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Confederation of Indian Industry

NewSpace: India Perspective

September 2023

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INDIA

Table of contents

Understanding NewSpace **12**

- Journey of the Indian space sector 13
- Paradigm shift in the space sector 13
- What is NewSpace? 14

Regulatory regime for NewSpace **18**

- India's space organisational structure 20
- Indian Space Policy 2023 21
  - Role of Indian Space Research Organisation (ISRO) 22
  - Role of Indian National Space Promotion and Authorisation Centre (IN-SPACe) 22
  - Role of NewSpace India Ltd. (NSIL) 23
  - Norms for Non-Governmental Entities (NGEs) activities 24
- Other Indian regulatory polices enabling NewSpace 25
- Initiatives/reforms by selected global organisations towards NewSpace 28

Financing trends in NewSpace **30**

- Global landscape of investments 31
- Global government expenditure into space activities 32
  - Case study of Australian Space Agency activities 34
  - Private investments into the global space sector 36
- Indian landscape of investments 37
  - Public investments by the Indian government 37
  - Private investments into the Indian private space 37

Collaborations in Indian NewSpace **40**

- Major and recent international coll aborations by ISRO 41
- Global inter-space agencies collaborations 42
- Other collaborations with entities in the Indian private space sector 44
  - Technology transfers from ISRO to the Indian private ecosystem 44
  - Sharing intellectual properties of ISRO with private entities 45
  - Sharing ISRO's resources with industry and academia 45

The Indian NewSpace ecosystem **46**

- Segmentation of the Indian space industry 47
  - Upstream segment 48
  - Downstream segment 49
  - Auxiliary segment 50
- Indian space companies driving the ecosystem 51
- Current key capabilities of India's private space sector 52

Socio-economic impact in the NewSpace era **54**

Appendix-A **58**

- Indicative list of PSUs involved in the space sector 58
- Indicative list of private/publicly listed Indian space companies 59
- Indicative list of start-ups 63

List of abbreviations **68**

Message from IN-SPACe

India, with its rich history of space achievements from Aryabhata to Chandrayaan-3 missions, has embarked on a bold trajectory that aligns with the evolving global space landscape. Our nation's endeavors have rippled across the skies, punctuated by landmark missions that have captured the world's attention.

In recent years, the emergence of the NewSpace paradigm has transformed the space industry, transcending conventional boundaries and fostering innovation and as the Chairman of the IN-SPACe, I am privileged to witness and contribute to this remarkable evolution. Through strategic initiatives and conducive policies, IN-SPACe has been facilitating the growth of Non-Governmental Entities and startups, propelling them toward the forefront of space innovation. IN-SPACe has been at the forefront of fostering private participation within our dynamic space industry. We are strategically aligned with the Indian Space Policy 2023, ensuring a seamless synergy between government initiatives and private sector aspirations. Innovative schemes like the seed fund scheme were introduced to encourage startups to develop transformative space products and services that can improve the quality of life for people in India and across the globe.

The government's strategic initiatives, coupled with a growing appetite for innovation and entrepreneurship, have culminated in the flourishing NewSpace ecosystem. Private players and startups have taken center stage, contributing innovative solutions, advanced technologies, and fresh perspectives to the space sector. This burgeoning landscape has generated a remarkable surge in the number of space startups, demonstrating exponential growth from just a single entity in 2014 to more than 190 startups in 2023. This is complemented by the private investments into private players, which has seen more than USD 200 million till now with USD 119 million funding in 2022 alone.

Crucially, these NewSpace pioneers are fostering an environment of competition and collaboration, complementing the efforts of ISRO. Their innovations span across the entire spectrum of space activities, from satellite manufacturing to launch vehicle technology, Earth Observation to space-based applications. The ascendancy of private players across the value chain is not only altering the dynamics of the Indian space sector but also establishing a robust foundation for achieving Aatmanirbhar Bharat (self-reliant India) and future space endeavors.

I am delighted to see CII and Deloitte collaborate to release this important report, "NewSpace: India Perspective." This report delves into how India's space policy initiatives, investments, collaborations, and burgeoning private sector are driving us towards realizing the full potential of socio-economic impact through space. I extend my heartfelt gratitude to all stakeholders, including the Department of Space, ISRO, private enterprises, and academic institutions, for their unwavering commitment to pushing boundaries and fostering innovation. This report is a testament to their collective efforts, and I am confident that it will serve as a source of inspiration and knowledge for all those (even outside the Space Sector) who seek to understand the immense possibilities that lie ahead in India's NewSpace journey.

Dr. Pawan Goenka
Chairman
IN-SPACe

Message from CII

The Indian Space sector stands at the cusp of transformational change, driven by positive regulatory enablers, global recognition, and Indian industry's unwavering dedication. India's vision for its space endeavors is to achieve self-reliance, foster technological advancements, and contribute to humanity. With a synergistic blend of visionary policymaking, Government support, and active collaboration with global counterparts and the enabling environment for domestic private space players, the Indian Space sector is poised to redefine the boundaries of human achievement.

Over the decades, we all have been taking pride in ISRO's remarkable achievements and strong footprint as being among the global space-faring nations. Over the past few years, the Indian Space ecosystem has been shifting gears with the Government announcing the privatization of space for aligning with global trends. The establishment of IN-SPACe and NewSpace India Limited are driving commercial growth and have led to the emergence of numerous private players in the space sector. Space manufacturing activities are now expanding beyond ISRO, public sector enterprises and a few large companies. With the rise of the NewSpace era in India, over 190 startups have registered with IN-SPACe and more than $200 million has been raised so far in the past few years.

ISRO has diversified its manifest over the past year and launched multiple diversified missions including a demonstration of the new launch vehicle SSLV, specific launches for commercial usage like OneWeb & Singaporean satellites, Space exploration and experimental missions like Chandrayaan & Aditya, signed an Artemis Accords agreement with the US, and undertaken many more initiatives.

As we embark on this journey through the intricate constellations of our nation's space achievements, it is with great pleasure that CII introduces this report "NewSpace: India Perspective" on the Indian Space ecosystem. This report unveils the tapestry of key enablers that have converged to catalyze the paradigm shift from conventional Space to NewSpace in India.

This report is more than a compendium of facts; it delves into the intricacies of space policies and reforms by the Government, the synergy of both public and private investments into the space industry, collaborations with international space agencies and domestic stakeholders, emerging private space players and the socio-economic impact of space achievements and initiatives. These act as strategic pillars that will shape India's ascent in the global space arena while making India Aatmanirbhar in Space (self-reliant) in the long run and meeting the global demand too.

Through "NewSpace: India Perspective," we recognize the multidimensional impact of the space sector in our day-to-day lives. It is a reflection on human ingenuity, scientific progress, and the relentless pursuit of the scientific and technological talent pool in the Indian Space ecosystem. It is my hope that this report would serve as a comprehensive guide, shedding light on the shift of India's trajectory from conventional Space to NewSpace.

Chandrajit Banerjee
Director General
Confederation of Indian Industry

Foreword from CII

Jayant Damodar Patil
Chairman
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From the launch of the first Indian satellite Aryabhatta in 1975 to the latest Chandrayaan-3 mission to the Moon, India has established itself among the leading spacefaring Nations, under the leadership of ISRO's Indian Space Program - ably supported by Private and Public sector industries. The Indian Space sector is today at an inflection point with Indian Space Research Organisation (ISRO)'s role transitioning from the one entirely driving the Space Sector ecosystem to the one continuing to explore the deep space, pursue research and assuming the role of a mentor, enabling and handholding of the new era startups bringing in fresh breath of innovation and collaboration in the sector.

Thus, the Indian Space sector is at the cusp of a major transformation with the rise of NewSpace - characterized and driven by democratization of space and the participation of private companies in space activities. In addition to the conventional usage of space, these NewSpace companies & startups are using innovative technologies and business models to deliver space-based products and services that are more affordable, accessible, and responsive to the evolving market needs and, in the process, contribute to increasing India's share of Global Space economy.

The Government of India has been embarked on several reforms to boost the domestic Space sector, including the establishment of IN-SPACe to promote hand hold and authorize Space activities, and NSIL for providing launch services; released the Space Policy, multiple consultation papers for stakeholder inputs and feedback prior to implementation. This is changing the landscape of the Indian Space industry under the guidance, hand holding and authorization by INSPACe. The Indian Space Policy 2023 also has defined the roles for ISRO, NSIL and IN-SPACe and opened up the sector for unrestricted participation by non-Govt entities. The upcoming FOi policy and the anticipated Space activities bill is expected to redefine and refine the picture better and attract investments in the Indian Space sector to build a vibrant NewSpace ecosystem in India. Consequently, India is emerging as a heavyweight contender on the global stage alongside major space-faring nations.

To bring forth various nuances of Indian Space ecosystem, understanding the current trends in terms of policies, investments, collaborations, technology and its impact, Confederation of Indian Industry andss Deloitte have come out with a comprehensive handbook on Indian Space ecosystem. I am sure that this report will serve as a valuable resource for readers interested in understanding the Indian Space sector as well as bring in clarity in direction of evolving policies. I hope that it will inspire more people to join the NewSpace movement and contribute to the advancement of space exploration and utilization of space gainfully for growth of space economy.

Jayant Damodar Patil
Chairman
CII National Committee on Space

Foreword from Deloitte

Space is no longer the exclusive domain of a few nations. Over the past several decades, the space sector has undergone a remarkable transformation, evolving from its nascent stages in the 1960s to become a dynamic and multifaceted industry. Initially characterised by the pioneering efforts of space agencies of the US and the Soviet Union, the sector focused primarily on government-led space exploration and satellite launches for communication and scientific research.

However, 21st century has witnessed a shift towards the commercialisation and democratisation of space. Advancements in technology have led to the emergence of NewSpace, marked by the participation from private companies and start-ups. The development of more efficient technological space systems, miniaturisation of satellites, and enhanced computational capabilities have lowered costs and expanded the scope of space activities. Moreover, the democratisation of space data and services through satellites has transformed fields such as agriculture, environmental monitoring, disaster management, and navigation. These satellites, combined with advancements in AI and data analytics, have unleashed new possibilities for understanding and addressing global challenges.

India, as a rising space power with a long history of achievements and aspirations, is well-positioned to play a significant role in this new era of space exploration and development. These achievements are underpinned by the evolving regulatory framework designed to foster innovation and attract investments. This is a testament to the nation's commitment to not only nurture established players but also extend a welcoming hand to emerging NewSpace companies. By providing companies a robust foundation of space infrastructure, a repository of existing technologies, and active guidance, the government is enabling a seamless fusion of traditional expertise and modern innovation.

Synergistic with government initiatives, the rise of private investments into space has been bolstering private players to reap the full benefits of space assets. In addition to technological advancements, empowering the private sector amplifies the potential socio-economic impact of space applications. By finding innovative solutions to pressing challenges in areas such as agriculture, disaster management, or communication, private players are poised to bring tangible benefits to the lives of every citizen. Thus, their efforts will enhance the nation's socio-economic fabric.

This report titled "NewSpace; India Perspective" provides a comprehensive overview of the current state of the Indian space sector, as of September 2023. It delves deeper into the intricate interplay of policy initiatives, investments, collaborations, emerging private players, and the impact driven by space-based solutions. As India enters the NewSpace era, this report will guide readers through the exciting breakthroughs and promising developments that will shape the nation's journey into outer space.

It is my pleasure to present this comprehensive analysis to each curious mind and stakeholder looking to better understand India's unique space landscape.

Sreeram Ananthasayanam
Partner

Executive summary

Space exploration has always captivated the human imagination, pushing the boundaries of what we thought was impossible. In the past few years, a new era has emerged in the space industry known as NewSpace. The Indian space sector's odyssey has been a remarkable transformation, with each milestone charting an ambitious trajectory and pushing the frontiers in space. Over the years, the Indian Space Research Organisation (ISRO) has steered a path of audacity and exploration, orchestrating a symphony of achievements that have captured the world's attention. From its humble beginnings of launching sounding rockets in the 1960s to its current global space exploration initiatives (such as Chandrayaan-3 and Mangalyaan missions), the Indian space sector's evolution is a testament to India's technological prowess, strategic vision, and unwavering commitment to technological advancement and innovation.

The global space sector, much like the cosmos itself, is dynamically changing. The shifts are driven by a multitude of factors, including advancements in technology, evolving geopolitical landscapes, and the insatiable human curiosity to explore beyond our planet. Over the past decade, private players have redefined the rules of the space game globally; the sector has witnessed an era of innovation, commercialisation, and democratisation that transcended traditional boundaries.

The proactive Indian Space Policy recognises the need to adapt to the changing dynamics of the global space landscape. For the past five years, the Government of India has taken multiple reforms to nurture domestic space industry by opening the doors for private participation and innovation, establishment of government bodies, such as NSIL and IN-SPACe. However, it was the landmark Indian Space Policy of 2023 that signified a quantum leap towards the NewSpace era, defining guidelines for Non-governmental Entities (NGEs) in setting up their business in space.

This handbook, NewSpace: India Perspective, depicts the state of the Indian space sector in the NewSpace era. Through this handbook, we uncover the essence of NewSpace—a paradigm driven by technological leaps and global dynamics. The driving factors behind NewSpace are the intersection of regulatory reforms, financing dynamics, collaborative endeavours, technology innovators, and socio-economic impact.

Navigating onward, it highlights the following and creates an understanding of the Indian space ecosystem:

Chapter 1: Understanding NewSpace
This chapter aims to define the NewSpace, the need for the transition into NewSpace aand the contour of the key constituents and enablers of NewSpace in India.

Chapter 2: Regulatory regime for NewSpace
The Indian government's regulatory initiatives to boost the space sector, focus on fostering self-reliance and expanding capabilities to cater to global demand. It highlights various policies and reforms implemented to date. It also gives the flavour of initiatives taken by global space agencies to foster the private space ecosystem.

Chapter 3: Financing trends in NewSpace
Financing trends in the NewSpace era elaborate on overall investments and captures the dual orbits of government and private investments, shaping the course of space endeavours.

Chapter 4: Collaborations in the Indian NewSpace
Industry collaborations have been a major indirect investment in the industry, and have had a huge impact on the growth of the domestic space ecosystem. This chapter deep dives into industry collaborations, including ISRO's collaborations with other countries, collaborations amongst global space agencies, and international collaborations. It also talks about ISRO's collaborations with private industry and academia through technology transfers, intellectual properties, and research initiatives.

Chapter 5: The Indian NewSpace ecosystem
With a favourable regulatory regime, financing, and collaborations at the fulcrum of the Indian space ecosystem, this chapter dissects the industry segmentation and how the private ecosystem has been evolving across the space sector value chain.

Chapter 6: Socio-economic impact in the NewSpace era
Since its inception, the Indian space programme has been at the forefront of making space technologies beneficial for society at large. The chapter covers major use cases being solved by space applications and how the programme solves the evolving demands of space applications across industry verticals such as agriculture, infrastructure, and the blue economy.

Call to action: As we navigate through the report , call to action boxes, attempt to highlight some 'need of the hour' action items necessary for the growth and promotion of the sector

The Indian NewSpace ecosystem, characterised by its regulatory frameworks, technological innovations, collaborative endeavours, has embarked on a journey of new exploration with the growing private sector. The collective efforts of stakeholders converge to propel India's current 2 percent market share to an ambitious 9 percent of the global arena by 2030*. This visionary aspiration is underscored by the profound anticipation for the ascension of India's NewSpace ecosystem, where the possibilities seem limitless.

https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/nov/doc20221125136001.pdf

Chapter 1
Understanding NewSpace

Source link: https://www.isro.gov.in/Gallery.html

Journey of the Indian space sector

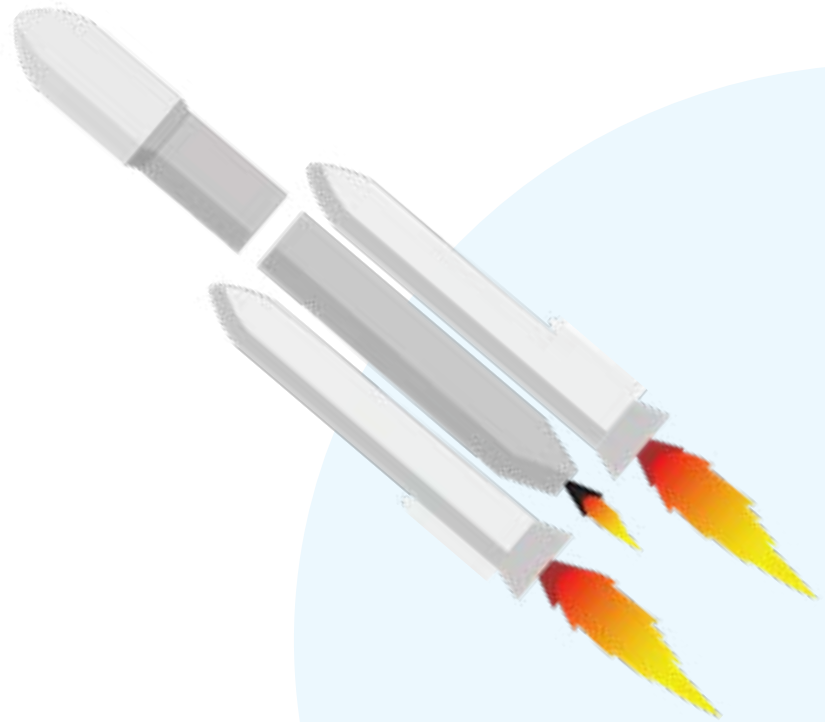
The journey of the Indian space sector has been remarkable and filled with significant milestones since its inception. India's space journey began in the 1960s, with the establishment of the Indian National Committee for Space Research (INCOSPAR) in 1962. In 1969, INCOSPAR was restructured, leading to the formation of the Indian Space Research Organisation (ISRO) in 1972.[1] Dr. Vikram Sarabhai, widely regarded as the father of India's space programme, played a crucial role in its establishment and development. Since the launch of India's first satellite Aryabhata in 1975 to being the first country in the world to reach the Mars orbit in the first attempt (Mars Orbiter Mission – Mangalyaan in 2013) and the latest launch of Chandrayaan-3 (2023), the Indian space programme has grown leaps and bounds.

ISRO's achievements reflect the country's determination to leverage space technology for societal development, economic growth, scientific exploration, and national security. Similar to the global space sector, the Indian space sector's journey continues to evolve with the state-owned agency leading it. This is followed by the influx of the private sector with a strong focus on innovation, international collaboration, and space commercialisation.

Paradigm shift in the space sector

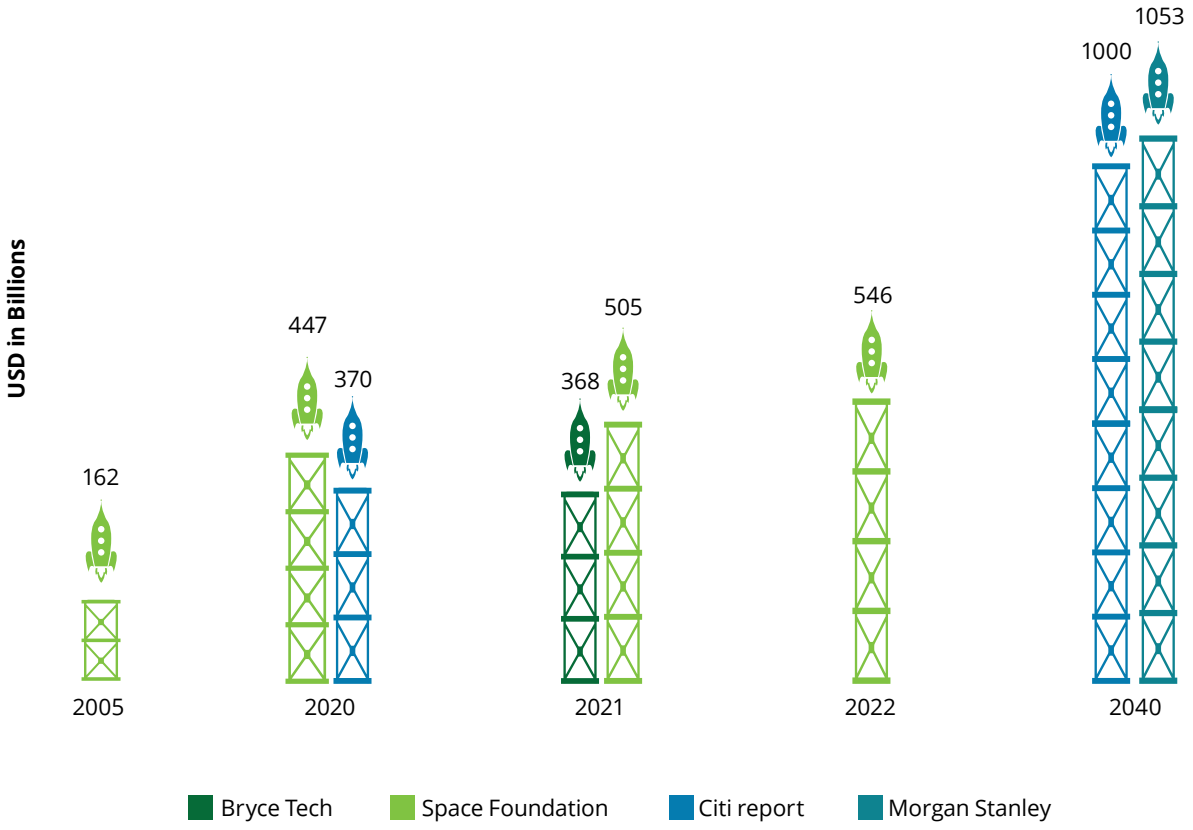
In the past few years, the landscape of the global space industry is evolving. A sector characterized by a government-driven strategy for growth and transformation is complemented by the cooperative efforts of private participants, which are made possible by enabling policies, reforms and regulations. This paradigm shift has resulted in the emergence of numerous private companies and start-ups that drive innovation, competition, and accessibility into the space economy. [2]

As a result, the global space economy valued at ~ US$ 546 billion[3] (in 2022) has been projected to reach ~US$ 1 trillion[4,5] by 2040. The growth will be driven by cost reduction efforts, accelerated turnaround times, and technological advancements made over the past two decades by private enterprises within the space industry of various spacefaring nations.[6]



[1]https://www.isro.gov.in/genesis.html
[2]https://brycetech.com/reports
[3]https://www.thespacereport.org/uncategorized/state-of-space-2022-industry-enters-era-of-access-and-opportunity/
[4]https://www.morganstanley.com/Themes/global-space-economy
[5]https://icg.citi.com/icghome/what-we-think/citigps/insights/space_20220509
[6]https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/apr/doc2023410179001.pdf

Figure 1: Estimates of Global Space Economy.



