities, particularly those with civilian applications. Most significantly, the policy envisions the reorientation of ISRO and the Department of Space's mandates from manufacturing and production of space technology to managing domestic and international space policy, technology sharing, and guiding India's overall strategic vision in space.

Representatives from Indian think tanks and space industry groups we interviewed acknowledged that the Indian Space Policy from 2023 is a good starting point for encouraging private sector-led growth and innovation, particularly among start-ups. However, they also emphasized that the Indian government has yet to release subsequent guidance on space defence asset prioritization, or pass concrete regulations through a comprehensive Space Bill, which would provide further clarity to private firms and investors.

ISRO's policy change (to open its technology and labs to startups) has fostered innovation and strengthened linkages between the public and private sectors. As we heard from various startup founders, IN-SPACe has also been a valuable resource in helping newer firms navigate logistical and

bureaucratic challenges. While industry advocates and private space firms we spoke with acknowledge that Indian space sector reforms are still nascent, and it may take at least 5 to 10 years to see tangible impacts, they underscore the importance of the Indian government driving this momentum through concrete measures, like a comprehensive Space Activities Bill. They also argued that the PMO – and not just ISRO – has a crucial role to play in addressing remaining issues with adequate funding and urgency.

India's strategic challenges along its borders have demanded increased focus on intelligence, surveillance, and reconnaissance (ISR) capabilities that rely on space-based assets. Moreover, a renewed global focus on space militarization has led India to enhance its space-based defence capabilities. In response to the US Space Force's establishment in 2019, India directed its existing Defence Research and Development Organization (DRDO) to support R&D in military space technology and established the Defense Space Agency (DSA) to manage military space assets, and directed the existing (V 2021).

India's aims to pursue defence indigenization and self-reliance in strategic domains, including outer space, have intensified due to major global conflicts. The recent Russia-Ukraine and Israel-Gaza wars have strained the military resources of countries like the United States, Russia, and Israel, from whom India procures military equipment. This situation has underscored India's vulnerability due to its dependence on foreign Original Equipment Manufacturers (OEMs). Consequently, these external pressures have intensified India's drive toward defence indigenization and self-reliance, particularly in strategic sectors, including outer space.

While defence is an area where India's private space sector can add value, India has yet to connect these demands with its domestic space suppliers, especially younger startups. Commodore JS Shergill (Retd.), a former Indian naval officer, explained this point in a 2024 op-ed for SIA India, arguing that the confidential nature of India's military space priorities domain prevents space industry newcomers from building technology with innovative space defence applications.

The Indian Ministry of Defence's Innovations for Defence Excellence (IDEX) Space Challenge scheme provides funding for startups to prototype and build products for the Indian military. Prime Minister Modi announced 75 IDEX Space Challenge areas at DefExpo 2022 in Gujarat, covering topics from AI/ML applications of geospatial imagery to anti-spoofing circuits for PNT services. This initiative aims to encourage innovative solutions to meet specific space asset needs. However, there is a need for clearer space defence priorities in India to enable startups to better innovate for defence applications, as compared to startups in the United States.

The Private Sector's Growing Role in the Indian Space Industry

The Indian government's recent efforts to end its monopoly on the country's space program have significantly boosted the private sector in the past few years. While ISRO still possesses the funding and political backing to undertake larger, riskier projects like human spaceflight and planetary

defence, the private sector has access to technology and capital to pursue projects that will scale up India's space industry.

Startups have been essential to the growth of India's private space sector, attracting significant private investments despite global market slowdowns from 2022 onward. However, overall venture funding remains less readily available in India compared to other major space-faring nations, especially for capital-intensive upstream space innovations. Consequently, many Indian startups are setting up parent companies in the United States, Europe, or Singapore. to take advantage of better opportunities for private and public seed funding for space startups (Dhingra 2022).

Besides private capital, the Indian government is another significant funding resource for domestic space startups, committing $112 million to firms in 2022 alone (The Hindu Bureau 2022). However, Indian government funding and procurement procedures are still insufficient, as startups often lack funding to bridge the gap between building a prototype, demonstrating a proof of concept, and scaling up operations.

A space startup we interviewed elaborated on the apparent mismatch between government procurement contract terms and the startup product development cycle. One of the founders remarked, "*Right now, the biggest concern for space and defence startups is [to build and scale] for a longer time horizon, and without a contract in place, they have no guarantee they can continue for very long, as they might not exist in three years.* "Another aerial and spatial defence startup founder we talked to echoed this sentiment, and added that venture capitalists are also less eager to give money to startups if government procurement contracts are not certain, creating a vicious cycle of limited long-term funding sources for startups.

Easing procurement contract bid requirements for startups can also help stimulate growth in India's private space sector. ISRO and DRDO are primary target customers for Indian space startups, but their contract terms have strict requirements that favour larger, more established firms. For example, current procurement policies stipulate that firms must have over 500 employees, demonstrate a prior track record and profitability, and provide security deposits and performance bank guarantees. These policies make it virtually impossible for startups to compete for government contract bids outside of IDEX Challenge Schemes, which inhibits overall growth and innovation from India's space startup sector.

As a result, the Indian space sector risks long-term brain drain, as many Indian space startups that have struggled to find a domestic market are already opting to find customers abroad (Dhingra 2022). Startups struggling to find a market in India often seek growth abroad. New Indian space companies, like Bangalore-based Pixxel, set up offices in the US to access capital and reach foreign markets. This strategy paid off for Pixxel, which raised $36 million in a Series B round led by Google in June 2023. Pixxel is also one of six commercial providers that signed agreements with the United States National Reconnaissance Office (NRO) in March under the agency's Strategic Commercial Enhancements program for hyperspectral imagery.

Pixxel's ability to secure the NRO agreement, which allows the agency to assess the company's technical and business plans and later procure hyperspectral data for demonstrations, can be largely attributed to its physical presence in the US market (The Economic Times 2023b). Pixxel's success abroad reflects the current opportunity gap within India's space market and is a testament to the opportunities that access to and collaboration within the US space sector.

2.3 Aligning US and Indian Space Value Chains

US-India collaboration is not just beneficial for Indian space companies. As the Indian space sector continues to evolve, the United States could gain from India's upward trajectory. India's present strengths are still modest but show a lot of promise.

- India boasts an 8.1% and 13.% compound annual growth rate (CAGR) in satellite manufacturing and launch services, respectively.
- On the whole, ISRO has proven its reliability in launch services, with 381 successful satellite launches for 34 countries, while utilizing a cost-effective approach that has been recognized by its international partners (Indian Aerospace and Defence Bulletin 2023).
- India also shows strength in satellite and ground segment services, representing 4.2% and 6.9% CAGR, respectively (Bhatt, Kant, and Sharma 2023).

Meanwhile, India's private space sector is growing exponentially, with space startups flooding the sector and contributing to segments across the space value chain. In 2021, India registered 368 space-focused companies— the fifth-largest concentration of space companies globally (Bhatt, Kant, and Sharma 2023). While still growing, India's private space sector is showing strengths across the space value chain. Startups in the upstream segment focus on satellite and rocket manufacturing, rocket fuel, and propulsion systems, while downstream startups develop data analysis and innovative end-user applications.

India's private space sector shows promising growth and potential. In a speech made to the 74th International Astronautical Congress held in fall 2023, IN-SPACe Chairman Pawan Goenka underscored India's strengths in small satellite manufacturing, and identified small launch vehicles and low earth orbit (LEO) constellation services as key growth areas (Jones 2023). Space industry stakeholders we spoke with also noted India's software capabilities for downstream space data services, leveraging the country's strong software talent.

Below, we assess the Indian space sector's strengths, which could generate investment and collaboration from the US government and US-based space firms across space value chain segments.

Table 3: Areas Where the Indian Space Value Chain Can Benefit the United States

	Innovation	Cost	Supply Chain Diversification	Market Access
Upstream	Small satellite constellation systems; Satellite design; Space-based sensors	Satellites and space hardware components; Launch services	Satellite subsystem components; Launch services	Supply of launch vehicles to Indian / Asian markets
Midstream		Small payload launch operations and maintenance	Ground station support services; Satellite communication services	Ground station support services
Downstream	SSA data fusion and processing; Higher-value geospatial imaging data	Software design; Space-based data processing, analysis, and distribution	Space-based data processing and analysis	Cloud computing capacity; Telecom services; Data value-added services

Innovation: India's innovation is evident in technological advances by space startups in the upstream and downstream segments, despite cost and capital constraints. Notable advancements include LIDAR and hyperspectral sensors, which can benefit US firms, and innovations in geospatial imaging and SSA data fusion in the downstream segment. In Bangalore, we spoke with the leadership at SSA and high-resolution geospatial imaging startups that are attracting attention from US-based firms like Google and SpaceX and the United States Space Force. We anticipate that future growth in India's innovative capacity in space, driven by startups, can produce technology that will be a value-add to the US space market.