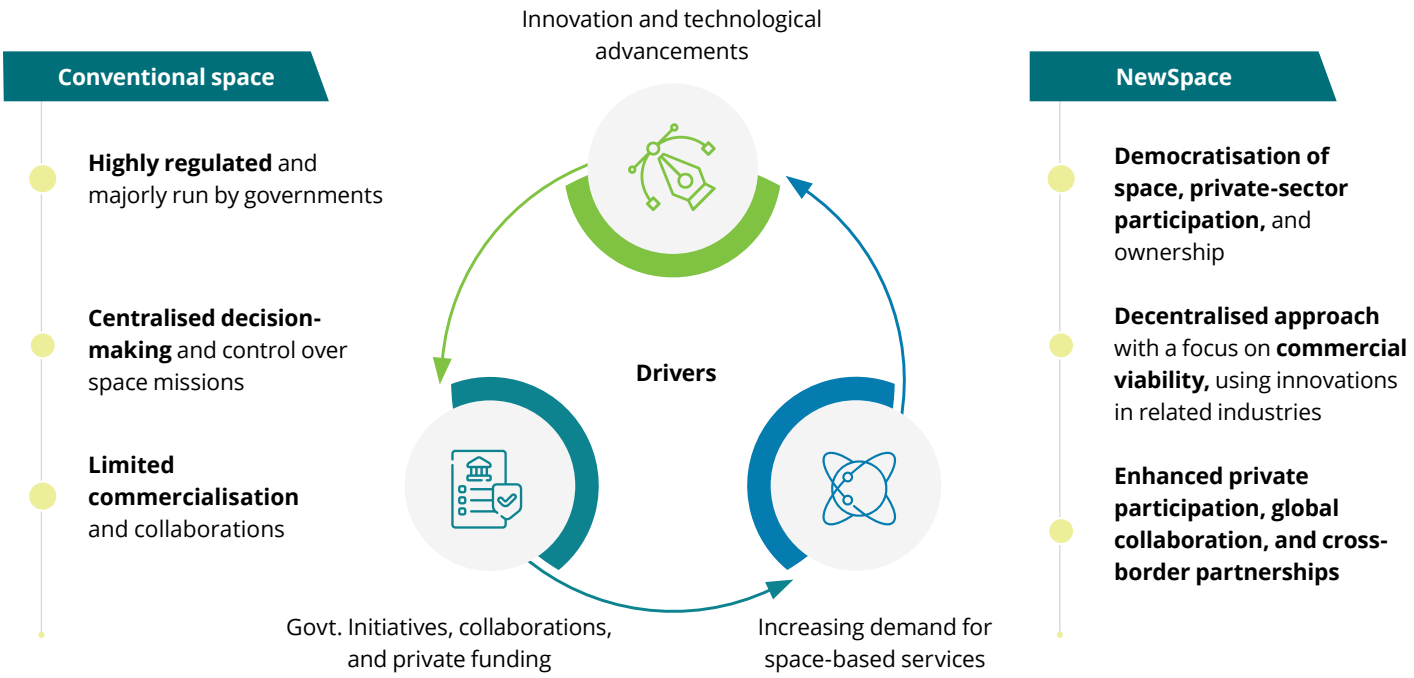
To make the space sector self-reliant and meet both domestic and global demand, the Indian government liberalised the space sector under the Aatma Nirbhar Bharat vision. Subsequently, the Department of Space announced its vision for the Indian space sector through Indian Space Policy, 2023. The policy has enabled the formal participation of Non-Government Entities (NGEs), i.e., private space players in the space sector.

The Department of Space aims to achieve indigenisation, innovation, and technological supremacy to position India as a major space power for the next few decades. The government also aims to bolster and sustain India's market share within the dynamic and ever-evolving global space economy.

What is NewSpace?

The emergence of NewSpace represents a paradigm shift in the space industry. The shift is driven by the key recognition that the private sector's involvement is essential to drive innovation, accelerate technological advancements, and unlock new commercial opportunities to eventually meet the increasing demand for space-based services. This shift is being complemented by progressive initiatives by the government, international collaborations, and the availability of private funding. These initiatives have contributed to the rapid advancement of the sector and its ability to meet the increasing demand for space-based services. These transformative factors have added a significant momentum to the NewSpace movement, igniting a flurry of unprecedented opportunities and growth prospects. Unlike the traditional model where space activities were primarily driven by government agencies, with ambitious goals, innovative technologies, and a drive for commercialisation and democratisation of space, NewSpace is reshaping the future of space exploration.

Figure 2: Key drivers enabling the shift into NewSpace



This shift in approach originates from the realisation that relying solely on state-funded programmes limits the pace of innovation and hampers the exploration of new frontiers. Private companies in the NewSpace sector are focused on not only serving their respective space agencies but also creating disruptive products and services that cater to commercial markets. By actively engaging in research and development, these companies can generate proprietary technologies and intellectual property, contributing to the overall industry growth. This collaborative and dynamic environment fosters competition and drives advancements in space technology, leading to a flourishing ecosystem where diverse entities contribute to the collective progress of the field and make way for exciting ventures into the cosmos.

> **In India, we are witnessing the emergence of new space. It is characterised by the active participation of industries, start-ups, and academia in space activities.** [7]
>
> -Somanath S., Chairman, ISRO & Secretary, Department of Space

Since its inception, ISRO has been the epicentre of the Indian space industry. The industry has had a rich legacy[8] of developing innovative and low-cost access to spaceflight technologies and applications for a wide range of use cases, from suborbital to deep space missions. As envisioned by Dr. Vikram Sarabhai,[9] ISRO focused primarily on using space technology for national development. Dr. Sarabhai had recognised the potential of space technology in addressing socio-economic challenges faced by India; the emphasis was on developing indigenous capabilities and achieving self-reliance in space technology. True to its vision, India has reached multiple milestones and achieved space missions that have received international accolades.

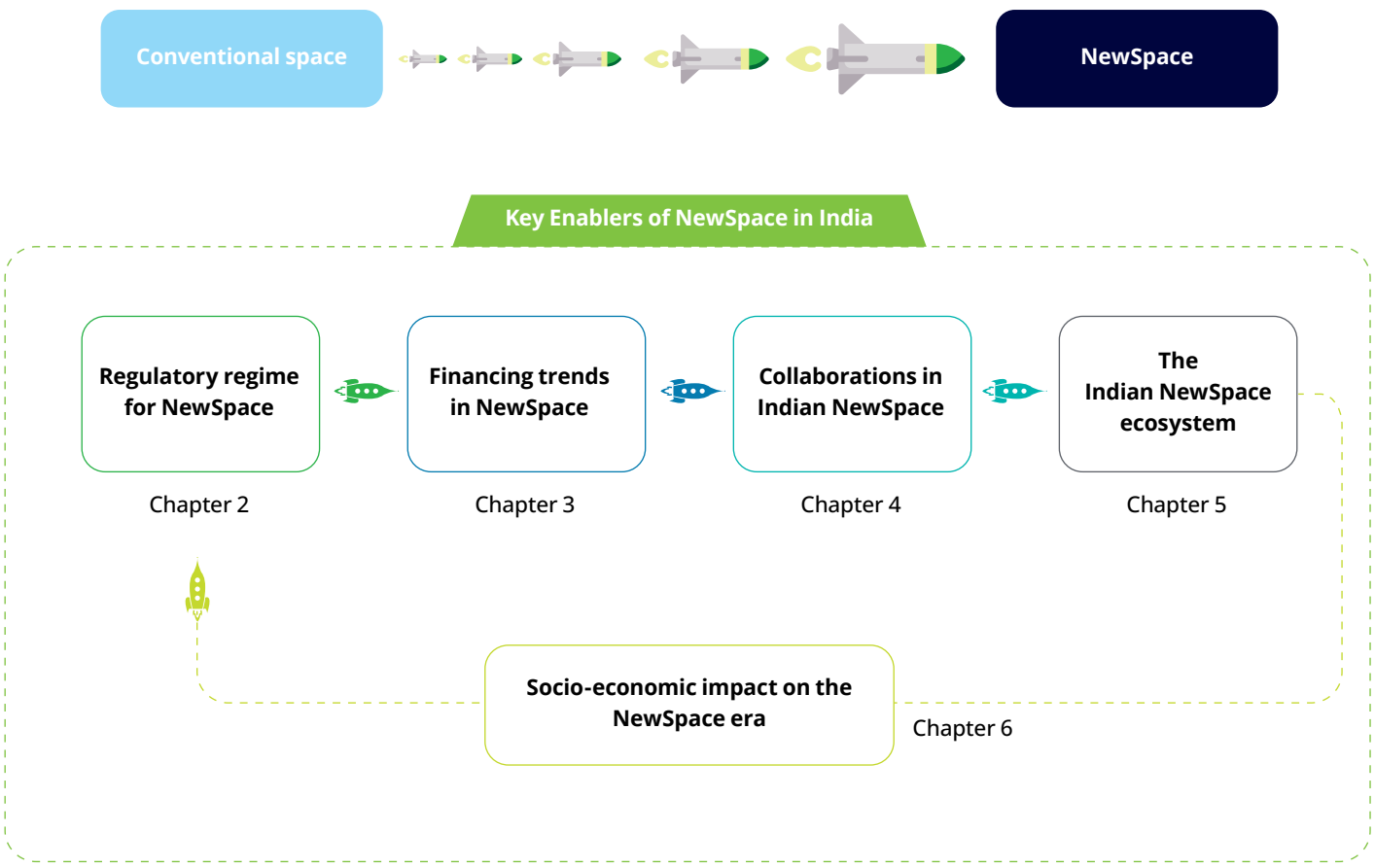
Over the years, ISRO's vision and mission evolved to encompass national development, in addition to space science research and planetary exploration. The evolution towards ISRO's new vision has been instrumental in shaping the NewSpace era in India. ISRO's pivot to space exploration and knowledge/research-driven

[7]https://twitter.com/IndiaembFrance/status/1570418503508705281?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E1570418503508705281% 7Ctwgr %5Ea1ccc5900c6b392536400a6689481a03a1009ed8%7Ctwcon%5Es1_&ref_url=https%3A%2F%2Fnews.abplive.com%2Fscience%2Findian-space-research-organisation-in-india-we-are-witnessing-the-emergence-of-new-space-isro-chairman-s-somanath-ahead-of-international-astronautical-congress-2022-paris-1553583
[8]https://timesofindia.indiatimes.com/business/startups/trend-tracking/isro-data-app-startup/articleshow/56388762.cms
[9]The founder of the Indian Space Program and supported the establishment of several institutions related to science and management in the mid-20 century

approaches have acted as the launchpad for NewSpace in India. By facilitating core technology transfer from ISRO to private players, from research products to launch vehicles and satellite data, new-age private companies are emerging to meet domestic and global demand.

The emergence of NewSpace in India has commenced a transformative era in the country's space sector. NewSpace has a dynamic landscape that sees private-sector participation and technological advancements in the following five areas: regulatory landscape, financing trends, collaborations (both international and domestic), evolving NewSpace ecosystem, and enhancement of the socio-economic impact on the NewSpace era. This paradigm shift is reshaping the traditional boundaries of space exploration and utilisation, driven by a combination of factors that collectively pave the way for a thriving and innovative space ecosystem.

Figure 3: Key areas enabling the NewSpace ecosystem in India



Together, these five crucial sectors support NewSpace and place India at the forefront of international space endeavours. These propel seismic shifts in the sector and sculpt the course of space exploration and utilization in the future.

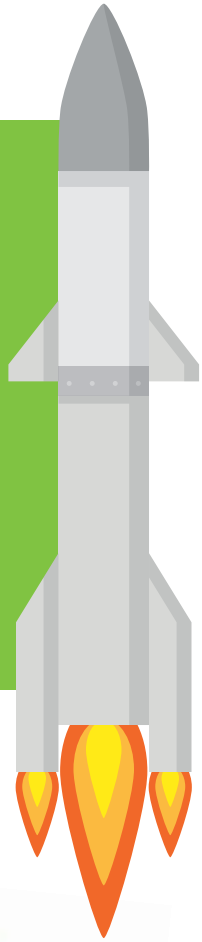
Source link: https://www.isro.gov.in/Gallery.html

Chapter 2

Regulatory regime for NewSpace

The Indian space economy comprises of long value chain, starting with Research and Development (R&D) outfits and manufacturers of space hardware and ending with providers of space-enabled products and services to consumers that enable technology, business, and governance propositions. To use these propositions for socio-economic development and governance, the Government of India has been introducing favourable space-related policies to create an enabling environment for Non-Governmental Entities (NGEs). These regulatory initiatives aim to not only foster self-reliance (Antariksh mein Aatmanirbharata[10]) but also expand capabilities and cater to the global demand (Vocal for Local and Make for Global).

Reforms are expected to boost supply and demand in the Indian space economy. India has a great potential to scale up its global space economy from current 2–3 percent to a sizeable share of 9 percent by 2030[11]. It can influence growth in innumerable facets of the technology sector of India

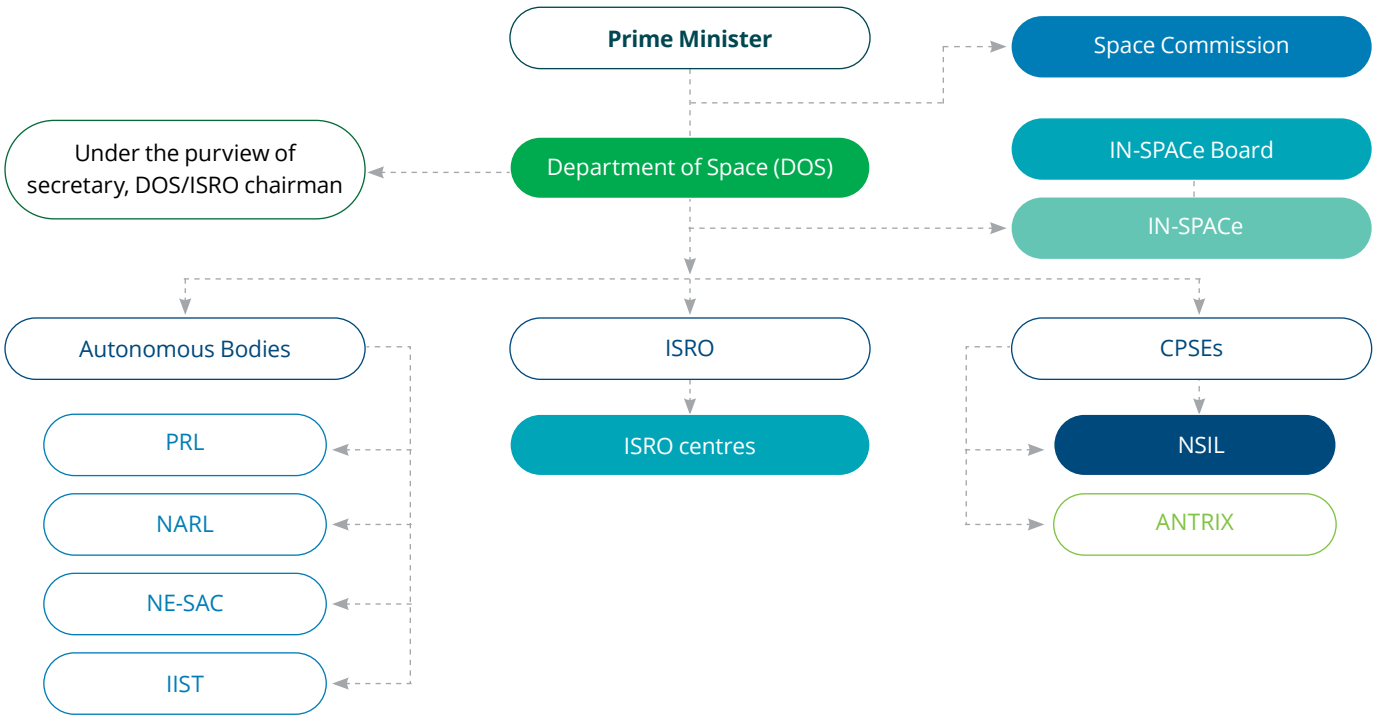


[10]https://www.isro.gov.in/Atmanirbhar/
[11]https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/nov/doc20221125136001.pdf

India's Space Programme Organizational Structure

Before deep diving into regulatory policies, let us see the overview of the current organisational structure of the Indian space programme as follows:

Figure 4: Indian Space Programme - Organisation Structure[12] (Source: ISRO)



Space Commission

- Acts as an apex decision-making body for space-related matters in India
- Provides guidance and strategic direction for the country's space programme
- Oversees the implementation and budgets of the Indian space programme

Department of Space (DOS)

- Acts as a nodal agency for space activities in India
- Formulates and implements space policies
- Coordinates activities of other space agencies in India
- Promotes development and application of space for the socio-economic benefit of the country
- Promotes and facilitates participation of private players in the space sector

IN-SPACe

- Acts as a single-window, independent, nodal agency
- Functions as an autonomous agency in the Department of Space (DOS)
- Promotes, enables, authorises, and supervises various space activities of Non-Governmental Entities (NGEs)

NSIL

- Is a public sector enterprise
- Takes responsibility for commercialising space technologies and services developed by ISRO
- Provides launch services, builds satellites, and offers space-based services

ISRO centres

- Acts as the national space agency of India comprising 14 centres across India
- Takes responsibility for developing and launching satellites, launch vehicles
- Conducts space research and exploration
- Provides space-based services

[12]https://www.isro.gov.in/organisation.html

Indian Space Policy 2023

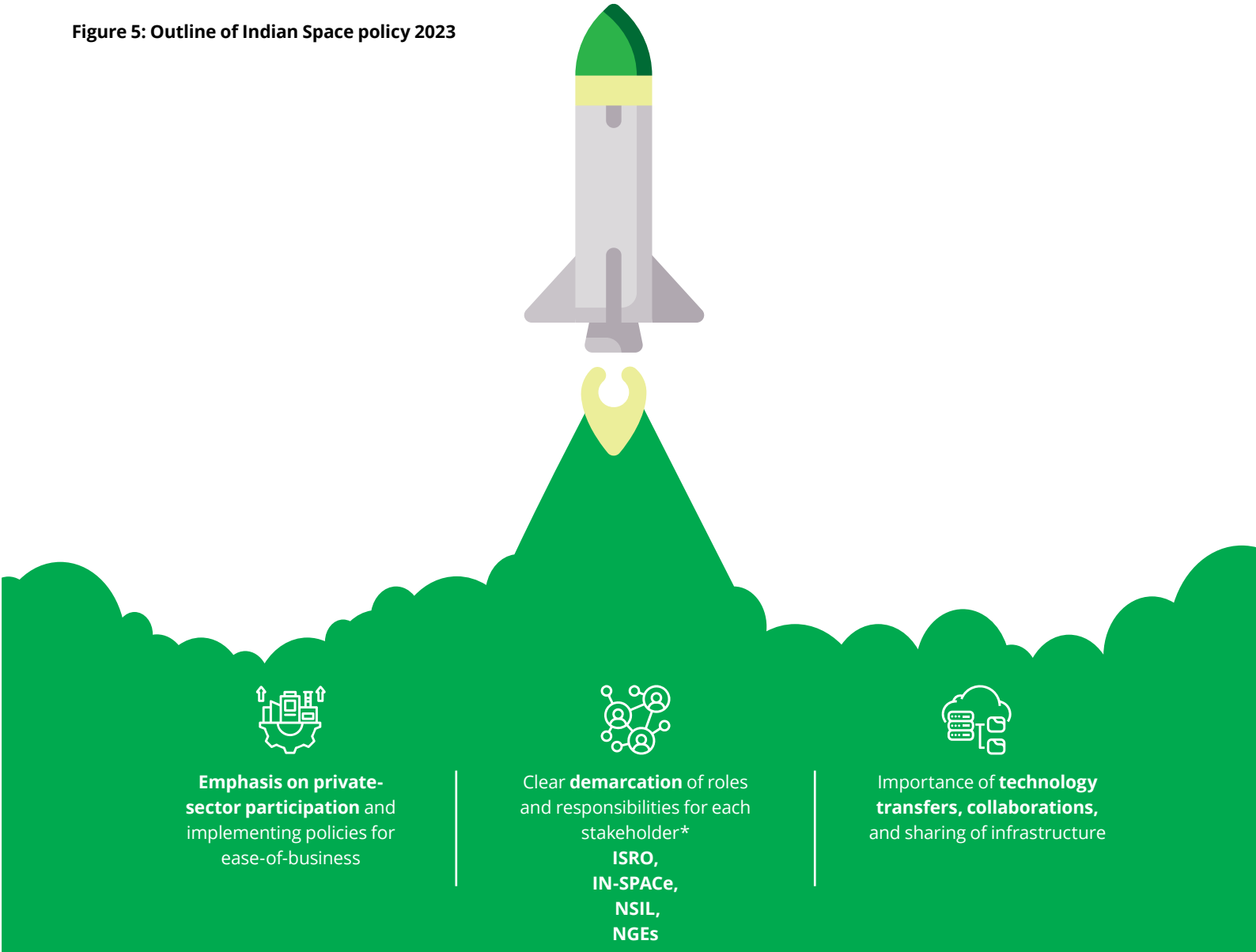
The Indian Space Policy-2023[13] provides a comprehensive framework and vision for the future of the Indian space programme. It outlines a strategic approach that aims to augment India's space capabilities in the following ways:

- Driving technological development to derive benefits using space technologies
- Deepening international collaboration within the contours of a thriving commercial space sector

This policy demarcates stakeholders' roles and paves the way for significant advancements in the Indian space sector. It sets the stage for a promising future.