Cost: India's space program is well known for its cost-efficiency in upstream launch services and satellite production. ISRO's low-cost approach is exemplified by its Polar Satellite Launch Vehicles (PSLVs), which cost about $25 million per launch, or $6579 per kilogram, to low Earth orbit. By comparison, NASA's SLS rocket costs $28,572 per kilogram (The Economic Times 2023c).

ISRO's frugal mindset mirrors the approach of many commercial space firms that are driving down costs of space assets. This includes a willingness to take calculated risks, optimize resources, and indigenize critical components. Indian space startups, many of which are run or mentored by former

ISRO employees, also embody this mindset and manage to build hardware and software at considerably low costs.

According to a venture capital investor based in Bangalore that we spoke with, Indian startups have the potential to produce high-quality hardware that could lower satellite production costs and disrupt the space market. However, he also mentioned that inefficiencies in India's space sector could hinder firms from maintaining cost advantages in the global space market. A space policy researcher from a Bangalore-based think tank echoed this sentiment, stating that India's cost advantages in the space industry may not last long enough to outperform firms in more efficient markets.

Despite this, the experts agree that India's labour force will remain cost-competitive due to its large, highly skilled, and relatively low-cost workforce, which can contribute to various segments of the space value chain. The same investor we spoke with also pointed out that India's labour cost advantages in the space sector are offset by the industry's less-developed ecosystem and regulatory burdens, making it less efficient. However, if the Indian government works to address these challenges, cost-efficient labour could be an advantage for India in the future.

Supplier diversity: The US government's primary supplier base is largely undiversified, relying heavily on the same set of US-based companies to support high-risk and high-expenditure space projects. For example, a handful of traditional defence companies and newer space companies carry out projects for NASA's human space flight and cargo transport programs.[1] While limited demand has driven the lack of supplier diversity for the US space program, the expected increase in future space activities in the decades to come will increase demand for space assets and launch capabilities, which will constrain existing suppliers.

Additionally, the United States' geoeconomic and geostrategic concerns toward countries like Russia and China contribute to a broader reorganization of global supply chains in critical technology sectors like space. These factors make India a prime destination for alternative sourcing in launch services, satellite and subsystem component manufacturing, and downstream services. As India begins to ramp up space-focused manufacturing and services across all levels of the space value chain, the US government and US firms can look to India to diversify their supply chains to hedge against market and geopolitical risks.

Market access: As India's space industry matures, US space and defence companies will likely want to gain more reliable access to Indian commercial and defence space markets. Given that India may rival China as a regional space power in the future, US firms will likely want to leverage their presence in India to access additional markets in the Indo-Pacific region. The United States can attain strategic and commercial advantages through having market access in India, particularly in areas specific to SSA and geospatial imaging.

One SSA startup leader we spoke with in Bangalore pointed out that though data sensors required for SSA and earth observation are all positioned all over the Western hemisphere; they are sparsely located between the Middle East and China. US firms can establish a presence or strike tie-ups with Indian firms to help build out data sensors that can serve the United States' civic and defence priorities.

An Indian defence startup founder we spoke with in Bangalore pointed out that India's vast geography and diverse terrain make it an ideal test environment for geospatial imaging and weather monitoring. US space firms can utilize India as a viable market to test and develop space-based products and services. Additionally, US companies can take advantage of Prime Minister Modi's Make in India initiative to launch partnerships with Indian companies and attract Indian talent, which may help them score political points.

For US firms to successfully penetrate the Indian market, partnerships must align with the interests of both Indian and US companies. Indian companies are seeking technology transfer from US firms, which possess a comparative advantage in advanced space technology. However, US firms are reluctant to share technology due to potential competition, despite the allure of capitalizing on lower-cost Indian software talent. Collaboration may face obstacles unless US firms commit to significant technology transfer, thereby enabling more productive partnerships.

Additionally, while the opportunities for bilateral collaboration are compelling incentives to bring the US and Indian private space sectors closer, prevailing regulatory and policy challenges could impede the relationship's progression. In the following section, we will delineate the barriers to collaboration between the US and Indian private space sectors and identify the contributing parties.

Part III: Barriers to US-India Collaboration in Space

Despite powerful market incentives and high-level political support behind US-India space collaboration and ecosystem integration, many institutional, economic, and bureaucratic barriers will blunt progress if they remain unaddressed. Interviewees highlighted the most significant barriers and how they impact the bilateral space relationship.