One of the key highlights of the policy is the emphasis on greater private sector participation throughout the value chain of the space economy. This opens up opportunities to engage in a wide range of activities, including communication services, remote sensing, navigation, satellite manufacturing, launch infrastructure, space mining and emerging use cases of space in everyday life. These opportunities will contribute to both commercial and socio-economic development of the nation, as a whole.

Figure 5: Outline of Indian Space policy 2023

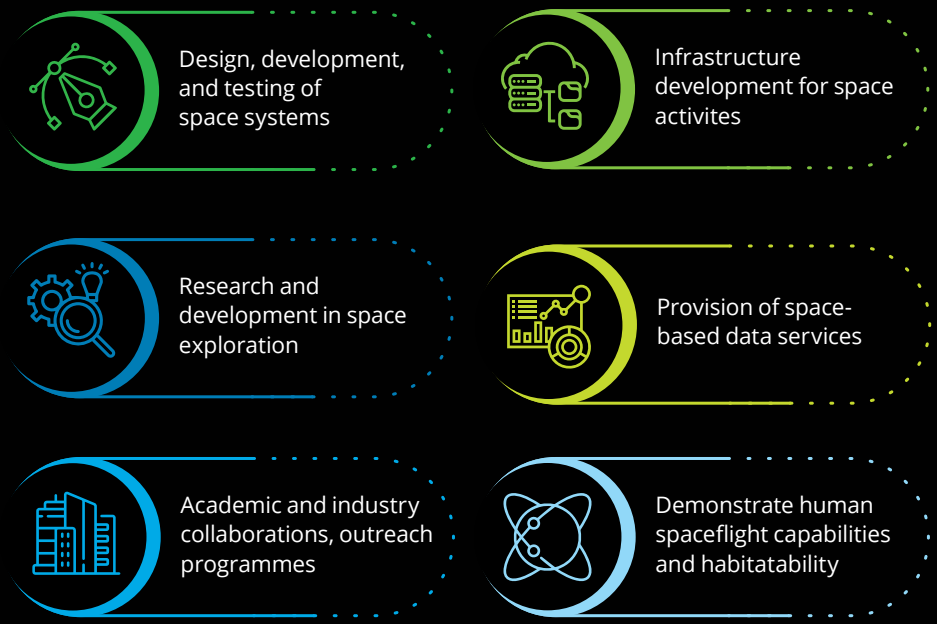


[13]https://www.isro.gov.in/media_isro/pdf/IndianSpacePolicy2023.pdf

Role of Indian Space Research Organisation (ISRO)

ISRO will focus on research and development, expanding technological capabilities, and advancing scientific knowledge in the outer space. As the primary research and development organisation and the torchbearer for India's space sector, ISRO under the envisioned ecosystem, is expected to push India's space frontiers.

Figure 6: Role of ISRO as defined by Indian Space Policy 2023

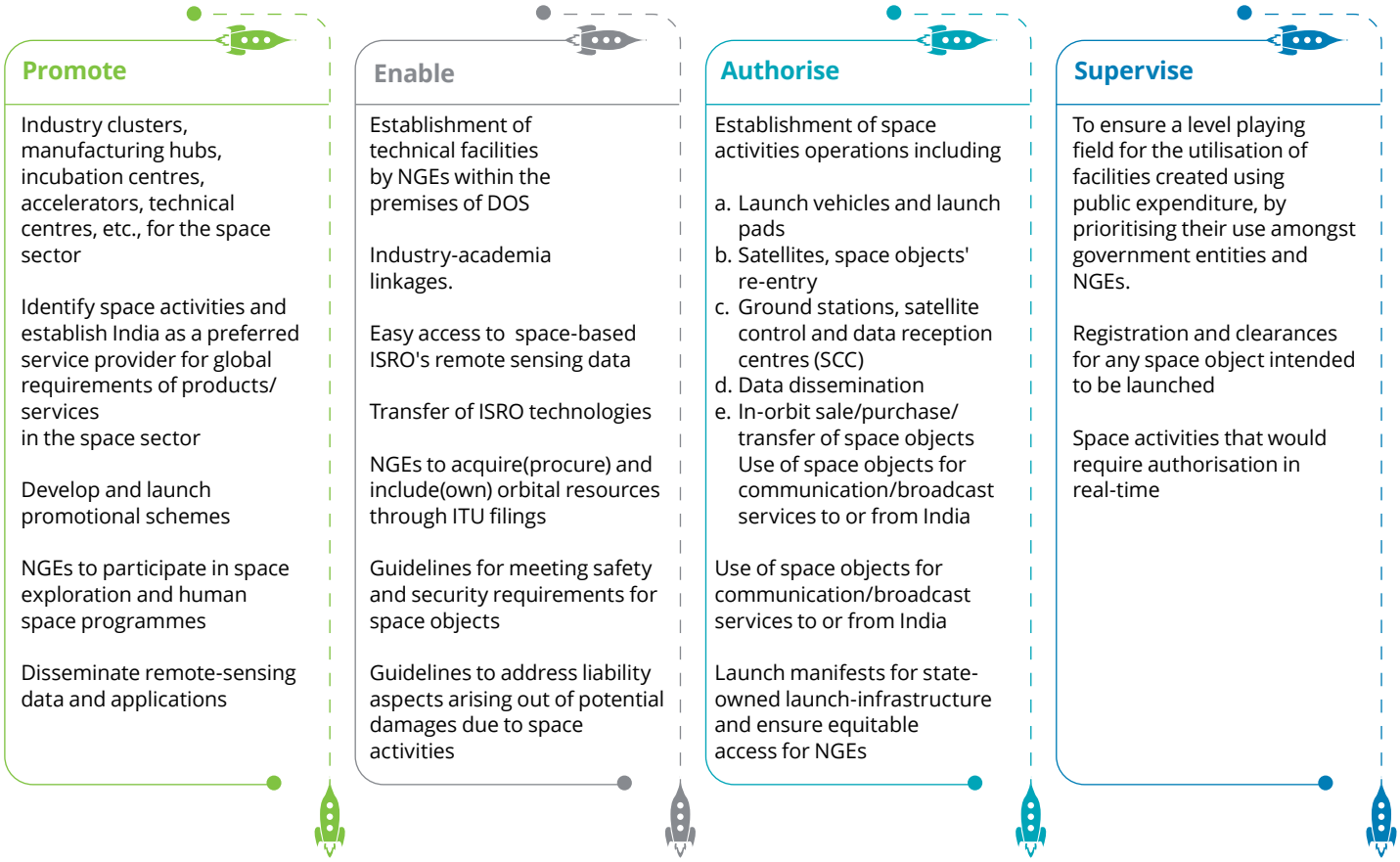


Role of Indian National Space Promotion and Authorisation Centre (IN-SPACe)

To facilitate the policy implementation, establishing the Indian National Space Promotion and Authorisation Centre (IN-SPACe) in June 2020 is a significant step. IN-SPACe is a "single window nodal agency" established to boost the commercialisation of Indian space activities and empower Non-Governmental Entities (NGEs) to engage in independent space activities. It aims to create a level playing field, streamline regulatory processes, and promote the ease of doing business in the space sector. IN-SPACe's[14] role in authorising space activities, promoting industry clusters and incubation centres, and ensuring equitable access to space infrastructure is crucial for the successful implementation of the policy.

Source link: https://www.isro.gov.in/Gallery.html

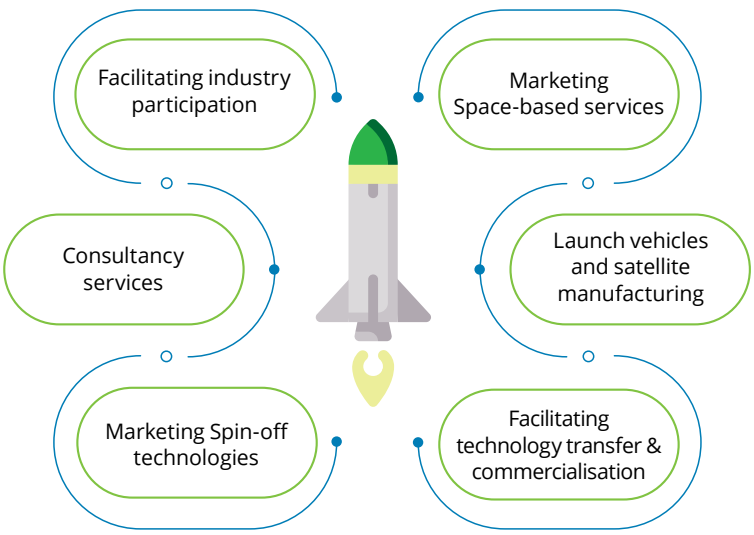
Figure 7: Role of IN-SPACe as defined by Indian Space Policy 2023



Role of NewSpace India Ltd. (NSIL)

NewSpace India Limited (NSIL) is a public sector undertaking company under the Department of Space, Government of India. NSIL was established in 2019 to facilitate the commercial exploitation of space products, services, and technologies. NSIL, under the purview of DOS, aims to shift the focus of space activities from a "supply-driven" model to a "demand-driven" model, thereby maximising the utilisation of space assets. Through its multifaceted activities, NSIL acts as a catalyst for the commercialisation and development of the Indian NewSpace ecosystem

Figure 8: An illustrative range of activities that NSIL, as defined by Indian Space Policy 2023



Norms for Non-Governmental Entities (NGEs) activities

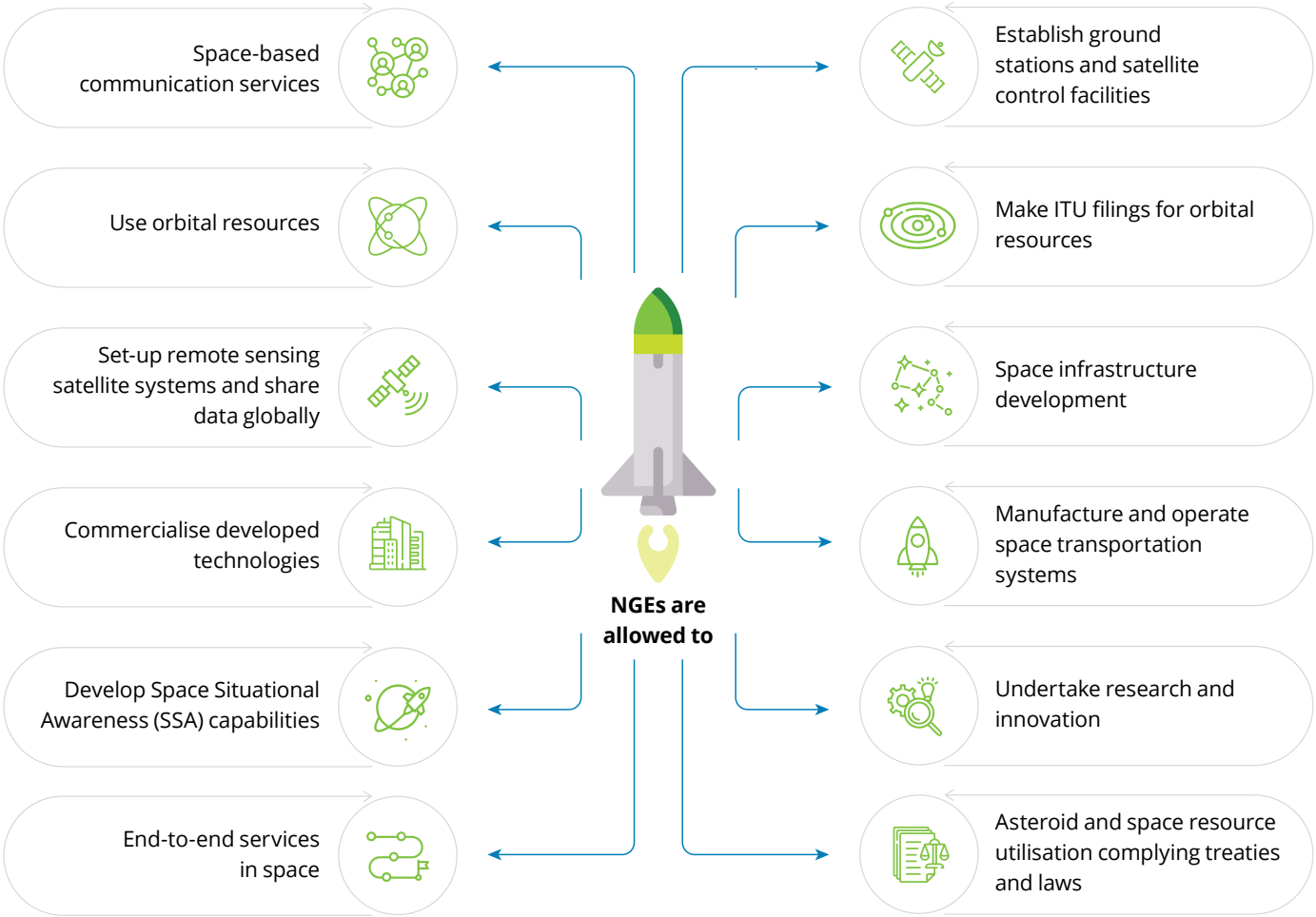
NGEs are private sector entities comprising legacy companies, start-ups, partnership firms and trusts or association of individuals. They are allowed to undertake end-to-end activities in the space sector through establishment and operation of spacecrafts, launch vehicles, components, ground-based assets, and related services, subject to guidelines and regulations prescribed by IN-SPACe.

The introduction of NGEs into the Indian space industry marks a transformative step towards using private sector capabilities, promoting innovation, and accelerating the growth and commercialisation of space activities in the country.

By encouraging NGEs to undertake end-to-end activities in the space sector, the policy promotes competition, innovation, and the growth of the commercial space industry in India.

Additionally, the policy recognises the importance of international collaboration and cooperation in the space sector. It highlights India's participation in global space governance and programmes and lays emphasis on sharing satellite data for disaster management efforts and sustainable development goals. This reflects India's commitment to being an active participant in the international space community and leveraging collaborations to accelerate progress.

Figure 9: Fostering NGEs participation per Indian Space Policy 2023



"There should be no space between common man and space technology."*

-Prime Minister Narendra Modi

*Source: https://www.isro.gov.in/g20selm/

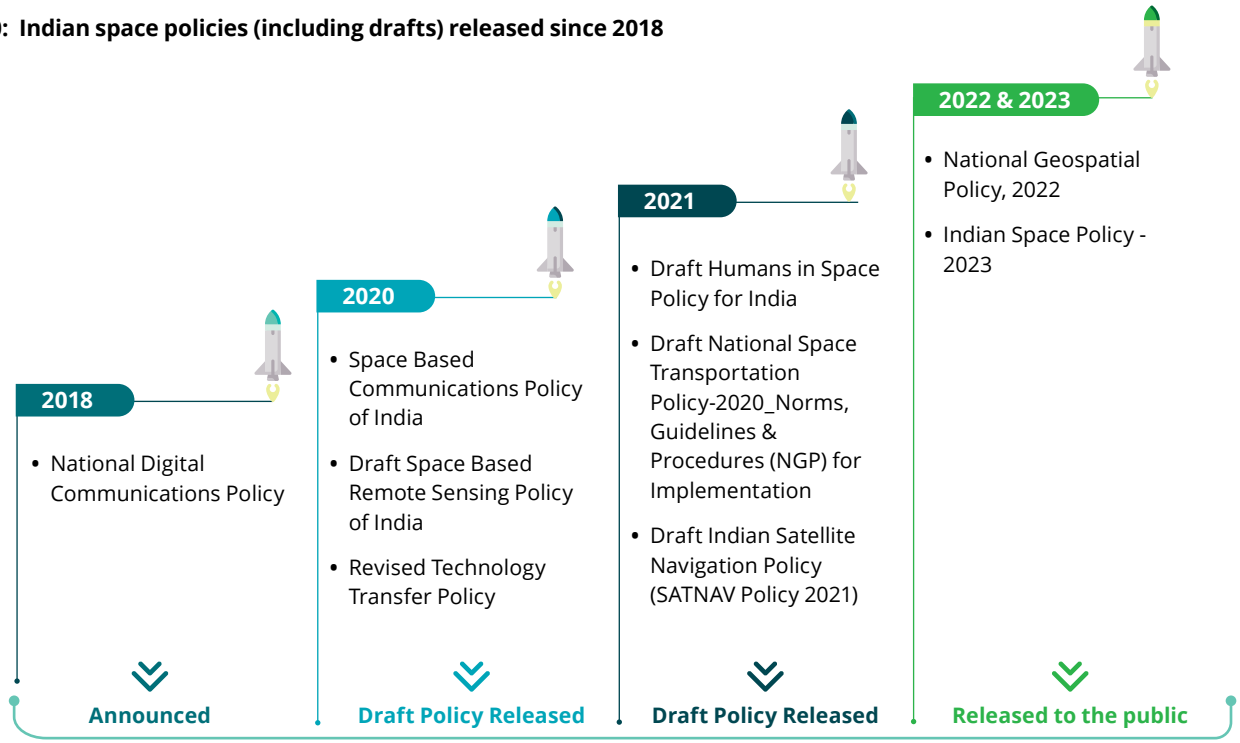
Call to Action

- **Government has extended the GST exemption provided on satellite launch services available to ISRO, Antrix and NSIL to other private organisations as well.** The industry described this as a l**andmark and transformative** move by the Indian government.**
- While the Indian government has started to provide tax impetus to the space sector, it **needs to take more initiatives for tax exemptions/tax holidays/accelerated depreciation** for companies directly or indirectly engaged in space sector activities, so that the benefits are available to the entire value chain and there is no embedded tax cost.
- A **detailed study on the tax reforms for supporting the industry growth** as well as making the end products fiercely competitive in the global market should be undertaken.

Other Indian regulatory polices enabling NewSpace

The Department of Space (DOS) has been charged with enhancing the diffusion of space technology and boost space economy within the country. The department has formulated and circulated various draft policies on remote sensing, navigation, communication, space transportation, technology transfer guidelines and humans space programs for comments by various stakeholders and the public. In 2022 and 2023, the Department of Space released two policies that encompass draft policies – National Geospatial Policy in 2022 and Indian Space Policy in 2023.

Figure 10: Indian space policies (including drafts) released since 2018

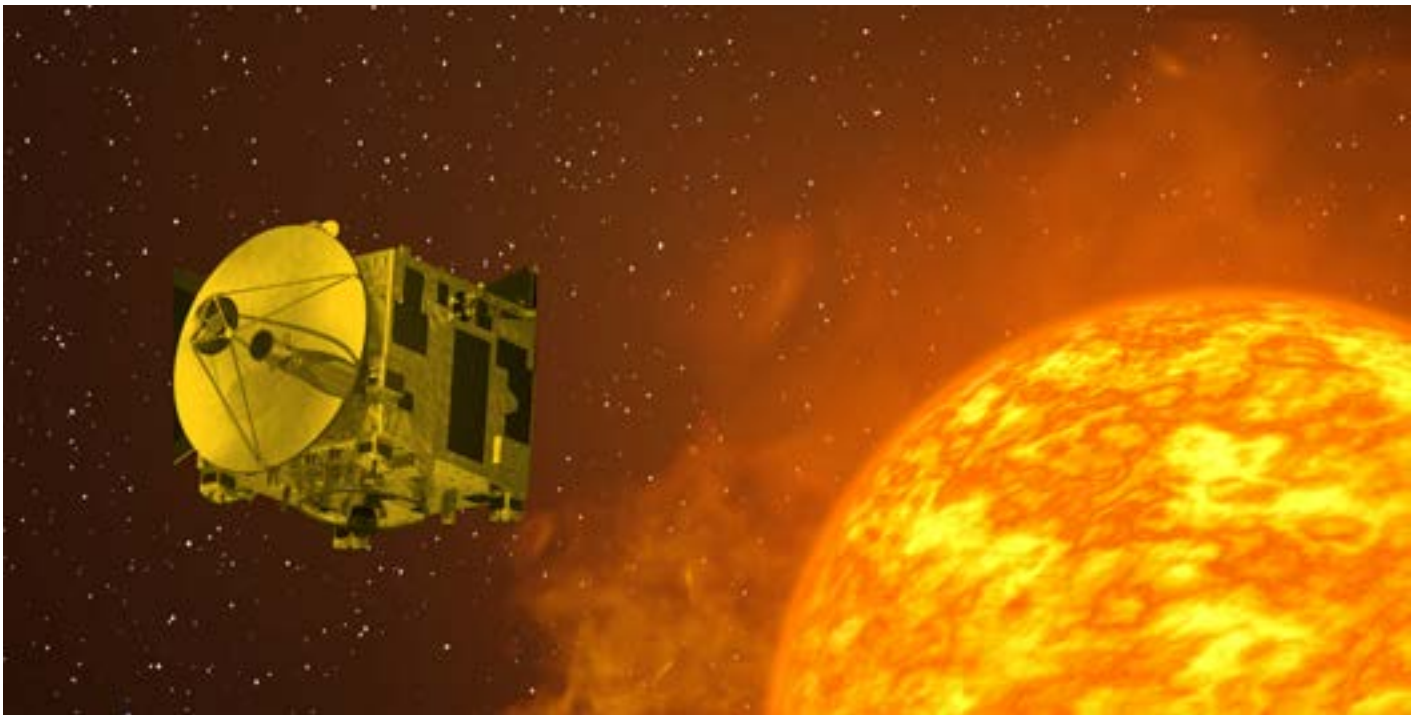


**https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1938812
[15]https://www.businesstoday.in/latest/in-focus/story/gst-exemption-to-private-satellite-launch-service-firms-a-huge-financial-incentive-to-boost-growth-industry-389459-2023-07-12

Table 1 below provides the overview of key regulatory policies that have been released the Indian government since 1990s:

Table 1: Overview of Indian space policies

Policy	Year of release	Policy overview
		Satellite communication policies
Satellite Communication Policy[16]	1997	It is a framework to develop a satellite communication industry in India and use the INSAT infrastructure for various sectors.
National Digital Communication Policy[17]	2018	It offers a comprehensive framework for the telecommunications sector in India. The policy focuses on space-based satellite communications, aiming to use satellite technology to enhance connectivity in remote and rural areas where terrestrial networks are limited. It recognises the potential of satellite communications to bridge the digital divide and ensure universal access to communication services across the country.
		Remote sensing polices
Remote Sensing Data Policy[18]	2001 and 2011	It is aimed to regulate the acquisition and dissemination of remote sensing data in India. The policy focused on the controlled release of sensitive data and for remote sensing activities. It was amended in 2011 to liberalise the acquisition and dissemination of remote sensing data.



[16]https://ispa.space/assets/pdf/policies/indian/policies/policy-framework-fo-satellite-communication-in-india-1997.pdf
[17] https://ispa.space/assets/pdf/policies/indian/policies/national-digital-communications-policy-2018.pdf
[18] https://www.nrsc.gov.in/EOP_irsdata_Policy/page_3

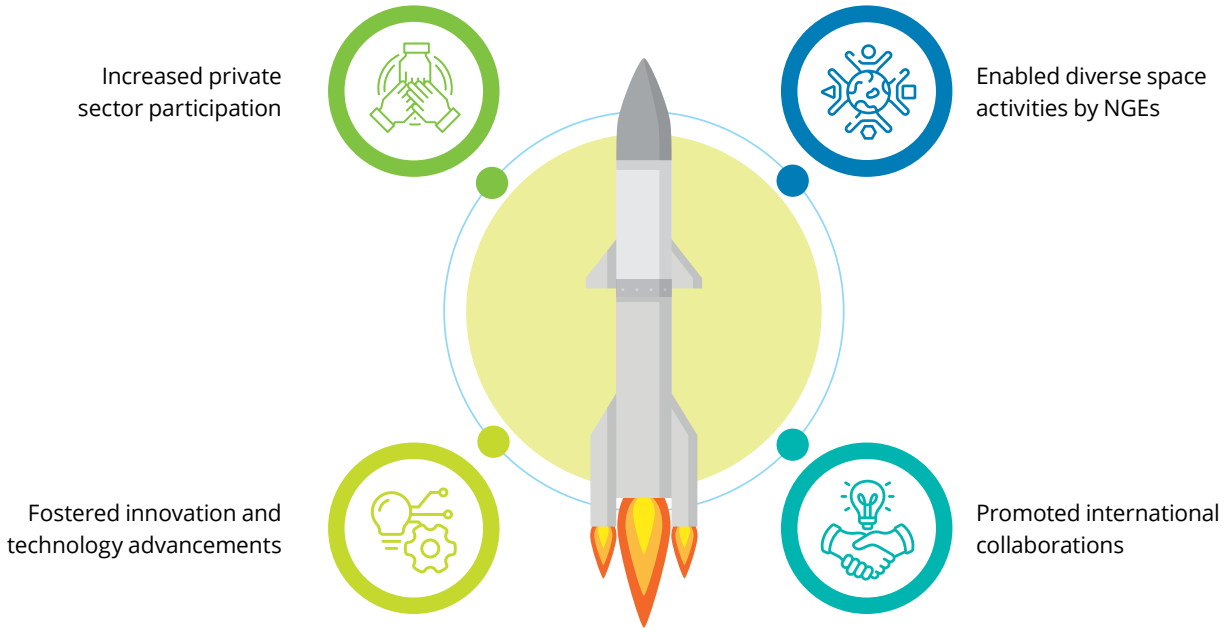
Policy	Year of release	Policy overview
National GeoSpatial Policy[19]	2022	This policy is a significant step towards leveraging geospatial technology and data for sustainable development and reducing dependence on foreign resources. It lays emphasis on the liberalisation of geospatial data acquisition, processing, and dissemination, with a focus on achieving Sustainable Development Goals (SDGs) and promoting the use of locally relevant maps and data. The policy outlines broad objectives to be achieved by 2025, 2030, and 2035. These objectives include the establishment of the Geospatial Data Promotion and Development Committee (GDPDC) as the apex body, the development of a Geospatial Knowledge Infrastructure (GKI), and the creation of a National Digital Twin of major cities and towns. This policy aligns with the NewSpace era by fostering innovation, promoting self-reliance, and integrating geospatial technology with space-based assets and services.
		Other policies and bills
Draft Space Activities Bill[20,21]	2017	It is a proposed legislation in India aimed at regulating space-related activities in the country. It expected to establish an authorisation and supervision mechanism for space activities conducted by both government entities and NGEs. The bill expected to also address liability aspects arising from potential damages due to space activities and provide guidelines for meeting safety and security requirements for space objects. Additionally, the legislation expected to facilitate technology transfers from ISRO to private entities, enabling sustainable value creation and growth in the Indian NewSpace sector.
FDI Policy in the space sector	Expected to be released soon	At present, Foreign Direct Investment (FDI) in the space sector is allowed up to 100 percent in the area of satellites-establishment and operations through the government route only.[22] The new FDI policy is expected to allow 100 percent FDI in the space sector in three different sectors:[23] • Sub-system manufacturing • Launch vehicle operations • Satellite operations and establishments Foreign investments in the three different activities will vary from 49 percent to 100 percent. The FDI policy is expected to release soon for implementation, which would allow facilitating overseas investment in NGEs.[24] It creates growth opportunities for Indian companies and allows foreign companies to invest in the Indian space sector.

[19]https://ispa.space/assets/pdf/policies/indian/policies/National-Geospatial-Policy-2022.pdf
[20] https://www.isro.gov.in/media_isro/pdf/Publications/Vispdf/Pdf2017/seeking_comments_on_draft_space_activities_bill201710.pdf
[21] https://pib.gov.in/newsite/printrelease.aspx?relid=186315
[22]https://pib.gov.in/PressReleasePage.aspx?PRID=1914226
[23]https://economictimes.indiatimes.com/tech/technology/new-fdi-policy-for-space-likely-to-be-out-in-3-months-says-in-space-chairman/articleshow/100453903.cms?from=mdr
[24]https://timesofindia.indiatimes.com/india/revised-fdi-policy-in-space-sector-to-facilitate-overseas-investment-in-nges-in-process-of-approval-minister/articleshow/97748822.cms

These policies/bills aim to enable and support the participation of private entities in space activities, promote innovation, and create a conducive environment for the commercialisation of space technologies.

The policies mentioned above set a positive trajectory for the future of the Indian space programme. By promoting private sector participation, fostering innovation and technological advancements, strengthening regulatory frameworks, and encouraging international collaborations, the these policies creates an ecosystem that is favourable to the growth and development of the Indian space sector.

Figure 11: Impact of policies and reforms on the Indian space ecosystem



Initiatives/reforms by selected global organisations towards NewSpace

Global space organisations have taken huge strides, towards enabling the shift to the NewSpace industry. Some countries started their initiatives way back in 2005. A few developed countries are ahead of the game. However, recent advancements by the remaining countries have been remarkable and are catching up with the global competition. Here are a few reforms/initiatives by governments across the world to promote their domestic space ecosystems.[25,26,27,28,29,30]

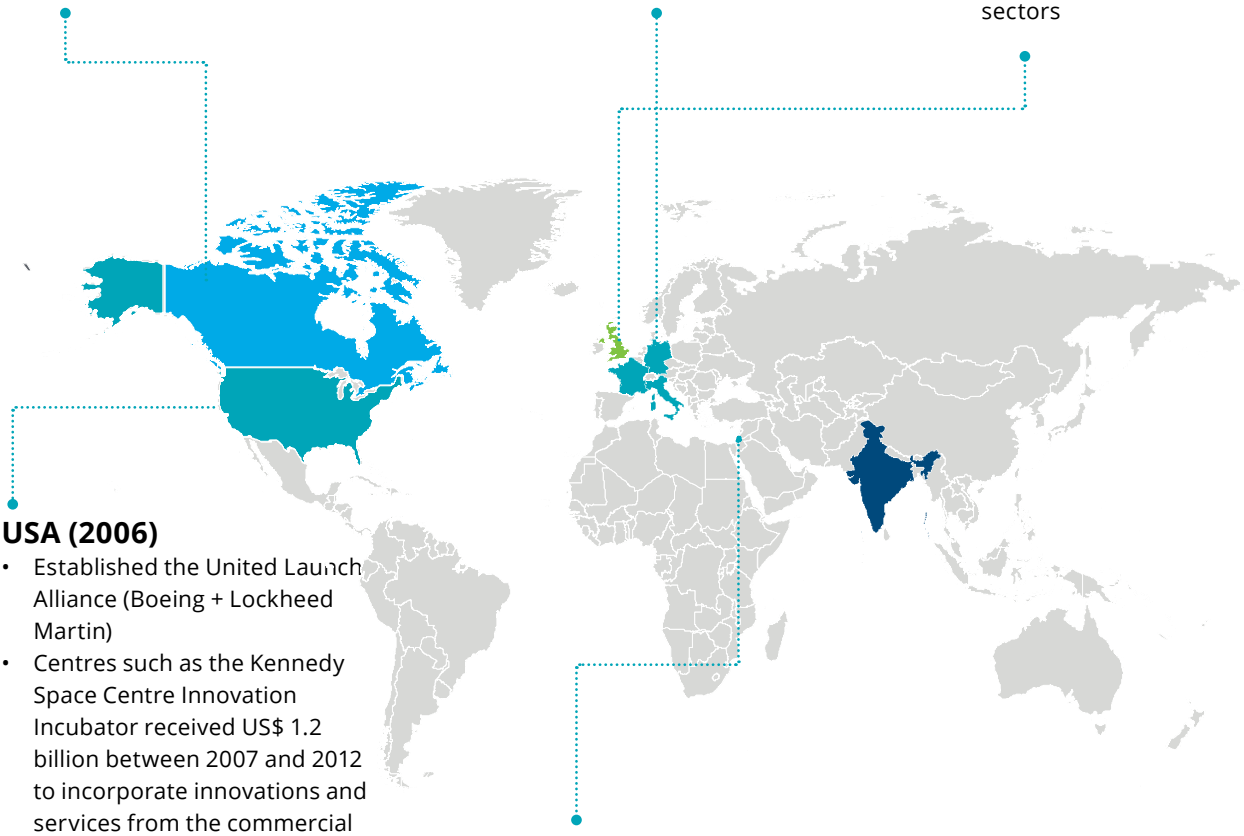
[25]https://www.nasa.gov/offices/ipp/centers/kennedy/innovation_incubator/index.html
[26]https://commercialisation.esa.int/esa-business-incubation-centres/
[27]https://www.space.gov.il/en/news-space/132912
[28]https://ised-isde.canada.ca/site/strategic-innovation-fund/en
[29]https://www.gov.uk/government/publications/national-space-strategy/national-space-strategy
[30]https://stage.tksc.jaxa.jp/spacelaw/country/japan/27A-1.E.pdf

Figure 12: A few reforms by governments across the world to promote NewSpace in their countries

Canada (2019)
Strategic Innovation Fund to help companies scale received US$ 150 million in 5 years

Europe (2005)
ESA set up 29 business innovation centres across 11 countries, supported more than 1450 start-ups

UK (2007)
UK Civil Space Strategy 2008-12 aimed to maximise investments in space across the government and private sectors



USA (2006)
- Established the United Launch Alliance (Boeing + Lockheed Martin)
- Centres such as the Kennedy Space Centre Innovation Incubator received US$ 1.2 billion between 2007 and 2012 to incorporate innovations and services from the commercial space industry to produce technologies needed for NASA missions.

Israel (2022)
Released a strategic plan for the Israeli Civilian Space; included US$ 180 million in funding over the next 5 years

Call to Action

- Globally, national space agencies have been taking multiple initiatives to promote and develop the domestic space ecosystem. The growth of domestic private players has become pivotal for creating an impact.
- However, an **in-depth study on global initiatives and their impact on the sector and, benchmarking with India** should be undertaken to further develop and outline additional initiatives and to refresh the Indian Space Policy 2023 periodically.

Chapter 3
Financing trends in NewSpace

Source link: https://www.isro.gov.in/Gallery.html

Global landscape of investments

The global space sector is projected to be about US$ 1 trillion by 2040.[31, 32] There is consensus that independent participation of private-sector entities in the sector will be one of the primary growth drivers. The increased private-sector participation will be funded by private investments that can drive cost optimisation and value generation.

Increasing technology sophistication also augments the strategic importance of space that includes, but is not limited to, space assets for national security, and insulation of space value chain from geopolitical and global supply shocks.

Hence, investments into the space economy by state agencies and the private sector may be driven by mutually divergent philosophies. Finding the balance between the two will drive the NewSpace ecosystem.

Call to Action

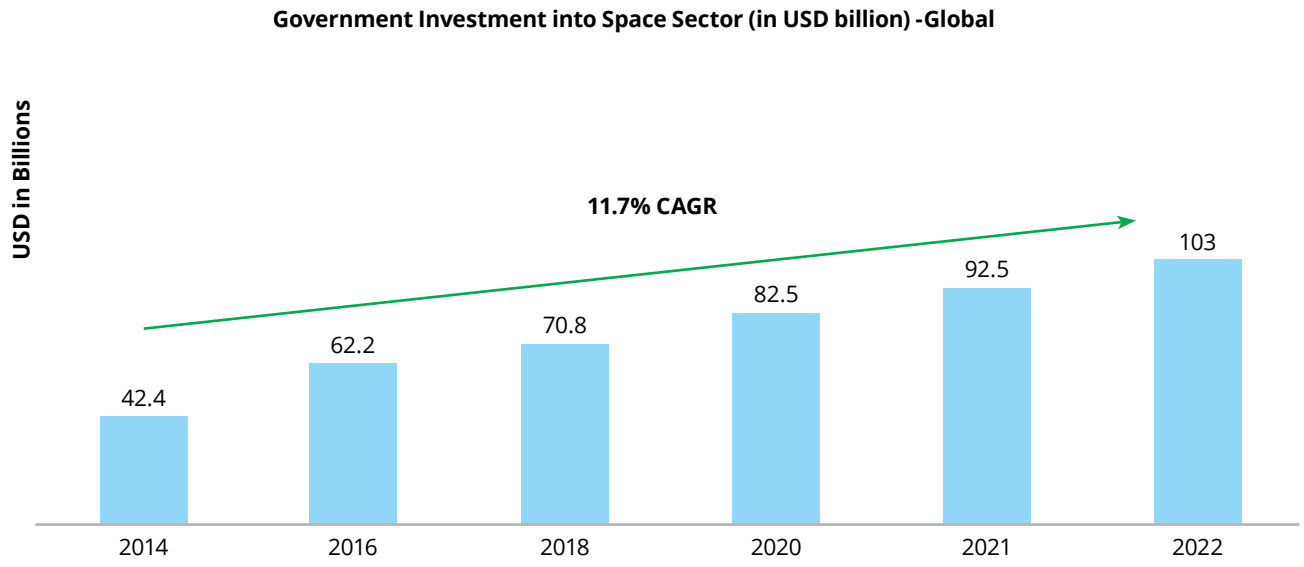
- **Different sources ascribe different market sizes of the Indian space economy,** leading to disparities in reported figures.
- Market size estimations for both the global and Indian space economies **play a crucial role in influencing decisions related to space policies, budget allocations, and investment strategies for governments, companies, and private investors.**
- Several prominent spacefaring nations, like the US and the UK, **conduct annual assessments of their space economies.** These exercises aid in shaping government policies and guiding investment decisions for stakeholders in the sector.
- Given the importance of a **standardized and comprehensive approach, a dedicated study aimed at defining the Indian space economy** using consistent methodology should be undertaken.