3.1 Barriers Within the Bilateral Relationship

<u>Geopolitical Uncertainty:</u>

Growing geopolitical alignment boosts collaboration, but uncertainties about the US-India relationship and broader geopolitics hinder it. Indian space companies rely heavily on US components, but American priorities favour domestic and defense customers. Geopolitical events, like Russia's invasion of Ukraine, have caused costly supply chain delays for Indian firms. Such vulnerabilities could affect India during future geopolitical crises, such as a hypothetical Taiwan Strait

conflict. Despite significant high-level momentum behind the US-India relationship, ambivalence and anxiety over the closeness of the relationship persist both within the private sector and at lower levels of each government's bureaucracy.

As a senior figure at a US aerospace trade association described, US industry views India's democratic backsliding and treatment of ethnic and religious minorities, as documented in the State Department's annual human rights report, with caution (U.S. Department of State 2023a). He explained that US industry is concerned that these developments along with actions of the Indian government, such as its plot to assassinate an American citizen in New York City, will harm the overall bilateral relationship and thus hurt government support business between the countries (McKinley, Barnes, Austen 2023).

Western diplomats and many in the Indian space industry pointed to US abandonment of India after the 1998 nuclear tests and contemporary tensions, including over Russia and Pakistan, as undermining Indian confidence that the US will continue to be a reliable partner. This, in turn makes the Indian government and firms reluctant to become what they perceive as too reliant on the US and contributes to the Indian goals of indigenization and strategic autonomy.

Trade Barriers:

Indian space companies import 95% of their components, with a large percentage coming from the US (Tejaswi 2023). One larger, well-established space company told us that imported components are its single largest cost. Tariffs raise those costs for Indian companies substantially. Multiple start-ups described the cost burden of tariffs, with one telling us that tariffs raised the cost of American components by 42%, and another estimating the cost increase at over 30%. All companies we spoke with mentioned that tariffs significantly raised expenses.

Companies also noted that customs and import approval permits can be costly, given the delays that they cause. In addition to the general effects of duties on Indian business, significant tariffs make American suppliers less appealing to Indian companies. Especially in comparison to some third countries like South Korea, which have FTAs with India or might negotiate them in the future, high tariffs on American components could undermine the supply chain linkages between India and the US that support ecosystem integration (Hindustan Times 2024).

Beyond tariffs, non-duty trade barriers such as differing technological standards also impact the relationship. Different standards mean that interoperability decreases and that systems cannot be built together as easily by American and Indian companies. For instance, American companies use NATO-defined standards while Indian companies do not.

3.2 Barriers on the Indian Side

India's Regulatory Framework for Space:

The continuing uncertainty in the Indian regulatory environment holds the sector back, including deterring foreign investment. Since the space sector was only opened to private companies five years ago, Indian space policy is not fully settled. Changing or not-fully-defined mandates for ISRO, IN-SPACe, NSIL, and the private sector make it difficult for foreign companies to know what parts of the ecosystem they will be allowed to play, which discourages investment (Rajagopalan 2023).

Passing a comprehensive Space Activities Bill has proved difficult; an initial draft was released in 2017, however, the legislation has still not been passed into law. Though the Indian Space Policy (released in April 2023) brought much-needed clarity, and is expected to serve as the basis for an eventual Space Activities Bill, true policy certainty will not come until legislation is passed. For instance, the new policy does not fully specify IN-SPACe's powers and responsibilities (Singh 2023).

A think tank we spoke to emphasized that the agency functions as a regulator and promoter, while the larger space sector still lacks a fully independent regulator. Furthermore, commercial access to particular technologies continues to change. One start-up explained that this year, 50-centimeter resolution satellite imagery was only approved for the private sector.

Further, American companies working with the Indian government face complications due to misalignment between central and state governments. Promising initiatives can falter if state governments do not align with central policies. For example, one trade association we spoke with cited Tamil Nadu as a case of Centre-State policy misalignment affecting business. Centre-State agitations across a range of domestic political issues have impacted Tamil Nadu's access to Union funds and necessary permit approvals to support capex investments, especially in new construction (Moorthy 2013, The New Indian Express 2024). Once hailed as a major centre for automotive manufacturing sector in Asia, these governance issues dampened Tamil Nadu's investment climate in the 2010s, triggering headwinds for future would-be investors (Isaac 2018). The issue of Centre-State misalignment is particularly challenging for American firms when it stems from Indian domestic party politics, which is both delicate and difficult for American firms to fully understand.