[31] https://icg.citi.com/icghome/what-we-think/citigps/insights/space_20220509
[32] https://www.morganstanley.com/Themes/global-space-economy

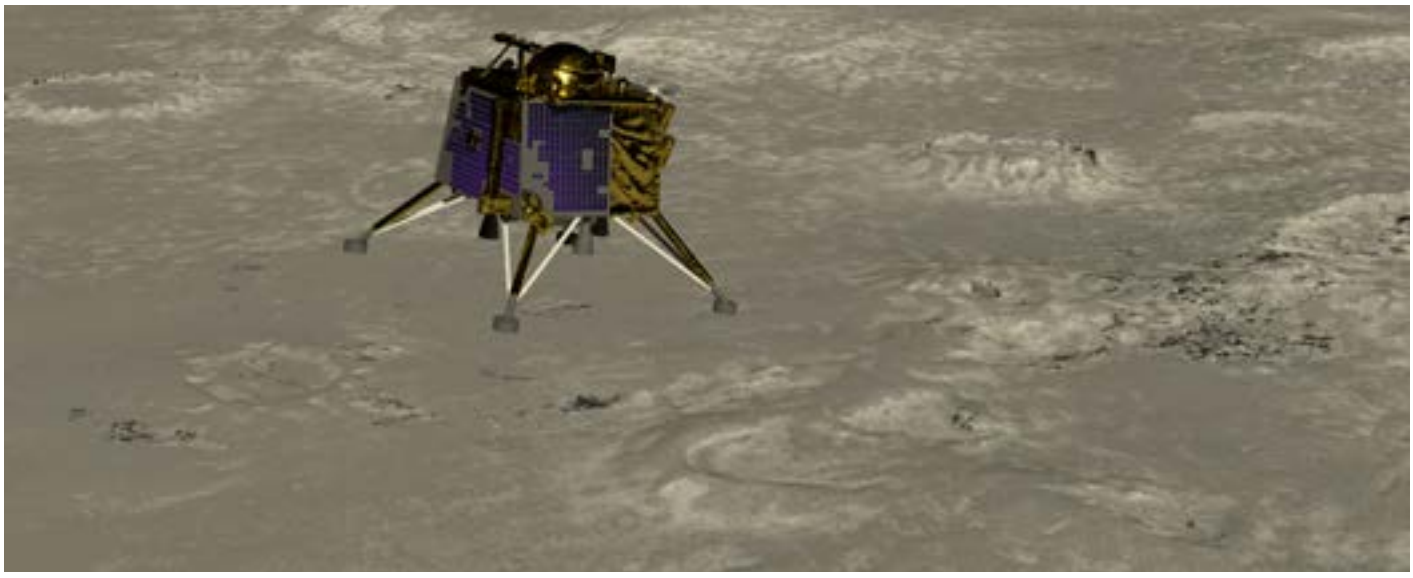
Global trends in investments into space activities

Global government expenditure into space activities[33]

Figure 13: Global government expenditure in the space sector across years (Source: Statista)

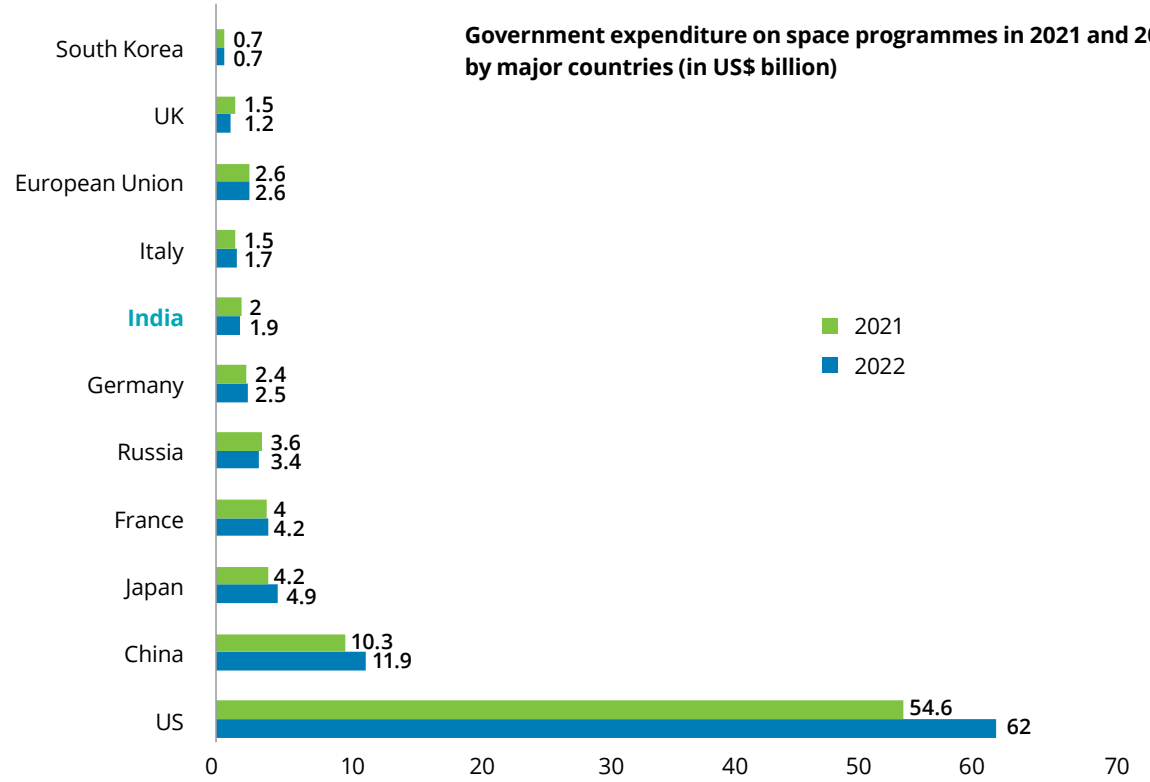


With total government investments into the space sector crossing US$ 100 billion in 2022, direct government expenditure continues to be the dominant investment instrument. At the aggregate level, government investments are into global and regional navigation satellite systems, earth observation, satellite communication, space exploration (probes, landers, and space stations), R&D, and assistance to other countries to develop space programmes.[34]



[33] https://www.statista.com/statistics/745731/global-governmental-spending-on-space-programs/#:~:text=Government%20space%20program%20spending%20worldwide%202014%2D2022&text=In%202022%2C%20government%20expenditure%20on,compared%20to%20the%20previous%20year.
[34] https://www.oecd.org/sti/inno/space-forum/measuring-economic-impact-space-sector.pdf

Figure 14: Government expenditure on space programmes in 2021 and 2022, by major countries (Source: Statista)[35]



Apart from traditional space power houses increasing their space budgets, several new entrants into the sector are increasing overall government expenditure into the sector.[36]

Table 2 : New entrants into the space sector (Source: Space Oscar/Space agencies)

Country/Region	Organisation Name	Responsible department/ministry	Year of creation
Spain	Spanish Space Agency (SSA)	Ministries of Science and Innovation	2023
Costa Rica	Costa Rican Space Agency (AEC)	Non-state public entity	2021
Luxembourg	Luxembourg Space Agency (LSA)	Ministry of the Economy	2019
Portugal	Portugal Space (PTSPACE)	Private, non-profit	2019
Australia	Australian Space Agency (ASA)	Department of Industry, Science, Energy and Resources	2018
Turkey	Turkish Space Agency (TUA)	Ministry of Industry and Technology	2018
Egypt	Egyptian Space Agency (EGSA)	Directors from multiple ministries	2018
Saudi Arabia	Saudi Space Commission (SSC)	Prime Minister	2018
New Zealand	New Zealand Space Agency	Ministry of Business, Innovation and Employment	2016
Poland	Polish Space Agency (POLSA)	Ministry of Economic Development and Technology	2014
United Arab Emirates	United Arab Emirates Space Agency	Minister of State for Public Education and Advanced Technology	2014

[35] https://www.statista.com/statistics/745717/global-governmental-spending-on-space-programs-leading-countries/
https://space.oscar.wmo.int/spaceagencies
[36] https://www.brookings.edu/articles/how-space-exploration-is-fueling-the-fourth-industrial-revolution/

Case study of Australian Space Agency activities

2018

Established Australian Space Agency

In July 2018, **Australian Space Agency** commenced operations to

- coordinate civil space matters across government
- support the growth and transformation of Australia's space industry.

Aim to significantly expand its space market segment from about 10,000 jobs and a market size of US$ 3.9 billion to 20,000 jobs and US$ 12 billion by 2030[37]

In 2019, Australia released **Australian Civil Space Strategy 2019-28**,[26] which outlines the government's plan to transform and expand our space industry over 10 years and improve the lives of Australians.
To achieve this, the strategy outlined actions to:

- open doors internationally;
- increase national capability;
- promote responsible regulation, risk management, and culture; and
- inspire and build a future workforce.

> **Space is a global industry that relies on strong international partnerships. Our agency is the gateway for the global space sector to engage with Australia – through space, climate, exploration, or industry-to-industry collaboration.**
>
> - Mr. Enrico Palermo, Head of the Australian Space Agency

Funding initiatives to enhance their domestic space economy[38] [39]

Figure 15: Funding initiatives by Australia in Space (used conversions of A$1 = INR 54.55 as of 1 Aug 2023) Source: Global Australia, Industry.gov.au

International Space Investment initiative (ISI)

- In 2023, to unlock international space opportunities, ISI awarded INR 60 crore to 24 Australian organisations.
- The ISI will be further expanded, with a dedicated INR 136.4 crore in funding over four financial years (2022-23 to 2025-26) for Australian businesses and researchers to tap into India's booming space industry.
- ISI will further award INR 16.4 crore for broader international partnerships.

Moon to Mars Initiative

- In 2021, INR 818.3 crore fund was released to support Australian businesses and researchers to showcase their best ideas and technologies.

Space Infrastructure Fund (SIF)

- In 2019, INR 106.4 crore fund was released to ensure local infrastructure development and meet the delivery of space-based services globally.

[37] https://www.industry.gov.au/sites/default/files/2022-07/advancing-space-australian-civil-space-strategy-2019-2028.pdf
Quote : https://www.industry.gov.au/news/australian-space-agency-reaffirms-global-partnerships-g20-space-meeting
[38] https://www.globalaustralia.gov.au/industries/space
[39] https://www.industry.gov.au/news/

Australia has other government agencies that have been supporting domestic space programmes in the following ways:

- Developing space technologies and launching their own space programmes by Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Defence Science and Technology Group (DSTG)
- Collecting/procuring satellite data for national usage by Geoscience Australia, Bureau of Meteorology (BOM)

Collaboration between Australia Space Agency (ASA) with ISRO

In 2021, DOS and ASA made an amendment to the bilateral MOU **"2012 India – Australia Inter-Governmental MoU for cooperation in Civil Space Science, Technology and Education"** and extended the cooperation activities in earth observation, satellite navigation, space situational awareness, and establishment of transportable terminal in Australia to support India's Gaganyaan programme.[40]

Australian start-ups collaborations with Indian private players[41]

Multiple MoUs were signed between Australian and Indian space tech start-ups at Bengaluru Space Expo (BSX) in Bengaluru in 2022.

Figure 16: Australian start-ups collaboration with Indian private players (Source: The Hindu)

Space Machines Company with Ananth Technologies	For product integration, testing, technology development, and joint-space missions
HEX20 with Skyroot Aerospace	To provide launch services, spacecraft avionics, and components to Australian Space Initiatives
QL Space with Skyroot Aerospace	To develop launch facilities in Australia and support joint mineral exploration missions in space
QL Space with GalaxEye	To develop a hybrid optic and radar payload to reduce the adverse environmental impact of critical mineral exploration in Australia
QL Space with SatSure	To build a satellite and AI-based solutions to support the agriculture, mining, and defence industries and apply this technology to the outer space environment
SABRN Health, Altdata, and India's DCube	To work together on the development and integration of hardware, sensor technology, and software to provide health support to astronauts

[40] https://www.isro.gov.in/Australia%20MoU.html
[41] https://www.thehindu.com/sci-tech/technology/isro-australian-space-agency-to-boost-bilateral-collaborations-in-space-tech/article65853736.ece

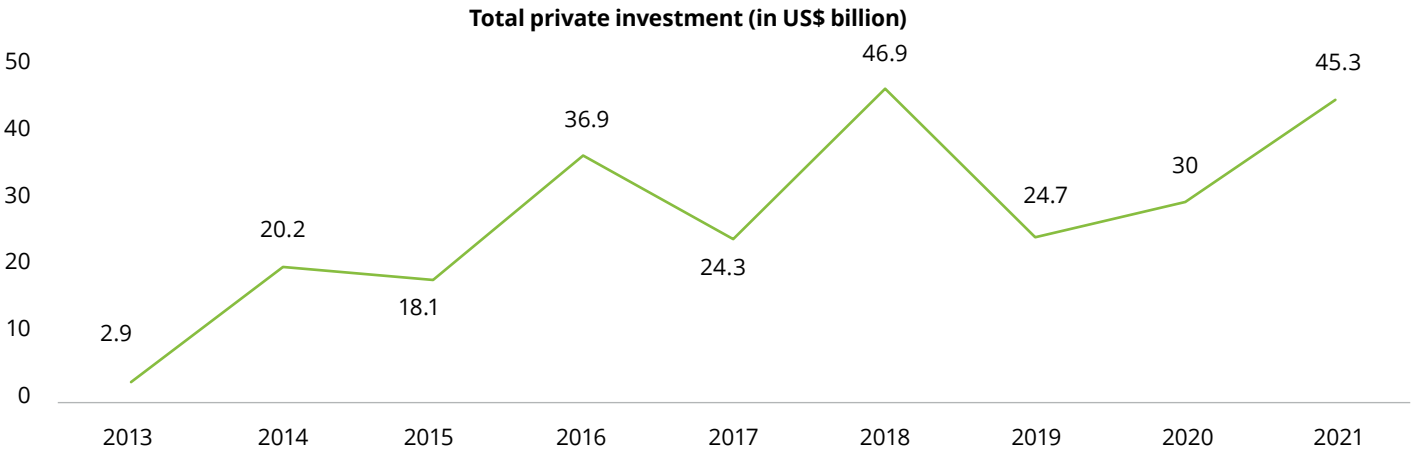
Other major agreements/steps to increase the space activities in Australia[42]

- In May 2023, Australia and the US entered into the Technology Safeguards Agreement (TSA) that will allow for the transfer of US space technology, including rockets and satellites, to be launched from Australia.
- In Feb 2019, the UK and Australia made a **space bridge agreement** to boost cooperation and speed up the growth of the Australian and UK space sectors. It will allow for increased trade and investment opportunities. It covers four main areas: government-to-government collaboration on space programmes and technology; regulation; trade, investment, and business; and research and education.
- In 2018, **Space Activities Act 1998** was amended to broaden the previous regulatory framework to increase participation of launches from aircraft in flight and high-power rockets. The amended act will reduce barriers to participation in the space industry by streamlining processes and insurance requirements for launches and returns.[43]

Private investments into the global space sector

Private investments into the global space sector grew at a CAGR of 41.0 percent (2013-2021) and witnessed a surge over the past decade due to several factors including, but not limited to, changing regulatory regimes across the world, favourable investment and tax policies, technology advancements lowering launch costs with re-usable launch vehicles & miniaturisation of avionics, increasing commercial possibilities for downstream applications. Unlike government spending, private investments into the sector are difficult to track. According to industry estimates, investments was between US$ 240 billion and US$ 280 billion over the past decade.[44]

Figure 17 : Industry estimates for private investments into the space sector[45]



Global investments in the space sector increased significantly. The active participation of private-sector entities, driven by private investments, is recognised as a crucial growth driver for the space industry.

[42]https://www.industry.gov.au/news
[43]https://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/Bills_Search_Results/Result?bId=r6129#:~:text=Amends%20the%3A%20Space%20Activities%20Act,for%20launches%20and%20returns%3B%20and
[44]https://ir.citi.com/gps/829sRzYY4sQ%2BOhctTEs%2B1WWLgPbyZktiZpoz3QRCC6ToaLgXov4Kxy852cz eh38jOi72XKhJGp0%3D
[45]Space Capital: https://app.powerbi.com/view?r=eyJrIjoiNGY4MWI4OWEtMjNmZS00OTM3LWE5M2QtYTgxZTdjODk3YTllIiwidCI6IjYzMDZkMTJjLTEwODMtNGNhOS04Yjk2LTdjYzM3ODcwMWIzMiIsImMiOjN9

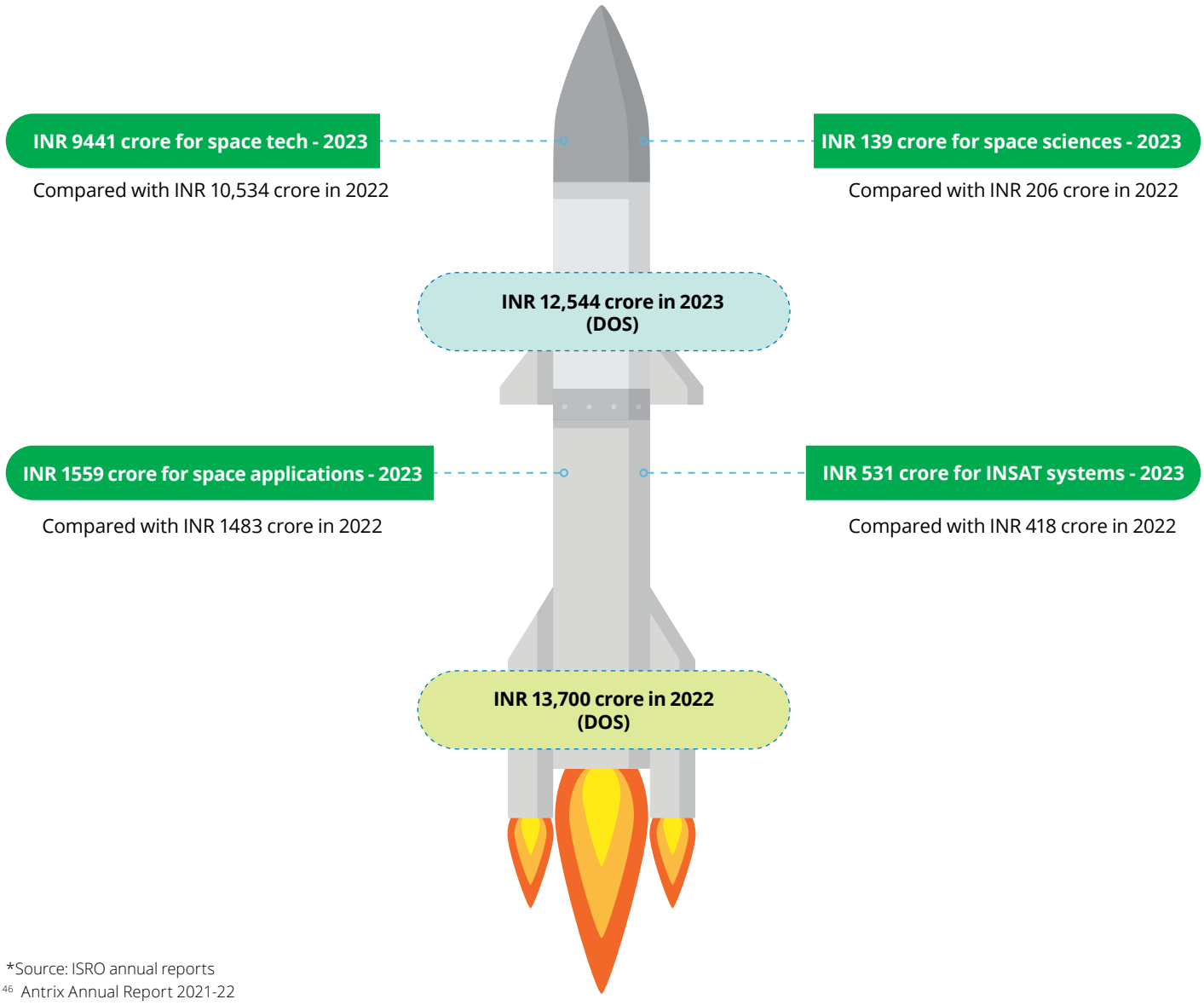
Indian landscape of investments

Public investments by the Indian government

DOS, which oversees ISRO, IN-SPACe NSIL, and Antrix, receives funding from the Union Budget of India. The allocated funds are used to finance various space programmes, satellite launches, R&D activities, and infrastructure development.

In addition to government funding, the department generates revenue through NSIL that has the mandate to undertake end-to-end commercial space activities. Antrix Corporation Limited is responsible for marketing and selling satellite launch services, satellite transponders, and remote sensing data to domestic and international customers. In FY 2021-22, Antrix generated profit after taxes of INR 25 crore[46] and NSIL generated profit after taxes of INR 343 crore. [47]

Figure 18 : DOS budget break-up and analysis (2023 vs 2022).*



*Source: ISRO annual reports

[46] Antrix Annual Report 2021-22

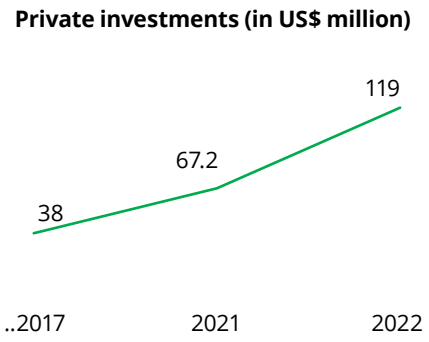
[47] NSIL Annual Report 2021-22

Private investments into the Indian private space

Similar to global trends, government investments are beginning to be complemented by private investments in India as well, most notably in the emerging and nascent space start-up ecosystem. Funding in the private space sector comes from various sources, such as venture capital firms, private equity investors, incubators, accelerators, and bootstrapped and international collaborations.

The private space industry has seen significant growth and investment in the past few years, with several companies receiving substantial funding from various entities.[48] Private investments in the sector have seen an accelerated growth of ~77 percent in 2021–22.

Figure 19: Private investments into start-ups (in US$ million)



(Source: Economic Times[48])

Figure 20: Trend of increasing private space-tech start-ups in India (Source: IN-SPACe Coffee Table book)[49]

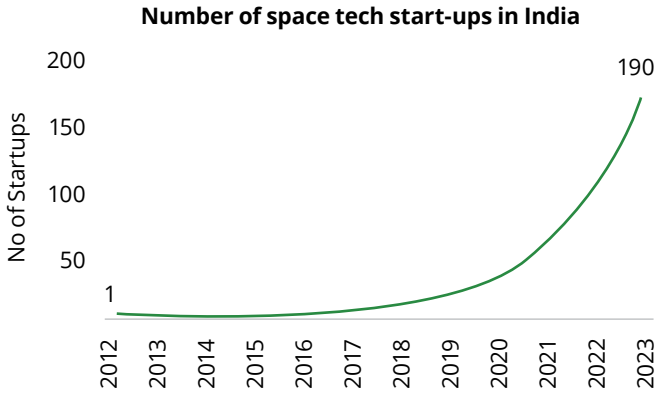
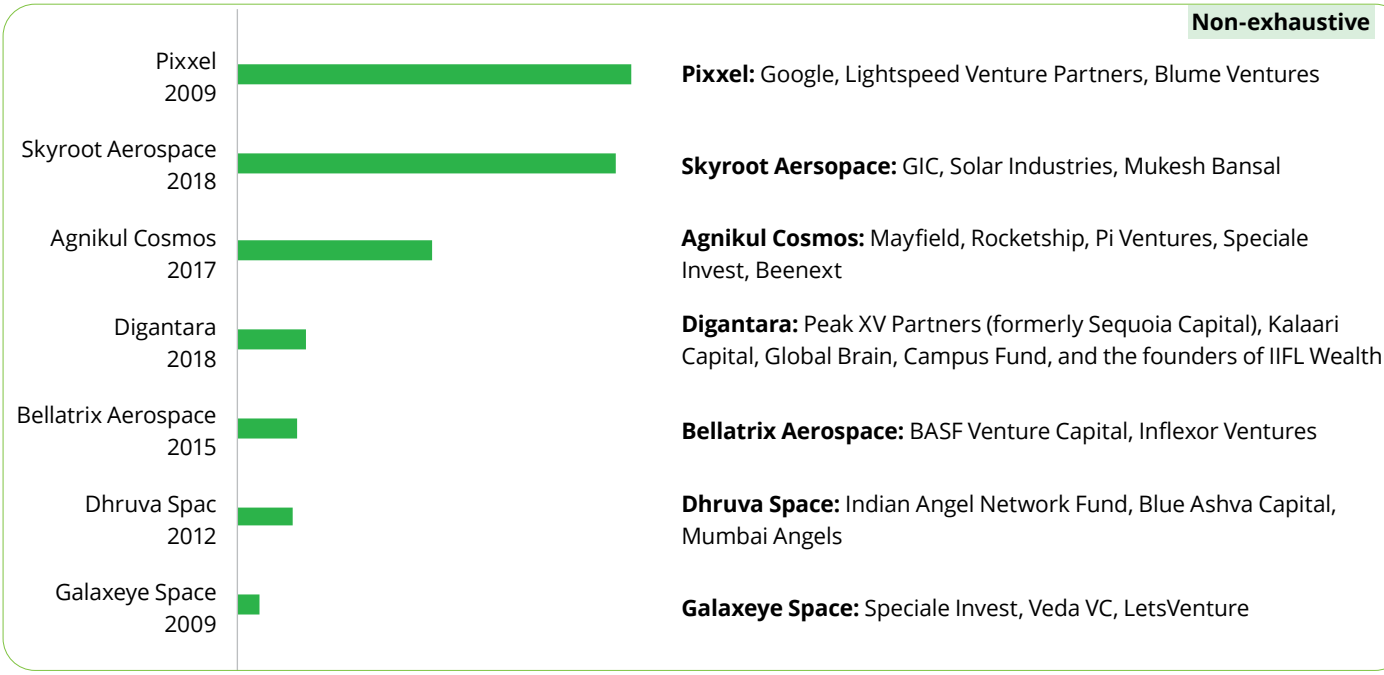


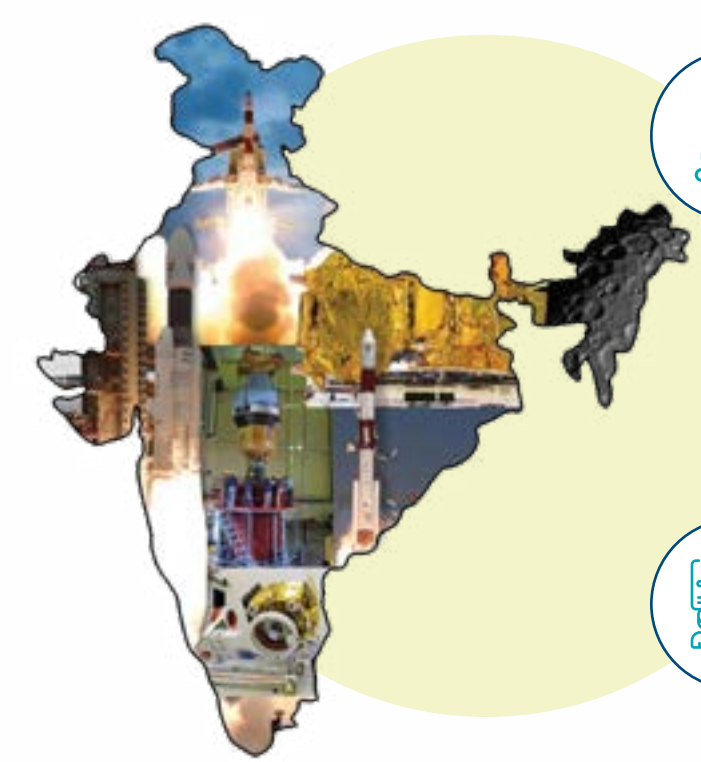
Figure 21:Funding into India's Spacetech start-ups as on 2023 (Source: Economic Times)



Note: The private space sector is dynamic and continuously evolving. Funding sources and trends may change over time as the industry develops and new players enter the market. For the most current and specific information on funding sources in the private space sector, refer to recent industry news and official announcements from space companies and investment firms

[48] https://economictimes.indiatimes.com/tech/newsletters/morning-dispatch/premium-products-power-online-sales-isro-grey-cells-fuel-spacetech-startups/articleshow/101651186.cms?from=mdr
[49] https://www.inspace.gov.in/inspace?id=inspace_pdf_carousel

Additionally, to sustain the emerging start-up ecosystem, IN-SPACe supports the ecosystem through incubation and guidance[50].



On 14 March 2023, IN-SPACe announced a **seed fund scheme** for Indian space-tech start-ups

The fund would provide up to **INR 1 crore (~US$ 121,000)** to each company.

Support from IN-SPACe would also include **mentorship**, **training**, and **networking** opportunities for companies.

Financing and funding the NewSpace ecosystem in India will involve a collaborative effort, with government investments into DOS enabling ISRO to advance India's vision and ambitions for space. Additionally, both private and government investments will support emerging companies in the space sector, while private investments will drive various segments of the Indian space value chain to create sustainable value.

Call to Action

- Within the space industry, **governments often serve as the initial customers** for numerous start-ups, while also acting as stable clients for companies engaged in strategic space and national security initiatives.
- To enhance investor interest in the space sector, **space agencies are fostering capital inflow**, with companies securing government contracts, offering a sense of assurance to potential investors.
- The grant of government contracts to established Indian private players play a pivotal role in fostering the demand for emerging private start-ups. There is a **need for creating sustainable market demand for the private start-ups,** which in turn contributes to the establishment of a robust private space ecosystem in India.

[50] https://www.inspace.gov.in/inspace?id=announcement_for_opportunities

Chapter 4
Collaborations in Indian NewSpace

Major and recent international collaborations by ISRO

International collaborations present a unique opportunity for ISRO to strengthen its position as a global space leader. These collaborations are not so new for ISRO as it has been collaborating with international space agencies, research institutions, and private companies to facilitate knowledge exchange, technology transfer, and joint R&D efforts. Through strategic partnerships, ISRO can access advance technologies, expand its capabilities, and enhance the efficiency of its space missions. Moreover, international collaborations can foster diplomatic relations, creating a platform for cooperation on shared space exploration goals and addressing global challenges.

A few key illustrations of such collaborations are mentioned below [51,52,53,54,55,56]

National Aeronautics and Space Administration (NASA)

- NASA is currently collaborating with ISRO on the NISAR mission that will be launched in January 2024; For the mission, radar imaging will be used to study Earth's surface and atmosphere.
- In 2023, India joined the Artemis Accords agreement, a global initiative that was conceived and spearheaded by NASA to put humans back on the moon by 2025.
- NASA collaborated with ISRO on several projects, including the Chandrayaan-1 and 2 lunar mission, the Mars Orbiter Mission, and the Asteroid Impact Deflection Assessment (AIDA) mission.

European Space Agency (ESA)

- ESA collaborated on the Astrosat astronomy satellite, the SARAL oceanography satellite, and the ExoMars rover mission.
- In 2021, both agencies signed a cross-support arrangement to exchange navigation, operations, and data handling support on selected future space missions. The arrangement also includes sharing tracking stations for each other's missions bilaterally.

Japan Aerospace Exploration Agency (JAXA)

- JAXA collaborated with ISRO on several projects, including the GSAT-6A communication satellite, the X-ray Astronomy satellite (ASTRO-H), and the Lunar Polar Exploration Mission (LUPEX).
- Both agencies are jointly developing a lunar rover.
- JAXA uses ISRO's navigation technology to improve spacecraft autonomy for interplanetary missions.
- Both agencies have also collaborated on earth observation missions to improve the monitoring of natural resources, weather patterns, and environmental changes.

[51] https://nisar.jpl.nasa.gov/mission/isro-partnership/
[52] https://www.esa.int/Enabling_Support/Operations/ESA_Ground_Stations/ESA_and_Indian_space_agency_ISRO_agree_on_future_cooperation
[53] https://www.financialexpress.com/business/defence-isro-jaxa-forge-a-lunar-partnership-lupex-mission-set-to-soar-3125434/
[54] https://www.isro.gov.in/CNESandISROFoster.html
[55] https://www.mea.gov.in/Portal/LegalTreatiesDoc/RU15B2629.pdf
[56] https://indbiz.gov.in/gaganyaan-gives-a-boost-to-india-russia-space-partnership/#:~:text=Most%20recently%2C%20the%20Indo%2DRussian,sent%20in%20January%20to%20Russia

Centre National d'Etudes Spatiales (CNES, France)

- ISRO and CNES have been collaborating on several projects for more than six decades. These include the Cartosat-2 series of Earth observation satellites, the SARAL oceanography satellite, and the TRISHNA earth observation satellite mission.
- They signed an agreement for training of Gaganyaan astronauts at microgravity facilities in France.

State Space corporation of the Russian Federation (ROSCOSMOS)

- Both agencies are currently collaborating on the development of a components related to launch vehicles.
- They also collaborated for the Gaganyaan programme astronauts training.

ISRO's international collaborations are essential to its mission of space exploration and space science. Through these collaborations, ISRO can exchange expertise with other countries and pool resources to achieve common goals. These collaborations are also essential in building international cooperation and understanding, which are essential for the future of space exploration.

Global inter-space agencies collaborations[57] [58]

Global collaborations amongst space agencies hold immense potential in shaping the future of space exploration and technology. Working together, space agencies can tackle complex challenges, such as developing sustainable space habitats, exploring new celestial bodies, and working on advanced space technologies programmes, such as International Space Station (ISS) and Artemis Accords. These collaborations are a testament to what can be accomplished when countries work together. It fosters a spirit of inclusivity, breaking down barriers to access space exploration and promoting international cooperation.

Furthermore, joint missions and projects enable a cost-effective approach to space exploration and offer diverse perspectives to address global challenges, such as climate change and resource management. By embracing cooperation, space agencies can propel the space sector into an era of unprecedented growth and exploration. This ushers in a new age of space democratisation, where benefits of space technology and knowledge are accessible to each nation, fostering a shared vision for the betterment of humanity and our understanding of the cosmos.

International Space Station (ISS)

- ISS is the largest human-made object and spacecraft in the low earth orbit.
- A joint project of five space agencies: **NASA (US), ROCOSMOS (Russia), JAXA (Japan), ESA (Europe), and CSA (Canada).**
- The ISS has been continuously inhabited since **November 2000.**
- It costs ~US$ 3 billion per year to operate.
- **About 269 individuals from 21 countries** have visited ISS until May 2023.

14 countries collaborated

[57] https://www.nasa.gov/mission_pages/webb/main/index.html
[58] https://www.mmx.jaxa.jp/en/

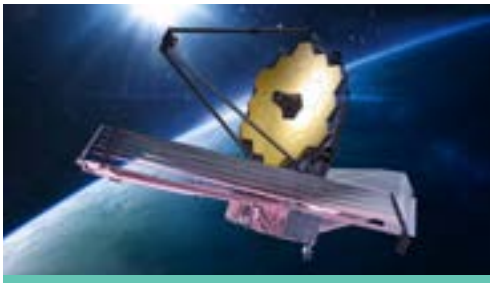
Artemis Mission & Lunar Gateway

- Artemis is a crewed spaceflight programme led by NASA(US) in partnership with international partners, including other space agencies of Europe (ESA), Japan (JAXA), Canada (CSA), and Australia (ASA).
- The programme's goal is to return humans to the moon by 2024 and make the moon the gateway to Mars and for future deep-space explorations.
- Artemis Accords, established in 2020 by NASA, was signed by 27 countries for international cooperation with the aim of going to the moon and then Mars.

27 countries collaborated

James Webb Space Telescope

- James Webb Space Telescope (JWST) was launched in December 2021.
- An outcome of 14 countries with NASA(USA) as a leading partner and 13 other countries are involved in building the Webb telescope: Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, the Netherlands, Spain, Sweden, Switzerland, and the UK.
- JWST's primary goal is to observe distant galaxies, stars, and planets, and study their formation and evolution.

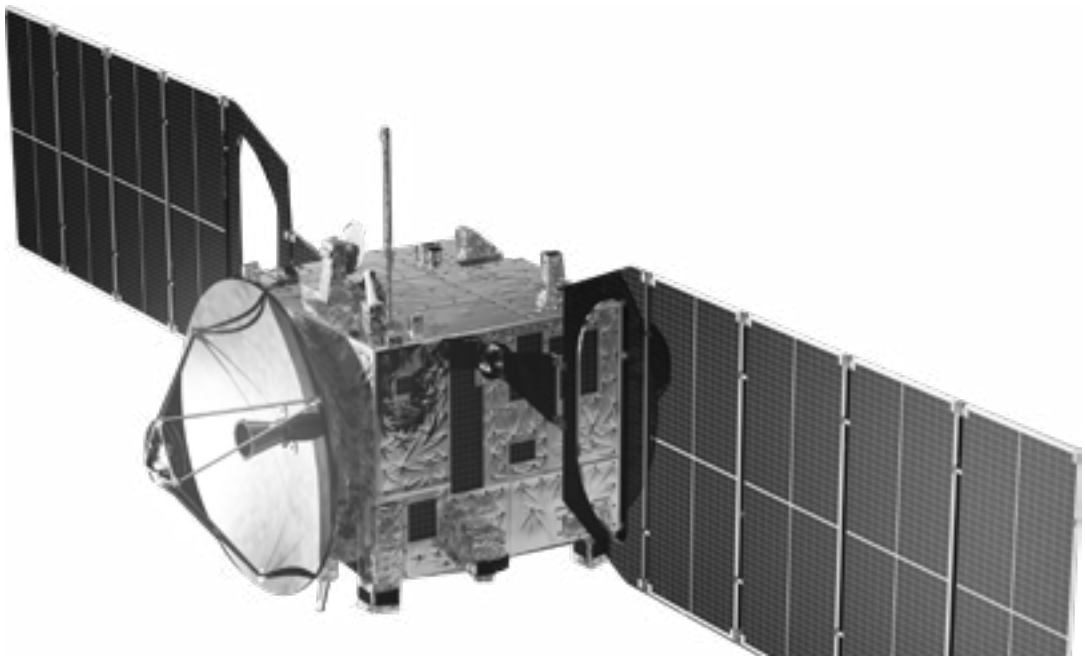


14 countries collaborated

Martian Moons eXploration (MMX)

- MMX led by JAXA(Japan) will carry a rover jointly developed by DLR (German Aerospace Centre) and CNES (National Centre for Space Studies).
- The rover will be released from the MMX spacecraft above Martian moon Phobos to observe the surface and contribute to a safe and secure landing for the MMX spacecraft.
- A trilateral agreement was signed by three countries in 2023.

3 countries collaborated



Other collaborations with entities in the Indian private space sector

Technology transfers from ISRO to the Indian private ecosystem

As the space sector is extremely capital intensive, conducting R&D for already existing technologies would be an additional cost, both in terms of time and money. Over the years, ISRO has developed many technologies and expertise in various aspects of satellite development, launch systems, and space exploration. By transferring these technologies to the private sector through NSIL and IN-SPACe, DOS has been enabling emerging companies to build upon ISRO's foundational technologies, reducing their development time and costs and helping them build advanced technologies. In addition, DOS has allowed to use its infrastructure for end-to-end development of technologies. This will also enhance the overall competitiveness and capabilities of NewSpace industries in India and position the country as a preferred service provider in the global space market.

ISRO's technology transfer programme,[59] currently facilitated by NSIL, has been instrumental in commercialising technologies developed by ISRO. More than 400 technologies have been successfully transferred to about 235 industries since the 1980s. The technology transfers encompass diverse sectors, benefiting organisations across the country.

These transfers fall into three broad categories: those intended for the ISRO programme buy-back, development of space systems and applications, and non-space applications, also known as spin-offs.

Figure 22: Technology transfer of ISRO to private players since 1980s (Source: ISRO)

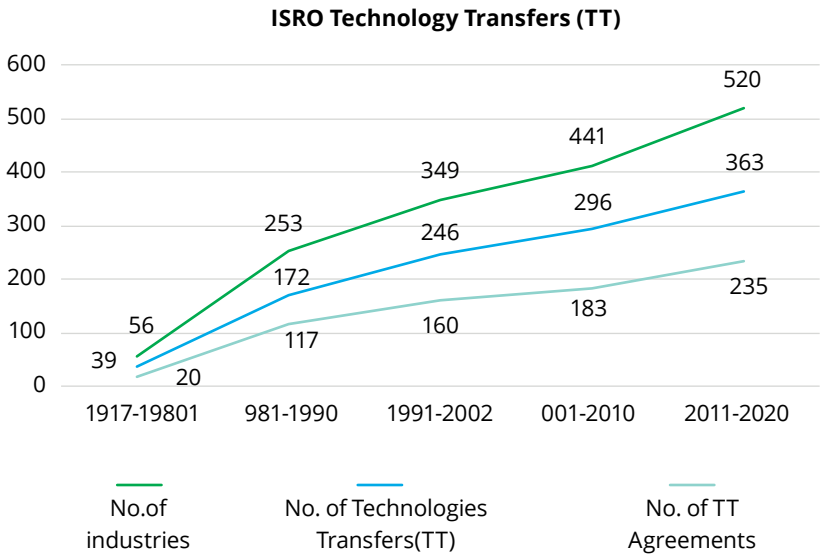


Figure 23: Impact of technology transfers to private players

This collaborative approach empowers the private sector to play a more active and competitive role in the space industry. This promotes self-reliance in the country and will further strengthens India's position as a key player in the global space market.

[59]https://www.isro.gov.in/media_isro/pdf/ResourcesPdf/technology_transfer_august_2022.pdf

Sharing intellectual properties of ISRO with private entities

ISRO under DOS has been conducting R&D on space technologies and developing Intellectual Property Rights (IPRs)[60] viz., patents, copyrights, and trademarks. ISRO has filed about 417 patents in the space technologies domain. Of which, 193 are active, 128 are lapsed, and 96 are under examination/yet to be granted. About 19 of these are developed and shared with the industry for end-product/service development through a technology transfer channel. This accelerates the capabilities of private space players, enabling them to build upon ISRO's foundational technologies and bring innovative solutions to the market.

Sharing ISRO's resources with industry and academia

By providing access to ISRO's testing facilities, infrastructure, and expertise, ISRO empowers both the private industry and academia to engage in space-related research and development, nurturing a collaborative ecosystem for technological advancement in India.

ISRO initiated the RESPOND[61] (Research Sponsored by Department of Space) programme in 1970, with an aim to foster R&D activities in the field of space science, technology, and applications within universities and academic institutions across India. The primary objective was to establish strong collaborations with premier academic institutions to conduct relevant research projects that contribute to the advancement of space technology and applications, ultimately supporting ISRO's space programmes.

Over the past five decades until 2022,[62] ISRO supported more than 100 academic institutions executing more than 500 projects space-related programmes to the public. Through RESPOND, ISRO provides technical facilities and fellowships to researchers, ensuring a strong foundation for the country's future space activities and complementing various missions undertaken by ISRO.

Call to Action

- ISRO has been actively engaged in **collaborations with academic institutions and research labs** right from its inception, aimed at fostering the development of space technologies and facilitating ground-level research.
- This strategic approach has not only **spurred private-sector engagement** but has also **inspired numerous individuals to embark on their entrepreneurial journey within the space sector.**
- Nonetheless, there **is a need to expand the reach of these collaborations to more remote institutes and research labs.** The existing collaborations should also **expand the scope of research to futuristic technologies.** Such an expansion is essential for retaining valuable talent within the Indian space sector and ensuring its sustained growth.

[60]https://www.isro.gov.in/IntellectualProperty.html
[61]https://www.isro.gov.in/RESPONDProjects.html
[62]https://www.isro.gov.in/media_isro/pdf/programme/respond_basket_2022.pdf

Chapter 5

The Indian NewSpace ecosystem

Source link: https://www.isro.gov.in/Gallery.html

The evolution of the Indian space sector towards NewSpace is further evident with the participation of private players across the value chain. India has experienced a boom in the ecosystem with numerous start-ups alongside legacy private companies expanding their businesses models and entering the space industry.