Funding and Financing for Indian Firms:

The Indian government recently announced a new FDI policy for the space sector, outlining rules for foreign investment in India's private space industry. This policy aims to ease foreign investors' concerns. Whether it will lead to increased investment remains to be seen. When we spoke to a small start-up working with the Indian government to manufacture drones, the firm's CEO said there was "*anxiety among foreign companies to invest in India.*"

The lack of a codified set of rules for foreign stakeholders, combined with the nascent nature of the Indian space private sector ecosystem has led investors to shy away from pursuing India as a stable place to invest capital. Even if foreign investors are interested, they are nervous to invest in a place with no demonstrable historical credibility for return on investments.

There is significant innovation in India's space sector, making it attractive for U.S. companies to acquire Indian firms and their IP. However, India's venture capital culture is conservative, often undervaluing start-ups for their IP and lacking space sector expertise. This creates an opportunity for U.S. companies to invest with little competition. Nonetheless, Indian firms are sometimes hesitant to be acquired, and the lack of a finalized FDI policy complicates joint ventures, limiting access to India's technological innovations.

Government Procurement:

The Indian government is a major customer for space-related products, potentially appealing to American companies. However, barriers exist, such as ISRO's established relationships with long-term suppliers familiar with its needs. This makes ISRO less likely to switch to potentially more expensive American suppliers, especially as these companies already have access to the larger U.S. market.

Several factors hinder U.S. companies' participation in Indian defence procurement. The Indian military's lack of clear priorities complicates navigation for both Indian and American companies. The bureaucratic and hierarchical nature of the Indian government makes it challenging for U.S. companies to identify key contacts. Furthermore, the Indian government prioritizes local industry, often awarding contracts to Indian firms to support this goal.

3.3 Barriers on the U.S. Side

US Business' Incomplete Understanding of the Indian Market:

Although American companies recognize the potential in the size of the Indian market, lack of cultural familiarity and inexperience in the Indian market can both lead to poor investment decisions and a lack of investment altogether.

An Indian space industry trade group stressed that for American companies to gain market share in India, they need to better understand India's commercial use cases for space technology and tailor their products accordingly. For instance, there is growing demand for spatial imaging in the agriculture sector and American companies neither understand Indian agriculture nor appreciate the importance of agriculture in the larger market. Similarly, senior leadership at a major Indian company told us that US companies need to be more willing to make long-term investments in India and take the time to understand India's market even if that is not initially profitable. Finally, an Indian startup conveyed that US space companies need to be willing to be the first to invest in India instead of waiting for other Western companies to move first.

Export Controls, Including ITAR

Among the various barriers we identified through our interviews, the International Traffic in Arms Regulations (ITAR) was consistently mentioned by all our interviewees. ITAR is a set of rules

regulated by the U.S. Department of State that controls the import and export of defence-related goods and services, including those relevant to the space sector. ITAR covers a wide range of products, such as weapons, military vehicles, spacecraft, software, and associated technical data. Its main goal is to prevent sensitive military and space technologies from falling into the wrong hands. This presents a barrier to Indian companies, and also affects close American allies like the UK and Australia, due to its focus on safeguarding sensitive American technologies.

Through our interviews, we understood that there were two different ways ITAR poses a barrier for small and large businesses:

1. **Small Businesses, and the high costs associated with filing ITAR papers**

   There are substantial expenses involved in filing ITAR paperwork, which can be prohibitive for smaller entities like start-ups. ITAR registrants must be based in the United States, and Indian companies must be incorporated within an American company or be independently registered in the United States to start the ITAR process. Following the paperwork, companies will embark on a complex and time-consuming ITAR process. Startups have emphasized that it can sometimes be unclear what is truly subject to ITAR regulations.[2]

2. **Large Businesses, inability to get technology transferred**

   In our interviews with larger firms, instead of expressing concerns about costs, we encountered complaints about delays in approvals and licensing for specific technologies. In an interview with a large Indian infrastructure conglomerate currently partnered with an American defence company, we heard that "resistance on the part of the United States to tech transfer is a major roadblock." Even after finalizing a contract with an American defence company, ITAR regulations prevented the Indian conglomerate from initiating their project. Notably, most space collaborations do not require ITAR-controlled items, indicating that criticisms of ITAR may sometimes arise without direct relevance to operational requirements.

Despite the complaints voiced about ITAR by interviewees, US government officials we spoke to made it clear that the United States has made considerable efforts to assist Indian firms with filing ITAR exemptions. The government aims to expedite ITAR exemption approvals within a 60-day timeframe and has organized workshops for Indian startups to navigate ITAR and export control procedures. However, feedback from numerous Indian startups indicates a need for enhanced expertise within the US government to effectively address specific and technical questions about ITAR.