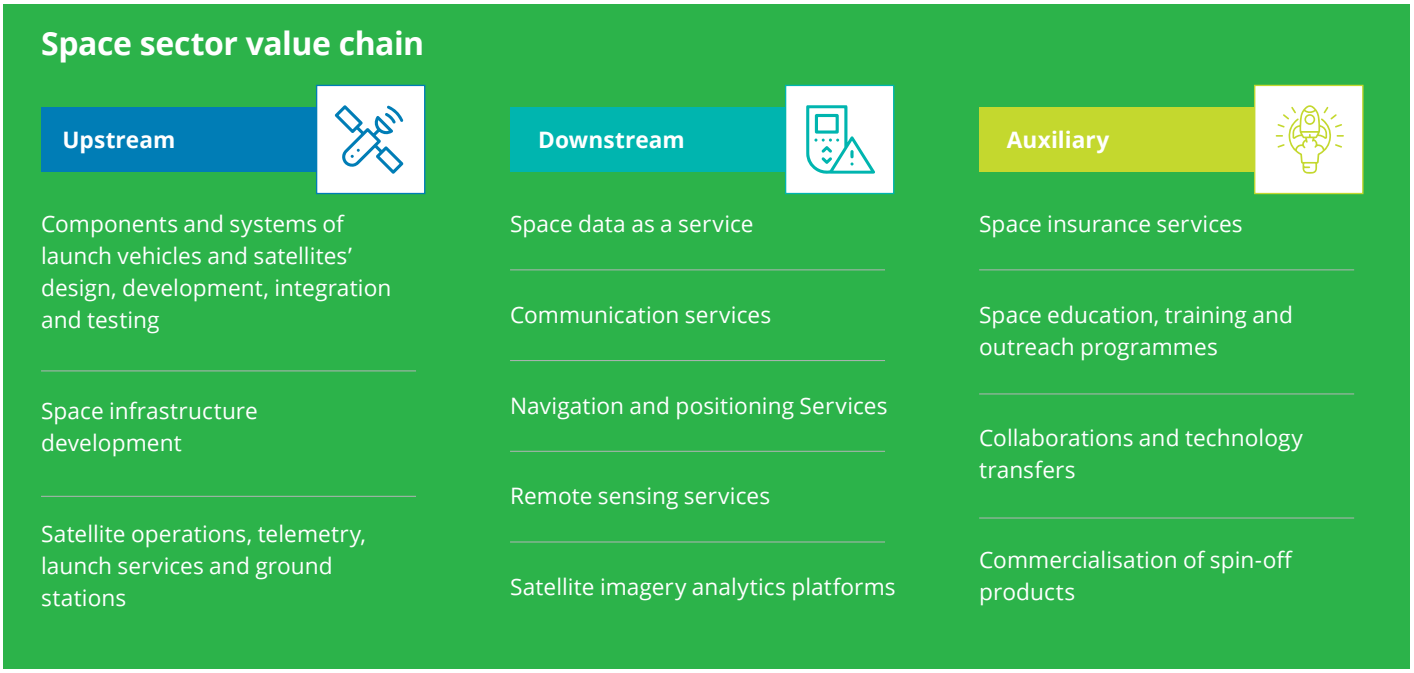
Historically dominated by government agencies, India's space sector is now experiencing a surge of private companies entering the arena. This trend is driving a new wave of entrepreneurship, investment, and technological advancements. With the liberalisation of the space sector and the government's supportive policies, private players are now actively participating and emerging as key players in the space industry. These players are also competing with global companies.

> **When the strength of government space institutions and the passion of India's private sector will meet, not even the sky will be the limit***
>
> - Prime Minister Narendra Modi

Segmentation of the Indian space industry

The industry segmentation across the value chain encompasses various domains, including upstream, downstream, and auxiliary activities. Upstream activities involve satellite manufacturing, launch services, and space transportation. Downstream activities encompass using satellite data for a wide range of applications, such as earth observation, communication, and navigation. The auxiliary segment comprises supporting services and technologies that enhance space operations.

Figure 24: Segmentation of the space ecosystem across the value chain



*Source: narendramodi.in

Upstream segment

The upstream segment of the Indian private sector space industry encompasses companies playing a critical role in the development and deployment of space assets. These companies include businesses from the grassroots level of space-grade materials fabrication for both satellites and launch vehicle until the launch of satellites into the orbit. They also provide supporting infrastructure ranging from software development to operations centres, telemetry, tracking and communication ground stations. This segment is witnessing significant growth, driven by increased launches, demand for more satellites, advancements in technology, cost-effective solutions, and eventually increased private sector participation.

Figure 25: Key drivers of the upstream segment

Major segments covered in the upstream segment

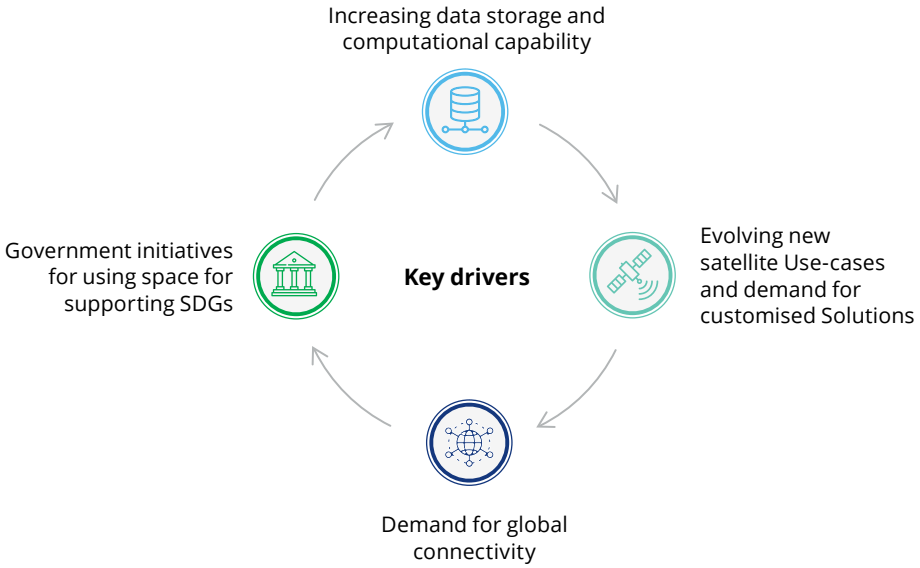
Figure 26: Segments covered under the upstream segment of the space sector value chain

Spacecraft and its components manufacturing	Launch vehicle components and system design and development	Satellites and launch vehicles integration and testing	Space infrastructure development	Spacecraft and its components manufacturing
Companies engaged in designing, building, and assembling satellites for applications of communication, navigation, earth observation, and scientific research	Firms dedicated to developing and manufacturing rockets and launch vehicles for commercial and scientific purposes	Entities conducting integration and testing of satellites to ensure their functionality and reliability before the launch	Providers offering launch pads and facilities or satellite launch services; includes telemetry, tracking and communication, and satellite operations centres	Firms involved in development and fabrication of hardware and relevant software for space systems testing, simulating and, for the launch

Downstream segment

Companies in the downstream segment carry out activities and applications that involve the use of space-based data and technologies to provide products and services for various industries and end-users. These companies use space-based information to cater to various sectors, including agriculture, environmental monitoring, disaster management, telecommunications, and navigation. The downstream segment plays a crucial role in providing insights and solutions to address real-world challenges.

Figure 27: Key drivers of downstream segment



Major segments covered in the downstream segment

Figure 28: Space activities covered in the downstream sector

Satellite date storage and computation services (data as a service)

Companies offering satellite data storage, computation and services related to data uplink and downlink

Communication services

Providers delivering communication services through satellite-based networks and solutions

Navigation and positioning services applications

Entities offering satellite-based navigation and positioning services

Remote sensing data analytics and platforms

Companies providing high-resolution satellite imagery and data analytics platforms for various industries

Space assets security and constellation management

Firms specialising in building security applications and constellation management platforms

Auxiliary segment

The auxiliary segment of the Indian private sector space industry comprises businesses that offer supporting services and technologies to enhance space operations and applications. These companies play a critical role in enabling the smooth functioning of the overall space ecosystem, fostering innovation and driving commercialisation.

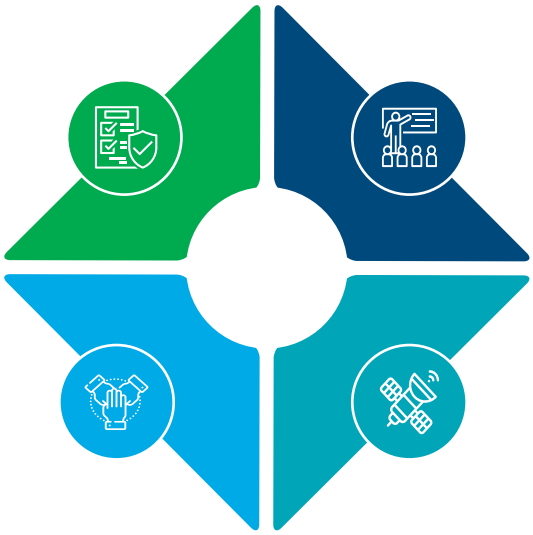
Figure 29: Key drivers of the auxiliary segment

Major segments covered in the auxiliary segment

Figure 30: Activities involved in the auxiliary segment of space

Space insurance services

Providers offering insurance coverage for space missions, assets and infrastructure



Space education, training and outreach programmes

Institutes and start-ups offering space science and tech programmes and also taking educational initiatives

Collaborations and consulting servcies

Increasing collaborations for using space-based technologies and space businesses enabling consultation services in the space sector

Commercialisation of Spin-off products

Transforming space technologies into commercial marketable products for other sectors

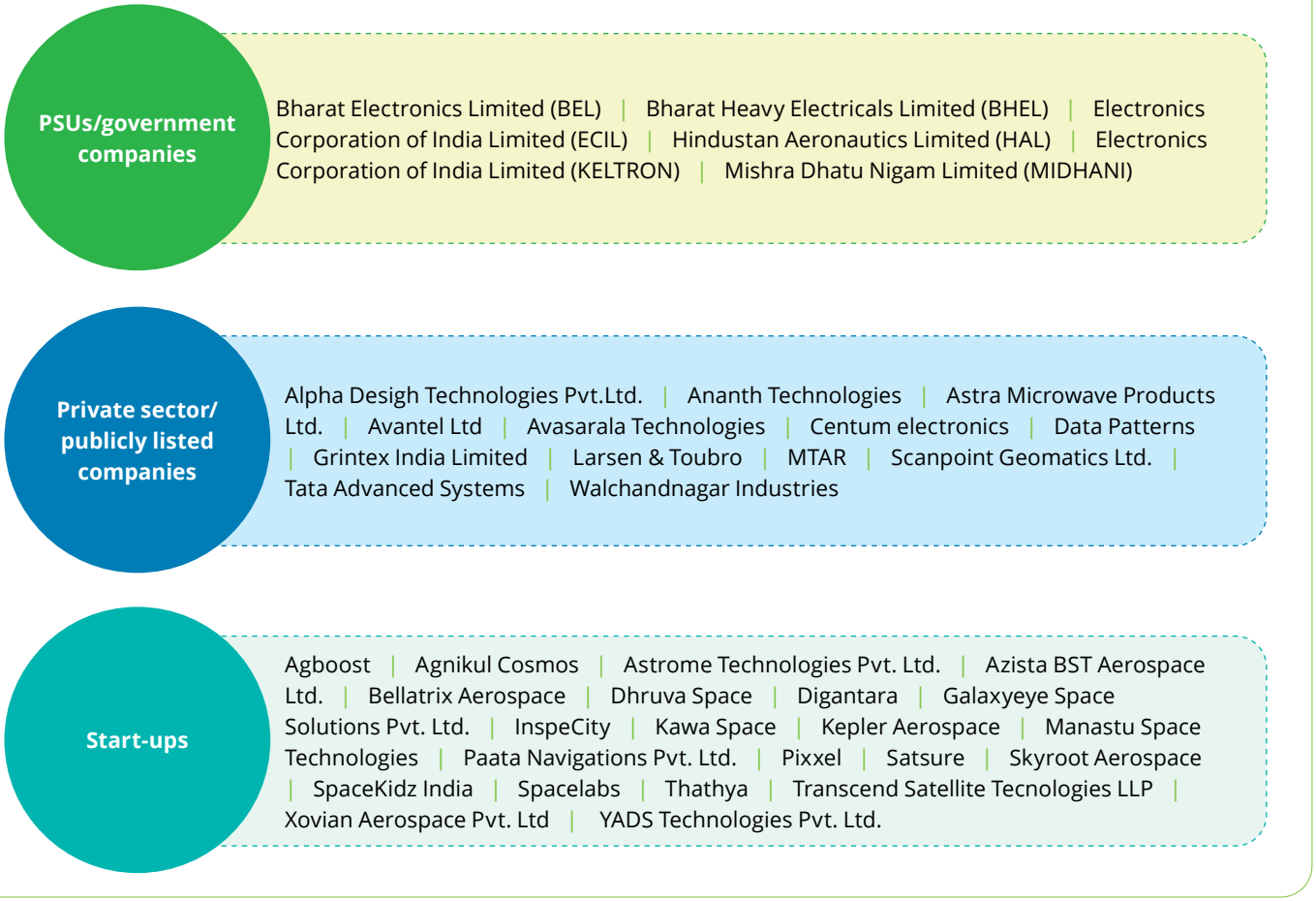
Indian space companies driving the ecosystem

The increasing presence of Indian private space companies, viz., Public-Sector Undertakings (PSUs),[63] private/publicly listed companies,[64] and start-ups[65] across the value chain showcases its diverse and rapidly expanding landscape. These segments drive innovation, commercialisation, and the democratisation of space technologies, laying the foundation for a robust and innovative space ecosystem and shaping India's position in the global space arena.

Here are a few companies driving the Indian Space ecosystem that are segregated into three categories: PSUs, private/publicly listed companies, and start-ups. The companies listed below is to showcase the private industry participation across the value chain.

Non-exhaustive

Figure 31: List of Indian companies driving the space ecosystem (Source: IN-SPACe, CII)



As the industry continues to evolve towards NewSpace, a few private players are shifting to play across multiple segments of the value chain. More private players are expanding their business across the space value chain considering new business models across the segments, end-customer targets and increase their profitability margins.

Disclaimer: The companies listed in this section are referenced from IN-SPACe's coffee-table handbook published in July 2023. Please note that mention of these companies does not constitute advocacy by Deloitte. The companies mentioned here are non-exhaustive for each segment and mentioned here in an alphabetical order, in no order of importance. More details of each company from the IN-SPACe coffee-table handbook and the PSUs' obtained from CII can be found in Appendix-A. List of companies supplying to ISRO missions can be obtained from ISRO and not all of them find mention in this list.

[63]PSU is defined per Govt. of India: https://www.lawinsider.com/dictionary/public-sector-undertaking
[64]Private companies defined per Companies Act 2013(page 20): https://www.mca.gov.in/Ministry/pdf/CompaniesAct2013.pdf
[65]Startup is defined per DPIIT: https://dpiit.gov.in/sites/default/files/notification_Definition_StartupIndia_06July2021.pdf
https://www.inspace.gov.in/inspace?id=inspace_pdf_carousel

Current key capabilities of India's private space sector

India's private space industry has grown leaps and bounds, driven by entrepreneurial spirit, technological prowess, and supportive government policies. With increasing participation from private companies and start-ups, the sector has diversified its focus, ranging from satellite manufacturing, launch services, space applications, to research and development. This section explores the current capabilities of India's private space sector, shedding light on its achievements in proof of concepts to commercial activities and contributions so far in the Indian space sector.

Snapshot of upstream segment

Indicative

End-to-end design of satellite payloads and sub-systems	Manufacturing capability of satellites payloads (partial) and sub-systems	Assembly, integration, and testing of satellite systems	End-to-end satellites development services
Design of launch vehicles and sub-systems	End-to-end manufacturing of launch vehicles and sub-systems	Assembly and testing of launch vehicles and sub-systems	End-to-end launch vehicle development and launch services
Fabrication of telemetry and tracking ground station antennas	Establishment of satellite operations and data receiving centres	Manufacturing satellite navigation and communication devices	Development of software and hardware for testing, simulations, and launch

Snapshot of downstream segment

Indicative

Satellite data storage services	Satellite data models building and computation services	Satellite and constellation management platforms	Space assets security software and platforms
Development of satellite data analytics platforms for each remote sensing application	Development of navigation platforms and applications for end-users	Development of communication platforms and applications	

Snapshot of auxiliary segment

Indicative

Space education, training, and outreach programmes	Space collaborations and consultation services	Commercialisation of spin-off products

Call to Action

- For the past few years, companies in the Indian space sector have been developing their space capabilities. As they move further, they must map their current capabilities and identify gaps to shape the future trajectory.
- To understand current capabilities, an **in-depth study on India's capabilities across the value chain of the space sector should be done. Tapping these gaps would make the Indian space sector self-reliant across the spectrum.**

Chapter 6
Socio-economic impact in the NewSpace era

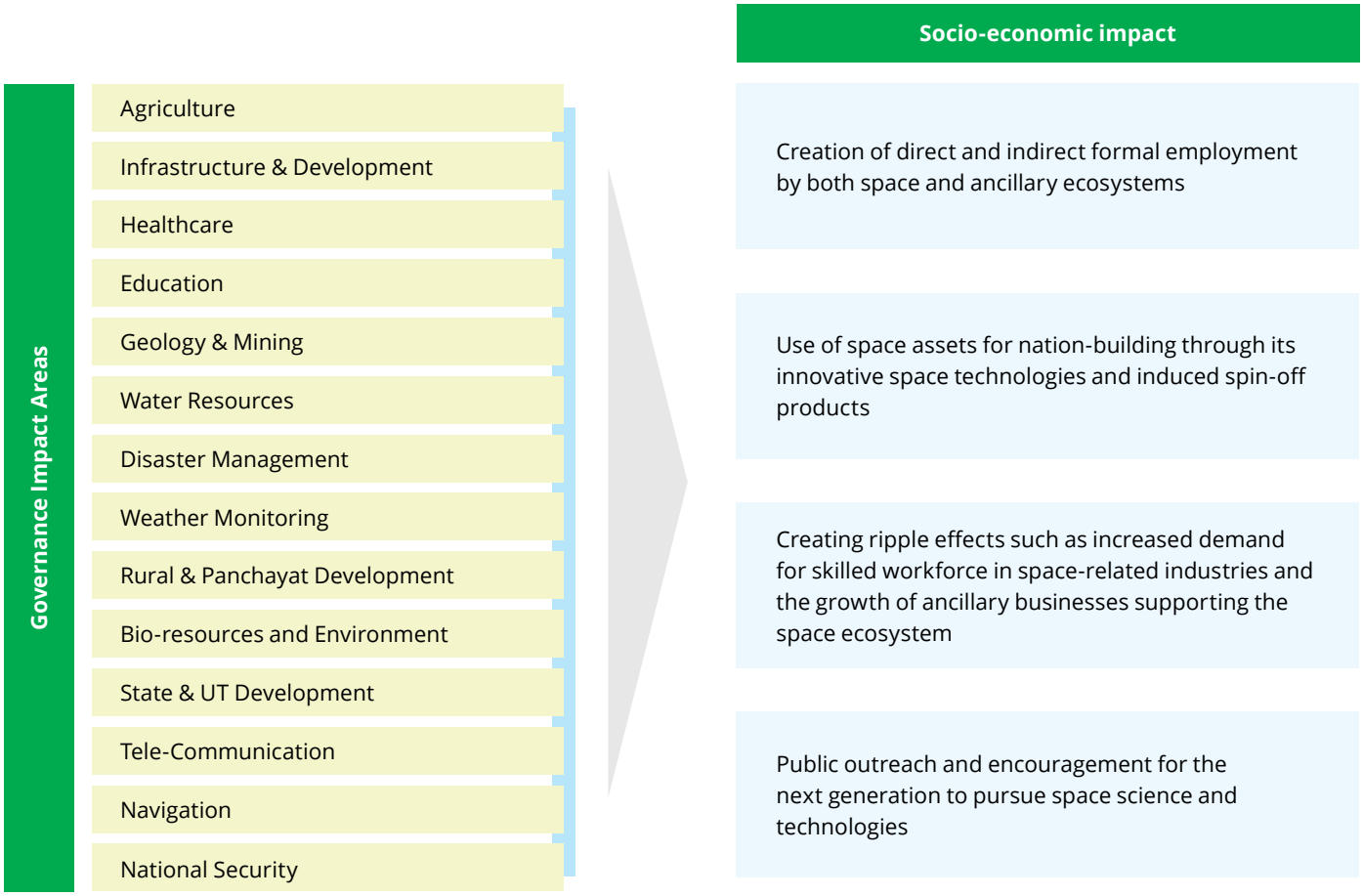
ISRO launched its first satellites namely Aryabhatta, Bhaskara 1, and Rohini Satellite RS-I, for experimental and earth observation purposes. The payload data of Bhaskara 1 and camera imageries were extensively used in the field of hydrology, forestry, and oceanographic studies.

Since its inception, India's space programme is committed to leveraging space for inclusive socio-economic development.

From choice of missions to mode of execution, ISRO's continued efforts have this common thread of placing socio-economic development at the heart of the space programme.

The following are some key areas in which India's space programme has created impressionable benchmarks in utilising space for socio-economic development:[67]

Figure 32 : Impact areas of India's space programme



[67]Analysis from ISRO Socio-Economic Impact Study Proposal: https://www.isro.gov.in/media_isro/pdf/Tenders/2023/HQDR2023002680.pdf

As indicated in the preceding sections, the shift towards NewSpace in India holds immense importance as it paves the way for accelerated growth for the sector. The overall realisation of commercial value for the sector can materialise only if it continues to be a major driver of socio-economic advancement, driving scientific exploration, empowering communication, and fostering sustainable development across the nation. Additionally, the global developmental challenges open up markets beyond India for the country's emerging private ecosystem. With the right strategy, effective reach-out, and efficient products, NewSpace in India has the potential to make an impact beyond Indian borders.

Early signs from the sector signal the synergy between the nascent ecosystem and ISRO's efforts to address some socio-economic problems through space.