Visas

The US visa system continues to stymie travel to the US that facilitates commercial collaboration. Our research revealed that many smaller Indian startups had issues getting visas to the United States, especially without existing or former collaboration with an American company.

A member of an Indian space trade association said "[People working at] startups often can't get visas. People who already [happen to have] long-term visas can renew quickly. But startups are small and new, so they find it very tough to get an American visa." They described prohibitive wait times and trips to the US that could never take place. Without easier access to visas, the type of exchange between entrepreneurs on which ecosystem integration depends will be impeded.

Part IV: Policy Recommendations for the US and Indian Governments

In the preceding sections, we mapped the evolution of the US and Indian space sectors, the trajectory of the US-India space relationship, and the barriers and incentives that shape it. In this section, we recommend policies for key stakeholders in the US and India to strengthen the bilateral space relationship even further. These recommendations consist of joint initiatives and steps that each government can take individually to boost their private sectors, facilitate private sector integration, and strengthen bilateral technology cooperation.

4.1 Recommendations for The United States Government

<u>Simplify ITAR and Enhance Export Control Mechanisms for Innovation:</u>

While navigating the complex ITAR process is challenging for close allies and new partners, there's no avoiding it. However, to bolster the US-India space relationship, the United States must review and simplify ITAR concerning space situational awareness and software capabilities. India's strength lies in its downstream capabilities, yet ITAR restrictions have hindered access to essential software for startups. Streamlining ITAR regulations tailored to India's downstream sector would incentivize prioritization of this sector, thus fostering US-India collaboration (U.S. Department of Commerce and Federal Aviation Administration 2017).[3]

In addition to reviewing software-specific ITAR regulations, the US Department of State should continue its ongoing effort to educate Indian startups about navigating ITAR (U.S. Department of State 2023b). Many startups have found these roadshows to be useful. However, startups have also cited the lack of clarity over which technology is subject to ITAR restrictions, and/or lack of capacity within their often-resource-constrained teams to attend such sessions. As such, we recommend employing people with the right ITAR technical knowledge to manage these roadshows to answer specific questions targeting a wide range of space startups across India.

Indian companies must realistically acknowledge that the United States is unlikely to swiftly or easily revise these procedures. ITAR is a barrier for even the closest American allies like Australia and the UK. A healthy dose of realism over ITAR is needed from the Indian side when navigating this complex process. Streamlining ITAR will be a gradual, iterative process.

Promote Better Understanding of the Indian Market and Facilitate Exchanges:

The Indian market differs significantly from the US, characterized by low margins, high volumes, and a strong focus on agriculture-related technology. Cultural differences, diverse conditions, and varying consumer purchasing power shape product success. Without understanding these factors, American companies may struggle to succeed and be less appealing as partners for Indian firms. The Department of Commerce should facilitate connections between US companies and potential Indian partners, and encourage US companies to invest the necessary time and resources to fully understand the nuances of the Indian market.

In parallel, the US State Department should create joint workshops, symposia, and internships for emerging space industry leaders from both countries.[4] These would increase understanding of shared challenges and opportunities and foster a collaborative ecosystem conducive to space technology innovation. To strengthen government-to-government and private-sector relationships, investments in India-focused technology programs (like the one that yielded this paper) and Hindi language programs will create a generation of private and public sector leaders with a much better understanding of India. In addition to creating new initiatives and further facilitating exchange, the State Department should continue to make it easier for Indians to obtain visas to the US by addressing long wait times.

4.2 Recommendations for the Indian Government

Support for Foreign Investment to Complement the New FDI Policy:

India's newly finalized FDI policies for the space sector provide needed certainty and permit greater foreign investment. FDI can now account for 100% of investment in satellite components, systems, or sub-systems, and up to 74% and 49% of investment in building satellites and launch vehicles, respectively, without special approval (Reuters 2024). India should automate FDI approvals and create a new Space Investment Facilitation Unit to accompany these new rules.

India should streamline approval processes for space-related investments to attract foreign investors. By implementing automated approval procedures, India can eliminate bureaucratic delays that have historically slowed down projects and discouraged potential investors. This will not only improve the investment climate and boost investor confidence, but also support both new and existing players in the space industry.

Creating a specialized Space Investment Facilitation Unit within the Indian government can simplify the investment process for foreign entities interested in entering the Indian space sector. Like how IN-SPACe facilitates domestic investment and procurement, unit could serve as a central point of contact for identifying and supporting foreign investment opportunities, providing guidance and support tailored to the needs of US firms. Along with fast-track FDI approval mechanisms, India can ensure that space projects proceed without unnecessary delays, ultimately contributing to the growth and competitiveness of the Indian space industry on a global scale.

Expedite the Passage of Comprehensive Space Legislation:

India should prioritize passing a comprehensive Space Activities Bill. The regulatory certainty that the legislation would provide is an essential tool to bolster India's position in the global space economy, attract more foreign investment, and support the overall growth of the space industry. Though the space industry pushed to finalize and pass the bill following the release of the Indian Space Policy 2023, another year has passed without parliament passing the Space Activities Bill.

Legislation would be key to creating a legal framework supporting public and private sector engagement in the space industry. Based on our conversations with industry stakeholders, this bill should specifically address the following issues:

- *Legal Protection and Incentives for Private Investment:* The Space Activities Bill should include provisions that protect and encourage private investments. This may involve legal safeguards against sudden policy changes, guarantees of intellectual property rights, and incentives such as tax breaks or grants for research and development.
- *Framework for Public-Private Partnerships (PPPs):* The bill should outline a framework for PPPs that allows private companies to have a more significant stake in space missions, and set clear rules governing public-private collaboration. Additionally, the legislation should facilitate partnerships, leveraging private sector innovation and government resources.
- *Open and Transparent Bidding Process:* The Space Activities Bill should mandate open and competitive bidding processes for government contracts related to space activities, providing fair access to opportunities for startups and private companies, and fostering a more competitive space industry in India.

The upcoming bill should also build on the Indian Space Policy 2023, by formalizing existing effective policies and addressing unresolved issues. Resolving IN-SPACe's dual roles and potential conflict of interest is imperative to ensure a fair competitive environment for the sustained growth of the space industry. Clarifying the roles of newer space institutions like INSPACe and NSIL would contribute to creating a reliable investment environment and fostering innovation.

Stimulate Further Growth in Targeted Sectors of the Indian Space Industry:

One of the most meaningful things India can do to boost space ecosystem integration is to support the growth in capabilities of its private sector which in turn provides U.S. companies with a wider range of potential India partners. To accomplish this, the Indian government should:

- *Define* clear space defence procurement priorities to provide guidance for potential investors, both domestic and foreign.
- *Extend* tax exemptions and review tariffs for private-sector rocket vehicles, satellites, and ground equipment to reduce costs and facilitate integration in the US-India space ecosystem.
- *Establish* a tailored Product-Linked Incentive (PLI) scheme for space manufacturing to accelerate industry growth, fill funding gaps, and attract private and foreign investment.

Build Trust and Assurance by Safeguarding Critical Government Processes:

The Indian government should enhance its security infrastructure to foster American trust when handling sensitive information. Given the critical nature of dual-use technology in the US-India space relationship, strong confidence is vital for closer collaboration. Investments in secure physical and cyber infrastructure will boost American confidence. Expanding bilateral cybersecurity cooperation, such as through the US-India Cyber Security Initiative, aligns with both nations' concerns about anti-satellite cyber threats. These measures could lead the US to ease ITAR and export controls, and aid with the advancement of a Reciprocal Defense Procurement (RDP) agreement with India, which would provide interoperability and market access (The Economic Times 2023d).[5]

4.3 Joint Recommendations for The United States and Indian Governments

Continue Alignment on International Space Norms and Regulation:

The Artemis Accords were momentous in aligning the US and India on space regulation. As global norms evolve, the two countries should continue coordinating internationally to ensure a favourable environment for their space sectors and sustain political momentum. Shared best practices in governance, regulation, and sustainability will set a precedent for responsible space exploration.

Establish "INDUS-X for Space":

The US and Indian governments should develop a comprehensive framework to enhance space sector integration and innovation, using INDUS-X as a model. This framework should include joint challenge grants, accelerators, university-private company programs, and mentor-protege initiatives. Additionally, they should establish a supportive venture funding ecosystem through public-private partnerships, R&D grants, and private investment incentives. The CSJWG's new Commercial Working Group could negotiate this framework, led by the US Department of Commerce and India's Department of Space.

Create a Common Investment Framework:

The U.S. and Indian governments should establish a specialized framework for investment in the space sector. This framework would simplify investments and provide a legal structure for joint ventures and partnerships between U.S. and Indian space entities, as well as establish market access rules to facilitate smoother space-related trade (United States Trade Representative 2024).[6]

By incentivizing joint ventures and easing regulatory restrictions, both countries can foster the development of cutting-edge technologies with shared intellectual property rights. Furthermore, amid the negotiations for a U.S.-India defence procurement agreement, it is essential to ensure the inclusion of the space sector. This agreement has the potential to enhance supply chain integration and collaborations, opening up new possibilities in the space sector once it is finalized.

Provide Necessary Confidence for Overseas Incorporation:

Given the importance of government contracts to each country's space ecosystem, Indian policy analysts suggested that companies are hesitant to do anything they might perceive as jeopardizing their ability to obtain government contracts. Both countries' major government purchasers should assure that creating subsidiaries in the other country will not harm their companies' ability to obtain contracts. Providing this confidence will boost collaboration by increasing the number of companies with a presence in both countries and making it easier for Indian companies with US subsidiaries to access technology subject to US export controls.

Part V. Conclusion

With private sector growth, political support, and frameworks like iCET, the US-India space relationship is set to integrate and enhance both countries' private sectors. For India, this collaboration offers opportunities to accelerate its space sector through technology transfer, FDI, and market access. India could specifically focus on developing advanced, low-cost launch services, satellite manufacturing, and leveraging its strengths in software and downstream services. Emphasizing India's comparative advantages and the US's expertise in propulsion and deep-space exploration can foster innovation and expand markets for both nations.

Successfully addressing the challenges holding back collaboration which this report details will ultimately determine the relationship's trajectory. Both countries should act deliberately and be willing to devote the necessary political capital to the policies that support space sector ties. Together, the governments should create a new, comprehensive framework to support private sector integration with institutions like an INDUS-X for Space and support for joint ventures.

Each government should address the bureaucratic hurdles embedded in their systems, like visas on the US side and tariffs on the Indian side. Following its newly released FDI policy that boosts foreign investment in the space sector, India should also take the full suite of necessary actions to ensure sustainable growth in its private sector over the long term as soon as possible. This suite includes creating a durable and fully impartial domestic regulatory regime by passing a Space Bill, clarifying space procurement priorities, and designing thoughtful tax and production schemes to support the young private sector in targeted subsectors.

India and the United States should understand the critical role of policy in achieving greater space sector integration. By intentionally addressing policy, regulatory, and bureaucratic hurdles, as well as other barriers, they can unlock the full potential of the US-India partnership.

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Notes

[1] These firms include Boeing, Northrop Grumman, SpaceX, Sierra Space, and the United Launch Alliance (Lockheed Martin and Boeing).

[2] Several Indian space startups we consulted expressed concerns about the prohibitive costs associated with ITAR compliance. Smaller startups, in particular, highlighted the high expenses of filing ITAR papers, which are burdensome given their limited funding, often needed for overhead costs. Larger, well-funded startups also pointed out the complexities of navigating the ITAR process, despite having the necessary resources. In both cases, ITAR posed significant challenges for both small and large startups and was a recurring topic of concern in our discussions with various companies and entities.

[3] As many Indian space startups teams shared with us, navigating ITAR restrictions and determining which components were covered under ITAR or Export Administration Regulations (EAR) proved to be onerous. The dual-use nature of many components – especially those required for downstream space activities – seemed to complicate export restrictions. While the US Department of Commerce's 2017 guide for navigating US export controls for the commercial space industry provides some clarity, similar documents should be reviewed and updated to assess whether some restrictions can be simplified or streamlined, given the global uptake in commercial space technology development.

[4] While our group spoke with US professors who are engaged in symposia and mentorship programs with Indian students and academics in space research and technology, we concluded that at this point, such exchanges are limited under to academic context under INDUS-X and direct US-India university partnerships. However, if the US Departments of State and Commerce were to facilitate exchanges tailored for US-India diplomatic and commercial engagement in space activities, high-level aims in the US-India space relationship are more likely to be met.

[5]In 2023, the US and India started discussions on brokering an RDP agreement, as well as a Security of Supply Arrangement (SOSA). An RDP agreement would allow Indian businesses to fulfill US Department of Defense procurement contracts, while allowing US businesses to fulfill Indian Ministry

of Defense procurement contracts. The SOSA would allow the US Department of Defense to request more rapid access to critical technology inputs and finished products from Indian companies.

[6] The United States currently employs a variety of tools to engage with key trade partners, such as Trade and Investment Framework Agreements (TIFAs), established with several trade partners worldwide. TIFA Councils typically convene annually, providing a forum for the United States and other countries to discuss mutual interests in various sectors. Although the United States and India currently do not have a TIFA, creating a similar framework to address space technology investment issues would be a first-of-its-kind initiative. It could help pioneer the development of forums between the US and key trade partners in addressing issues relevant to critical technology sectors.