Some key problems that can be solved/improved by India's NewSpace, are mentioned below:

Agriculture

- Improved crop disease monitoring and yield estimation
- Improved crop insurance
- Improved agricultural analytics and precision agriculture until the last mile

Biodiversity conservation

- Improved habitat, deforestation, and illegal activities monitoring
- Enabling health assessment of ecosystem and conservation
- Improved disaster tracking, such as wildfires, floods

Infrastructure planning

- Assisting in site selection for infrastructure development
- Enabling environmental impact assessment of planned projects
- Monitoring of infrastructure projects and estimation of impact

Urban development

- Urban expansion projects and areas planning, development, and monitoring
- Enabling land records monitoring and value assessment
- Improved traffic management and public service planning

Rural development and remote area connectivity

- Enhanced last mile telecommunication services e-governance
- Enhanced telemedicine, healthcare access and education using e-learning
- Resources management, planning and monitoring growth/development

National security

- Improved border intelligence, surveillance, and reconnaissance
- Maritime domain awareness and terrorism threat assessment
- Border area strategic development and disaster response planning

Blue economy

- Improved management of ocean resources, fisheries, and detection and of oil spills, shipwreck, and deep-sea disasters
- Enhanced maritime security, navigation, and connectivity
- Improved planning and management for coastal zones, marine tourism, recreation activities, and environmental impact assessment of offshore projects

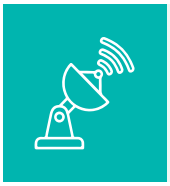
Water resources management

- Improved remote sensing for water availability and monitoring water bodies and distribution across India
- Improved water quality assessments by measuring water quality parameters and helping identify potential pollutants
- Enhanced monitoring of glaciers and watershed management

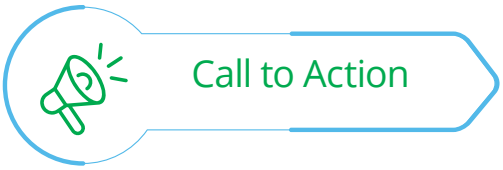
SATCOM

- Satellite communication for satellite Internet of Things (IoT) smart grids, autonomous vehicles, drones, and flying taxis in the future
- Emergence of handheld portable devices for end-to-end communication
- Improved last mile connectivity and redundant global connectivity

Navigation



- Improved GIS applications
- Improved precise navigation for defence and commercial navigation with enhanced strategic advantage
- Enabling new use cases, such as navigation for swarm robotics, IoT, and autonomous systems



Call to Action

- Over the years, India has developed great downstream capabilities. However, there is still a huge gap between the insights from the satellite imagery and the use cases for which they are being applied.
- Government should consider introducing PLI scheme / customs exemptions to encourage indigenous manufacturing capacity in a more cost-effective manner and with improved commercial traction.
- **An in-depth study on how the existing enormous potential of the downstream capabilities of this sector should be tapped to its full extent has to be undertaken.**

Appendix-A

Indicative list of PSUs involved in the space sector

Representative & Non-exhaustive

Company name	Present capabilities	Website
Bharat Electronics Limited (BEL) Founded in 1954 in Bangalore	• Electro-optics and laser range finders • Defence communication products • C4I systems • Batteries • Microwave components and Micro Electro-Mechanical System (MEMS) • Cyber security solutions	
Bharat Heavy Electricals Limited (BHEL) Founded in 1956; headquarters in New Delhi	• Space grade solar panels • Space grade batteries • Non-corrosive coating on the Secondary Injection Thrust Vector Control (SITVC) tanks of PSLV and GSLV	
Electronics Corporation of India (ECIL) Founded in 1967 in Hyderabad	• Development of antennas for ground stations and a deep space network • Space grade electronics • Develop and manufacture − Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA) systems • Develop multi-band composite feed systems used in earth stations	
Hindustan Aeronautics Limited (HAL) Founded in 1940 in Bangalore	• Aluminium alloy riveted structures • Welded tankages of conical, cylindrical, and other shapes • Heat shield assembly, nose cone assembly, and tank and shrouds used in satellites • Fabrication and assembly of sub-systems for launch vehicles stages • Full integration and testing of launch vehicle stages	
Kerala State Electronics Development Corporation (KELTRON) Founded in 1973 in Thiruvananthapu-ram	• Launch vehicle navigation and guidance computers • Stage processing modules • Control electronics modules • DC−DC converters • Resin electronic module • Avionics packages for launch vehicles • Test and evaluation support • Electronics modules for satellites	
Mishra Dhatu Nigam Limited (MIDHANI) Founded in 1973 in Hyderabad	• High-end aluminium alloys • Special steel and stainless steel for cryo stages, liquid engines, motor cases, and base rings • Titanium and titanium alloys • Superalloys for rocket engines	

Source: IN-SPACe Coffee table-handbook & CII

Indicative list of private/publicly listed Indian space companies

Representative & Non-exhaustive

Company name	Present capabilities	Plans	Website
Alpha Design Technologies Ltd. (ADTL) Founded in 2004 in Bangalore	• Possess ISRO trained and skilled 60-member team for conducting Assembly, Integration & Testing (AIT) of small /medium/large satellites. • Established supplier of ISRO for PSLV/ GSLV • Launcher subsystems over past 10 years, through ADTL subsidiaries. • Over 10 years experience in establishing Satellite Earth Stations catering to TT&C, multimedia communications & large number of VSATS. • Established state of the art manufacturing / production centers in Bangalore, Hyderabad and Trivandrum to meet the requirements of land, ship, space and air borne systems. • Developed successfully high dynamics 2-axis aircraft tracking systems for high-speed communications for DRDO & HAL	• Building small and medium satellites through industry collaborations and ISRO • Establishing satellite and sub-system manufacturing facility • Addressing opportunities for contract manufacturing of satellite sub-systems and ground exploitation systems for small and medium satellites through a JV and TOT from a foreign collaborator	
Ananth Technologies Pvt. Ltd. Founded in 1992 in Hyderabad	• Satellite systems • Launch Vehicle systems • Space applications • Satellite AIT activities • Small satellites	• Small satellites constellation for mapping GEO satellites for communication • AIT for launch vehicles	
Astra Microwave Products Ltd. Founded in 1991 in Hyderabad	• Design and development of RF payloads, such as SSPAs, receivers, TR modules, switch matrices, integration blocks, LNAs, DAs, and up-down converters • Design and development NavIC, CORS receiver, and timing receivers • Manufacturing transponders for various frequency bands, transmitters, and antennae • Design and development of sub-systems for space-based ELINT	• Design and development of space-based SAR • Satellite integration and testing • Design and development of a space-based ELM system	

Source: IN-SPACe Coffee table-handbook & CII

Representative & Non-exhaustive

Company name	Present capabilities	Plans	Website
Avantel Ltd. Founded in 1990 in Visakhapatnam	• Design and development of SATCOM (MSS and UHF) • Earth stations and user terminals • Software defined radios in UHF and S band • Embedded systems and digital signal processing • Network management and application software	• Design and development of the Ku Band ground segment • Software defined radios in the L and Ku bands • Manufacture and integration of small satellites. • GSAAS services	
Avarasala Technologies Ltd. Founded in 1987 in Bangalore	• Heat pipe for thermal management • Solar array deployment mechanism • Wave guides • Bonded film lubrication • Critical equipment for space	• Structures • Other mechanisms • Critical systems and sub-assemblies	
Centum Electronics Founded in 1993 in Bangalore	• Space object tracking radar payload • Electronic warfare • Hyperspectral • Bus management unit • Satellite avionics Systems • Launch vehicle avionics systems	• Payload integration • AIS, ISI, and TSM • Assembly, Integration and Testing (AIT) • Small satellites • Atomic clock	
Data Patterns (India) Ltd. Founded in 1985 in Bangalore	• Micro satellites • Payloads subsystems such as gyros, magnetometers, torquers, sun sensors, reaction wheels, TMTC, payload transmitters, and on-board computers Ground stations, Software Defined Radios (SDRs)	• Electro optical • Imaging • Synthetic aperture • Radar imaging • RF spectrum • Monitoring • Custom payloads • High capacity • Ground stations • IGbps downlink • Capability	
Grintex India Ltd. Founded in 1996 in Gurgaon	• System integration and engineering services for the defence, aerospace, and space industries • Air traffic control and airport safety systems • Ship design, construction supervision, and integration services • Satellite communications, design, and implementation • Surveillance and security systems • Software development and maintenance • Artificial Intelligence (Al — NLP and computer vision, audio and acoustics analysis), web-based technologies − AR/VR, and mobile apps	• Support Make in India initiatives for the Indian government in existing domain areas • LEO nano satellite constellations for aviation, meteorology, and marine applications and support services data products • ARNR/MR and metaverse applications in the ground segment− space technology areas to support ISRO programmes • Technologies to MBRSC, Dubai, in the aviation, marine, and space sectors; setting up satellite manufacturing and services in the UAE as an eligible UAE defence offsets with maximum multiplier benefits • For technical work, ISRO, and defence and aerospace organisations contract human resource services	

Source: IN-SPACe Coffee table-handbook & CII

Representative & Non-exhaustive

Company name	Present capabilities	Plans	Website
Larsen & Toubro Founded in 1946 in Mumbai	• System integration for launch vehicle • LV subsystems (PSLV, GSLV, GSLV Mk3, and SSLV) • Satellites subsystems (SADM, RADM, solar substrates, bus structure, ADCS) • SATCOMM infrastructure (Gateways for GSAT) • Antenna and radars • R&D test facilities (wind tunnels/high altitude engine test) • Space grade additive manufacturing • Composite structures for spacecraft and Launch Vehicles	• End-to-end launch solutions • System integration of LVs • System integration of satellites • Mobile launch solutions	
MISSAR Systems Founded in 2010 in Ahmedabad	• Developed 50+ industrial products for various industries for indigenisation. • Executed 10+ Product/Project for ISRO like satellite gateway unit; servo control system for X-Band PSR, X-Band DWR and C-Band DWR; Vehicle tracking using NavIC; High precision water level measurement etc. • Developed 15+ products and prototypes for PSUs and government organisations like Indian Army, ONGC and Indian railways like vehicle tracking unit, SRP remote monitoring system, universal input USB charger etc.	• Development of indigenous servo control and motion control components as well as hardware avigation and positioning systems for military use and gyro stabilised and reaction wheel systems	
MTAR Technologies Ltd. Founded 1970 in Hyderabad	• Equipped with advanced machining, assembly (2' 10,000 class clean rooms) and state-of-the-art quality control facilities • MTAR supplies the following products to ISRO: • Vikas engine • Upper stage cryogenic engine sub-systems • Electro-pneumatic modules • Satellite valves • Semi-cryogenic engine combustion chamber • Grid fin for the Gaganyaan project	• With a vision to graduate into system design and development, MTAR has initiated the development of a two stage to low earth orbit small satellite launch vehicle powered by semi cryogenic propulsion with a 1,000 kN thrust booster engine in the first stage and a 100 kN thrust cruising engine in the second stage for a payload capacity of 500 kg with the support of ISRO through IN-SPACe	

Source: IN-SPACe Coffee table-handbook & CII

Representative & Non-exhaustive

Company name	Present capabilities	Plans	Website
Scanpoint Geomatics Ltd. Founded in 1992 in Ahmedabad	• IGiS: An integrated geospatial software platform for GIS, image processing, and photogram metry • Advanced geo-analytics using AI/ ML • Seamless experience: Web, mobile, and global-scale 3D data support compliant to OGC and other global standards • IGiS-based frameworks for industry verticals, such as urban and smart cities, agriculture and forest; land records; disaster management; utilities geology and mining; and water resources, • Spatial data infrastructure, etc. • End-to-end geomatics solution provider	• IGiS-based cloud native solutions, such as geospatial platform as a z service, geospatial framework as a service, mobile CIS as a service; and geo-enabled agri-tech platform	
Tata Advanced Systems Ltd. Founded in 2007 in Hyder-abad	• Assembly, integration, and testing various satellites for ISRO • Satellite components, such as metallic/ composite parts for satellites and launchers • Ground stations, such as mobile telemetry systems for LCA, and modern air defence command and control systems	• Providing end-to-end satellite-based solutions to India and globally	
Walchand-nagar Industries Ltd. Founded in 1908 in Mumbai	• Manufacturing facilities and skilled team, coupled with 5 decades of expertise in manufacturing solid metallic Rocket Motor Cases (RMC), nozzles, and subsystems for launch vehicles • Testing labs, ND examination and data acquisition; tool room • Exclusive proof pressure testing facilities for RMC segments for PSLV, GSLV MKIVIII, SSW and human-rated LV • Developed subsystems for crew escape system for Gaganyaan	• Composite rocket motor casing and nozzle hardware • Huge capital expenditures for increased production rate	

Source: IN-SPACe Coffee table-handbook & CII

Indicative list of start-ups

Representative & Non-exhaustive

Company name	Present capabilities	Plans	Website
AgBoost Tech Consultancy Founded in Noida	• Offering geospatial technology and predictive data analytics services to the agriculture and utility industries • AI-powered agriculture health monitoring and climate resilience solution • Land cover digitisation powered by AI (HD vector map) • Agricultural drone and IOT services (precision AgTech) • Design and build automation solutions for the agriculture and utilities industries	• A new innovation in the integration of IOT devices and satellite images by intervention of AI/DL agriculture solutions, such as soil moisture and depth analysis of up to 120 cm • IOT leasing services for commercial enterprises and carbon trading • A real-time AUML-based method for monitoring subsurface water • Introduction of a space application into a digital twin • Design and development of agriculture satellites in collaboration with ISRO • Satellite-based assets tracking system	
Agnikul Cosmos Pvt. Ltd. Founded in 2017 in Chennai	• Ability to design and manufacture single piece 3D printed rocket engines. Only company in India to successfully test semi-cryo 3D printed engines at VSSC. First private company to establish launchpad in SDSC SHAR. Inhouse facility that allows end to end manufacturing of two rocket engines per week. Inhouse capabilities to develop launch vehicle flight software end to end. Inhouse facilities to test semi-cryo engines upto 40 kN thrust	• Launch contract to launch within two weeks' timeframe. • Launch ability to launch from multiple launchpads in the country • 30−300 kg at same price per kg	
Astrome Technologies Pvt. Ltd. Founded in 2015 in Bangalore	• Mobility satellite terminal for Ku and C bands • Ka- and W-band frequencies • User and gateway terminals for low earth orbit • (LEO) and Medium Earth Orbit (MEO) satellite • Constellations • Very high throughput inter-satellite data links in V-band	• Signal Intelligence (SIGINT) airborne and space-borne solutions • Electronic Intelligence (ELINT) airborne and space-borne solutions	

Source: IN-SPACe Coffee table-handbook & CII

Representative & Non-exhaustive

Company name	Present capabilities	Plans	Website
Azista Bst Aerospace Pvt. Ltd. Founded in 2019 in Ahmedabad	• AFR: Wide Swath Satellite (4.6m GSD and 60km swath) • Small satellite bus: LEOS 50 for 40 kg to 100kg class satellites • Nanosatellites buses: Azista - X Series from IU to 27U • Satellites and sub-systems: Mass manufacturing • Data processing and data analytics as a service	• Azista Vista: Wide swath maritime • satellites - 5m GSD, 150 km swath and - 5m GSD, 600 km swath • Azista fine view: Submeter electro — Optical satellite (0.67m GSD, 10km Swath) • Azista ultra view: C — Band Synthetic Aperture Radar (SAR)	
Bellatrix Aerospace Founded in 2015 in Bangalore	• Advanced electric propulsion • High-performance alternative green propulsion • In-house production and test facilities • Short lead times	• Establishment of world's largest spacecraft and propulsion manufacturing facility • Full-range of technologies for in-space mobility • Revolutionary business model for space of satellite-as-a-Service (SaaS) • Last-mile in-space connectivity	
Dhruva Space Founded in 2012 in Hyderabad	• Building satellite platforms and subsystems. • Launch facilitation and development of separation systems. • Development and operation of satellite Earth Stations. • Design and development Of Space-grade Solar Arrays	• Enabling rapid constellation deployment across diverse space missions.	
Digantara Research and Technologies Founded in 2018 in Bangalore	• Ground and space-based sensing capability • Sensor fusion for increased accuracy • Data agnostic processing engine • Common operational picture for comprehensive awareness	• Dedicated satellite constellation for space-based sensing • Multi-modal data pool for increased data accuracy and latency • 50+SSA based analytics across the value chain	
Galaxeye Space Solutions Pvt. Ltd. Founded in 2020 in Chennai	• Expertise in data fusion of EO and SAR from aerial and satellite imagery • Drishti sensor for low altitude imaging • In-house SAR development capabilities • In-house satellite bus development capabilities	• Very high-resolution satellite imagery • Near real time capture to deliver fused dataset • Edge computing on the satellite • On-demand tasking around the globe	
InspeCity Founded in 2022 in Thane, Maharashtra	• Cubesat propulsion systems • Microsat propulsion systems • Rendezvous and proximity operation systems • Thrust stands	• Satellite (individual and constellation) deployment • End-of-life deorbit • Refuellable propulsion systems • Mission extension	

Source: IN-SPACe Coffee table-handbook & CII

Representative & Non-exhaustive

Company name	Present capabilities	Plans	Website
Kawa Space Founded in 2019 in Bangalore	• Powerful software platform to combine AIS, SAR, and RF geo-intelligence • Monitoring S & X Navigations radars to track any vessel activity • Dark vessel identification using data fusion and AI • Deployment-ready solutions for IUU fishing, decarbonising maritime transport, and global maritime logistics monitoring End-user query processing within milliseconds	• 18 satellite RF constellation to provide frequency mapping from 30 MHz to 18 GHz • Near-real-time visit to any location • Area domain awareness toolkit - SIGINT, ELINT, and MDA as a service - Age of data as low as 30 min - Millions of square kilometres covered in each scene/capture - Emitter location accuracy of <100m	
Kepler Aerospace Founded in 2018 in Bangalore	• Satcom equipment capable of TX up to C band and RX up to X band; to be used in remote ground stations for operations • Offering ground stations as a service through the Kepler united satellite command centre backend infrastructure • Developed long-range UHF TTC, UHF beacon for spacecraft, multi-band SDR-based TX/RX, and micro space grade GNSS for small satellites • Satellite subsystems, such as communications systems, ADCS, GNSS receivers, and satellite systems engineering	• Formation flying spectrum monitoring ELINT satellite constellations monitoring 90 MHz — 3 GHz; and data link through SIX band • EO satellites and satellite constellations for persistent intelligence, surveillance, and reconnaissance • Ultra-ruggedised GNSS solutions for satellite, drone, and high-resolution applications • Encrypted high-reliability high data rate transceivers and data links • Intelligence, surveillance • Intelligence as a service • Reconnaissance data-as-a service	
Manastu Space Technologies Founded in 2017 in Mumbai	Developing green propulsion system for satellites, including: • High-performance fuel − A new hydrogen peroxide-based fuel with additives to enhance performance • Reliable and efficient engine − A new combustion chamber for fuel • Ultra-high temperature catalyst − This catalyst faces 1400 degree Celsius, making it the world's most cutting-edge catalyst	• In-space refuelling • Life extension services • De-orbiting services	
Paata Navigations Pvt. Ltd. Founded in 2021 in Indore	Digital addressing • Geo tagging solutions for logistics and delivery companies • Drone delivery solutions (API)	• Augmented reality on maps • Location intelligent solution by predictive proximity	

Source: IN-SPACe Coffee table-handbook & CII

Representative & Non-exhaustive

Company name	Present capabilities	Plans	Website
Pixxel Founded in 2019 in Bangalore	• Pixxel is a space data company, building the world's first constellation of hyperspectral earth imaging satellites and analytical tools to mine insights from that data. • The constellation is designed to provide global coverage every 24 hours, with the aim of detecting, monitoring, and predicting global phenomena. • It is the first Indian company ever to launch a commercial private EO satellite. • It has launched three fully functional demo satellites in orbit with sample imagery being beamed down regularly.	• Hyperspectral satellite imagery: Building the world's highest resolution hyperspectral satellite constellation at 5m spatial resolution (2504 bands of information at a 24-hour refresh rate). This provides 50x more information than existing satellites in orbit. • Geospatial analytics platform: For • rapidly deployable use cases, a sand-box environment for developers to build automated workflows to gener-ate relevant insights.	
SatSure Analytics India Pvt. Ltd. Founded in 2017 in Bangalore	• Monitoring one million+ sq. km every week • SatSure sage: It is an agricultural loan lifecycle risk management product suite through which we have enabled more than 2 million farmer loans. • SatSure Sparta: It is an application and API-ready remote sensing data products platform for AgTech and climate tech. Through this platform, we have classified 18+ crops and monitored 300+ districts in India alone. • SatSure skies: It is a high-resolution satellite imagery change detection product suite for infrastructure, power utilities, renewable energy, oil and gas and aviation. Four patents were filed, and two patents were received for remote-sensing data products. • SatSure Cygnus: It is an all-weather vegetation monitoring data product that reconstructs optical satellite data from Synthetic Aperture Radar (SAR) data. • A farm scoring patent was received that uses satellite imagery and Al to create land scores for crop loan underwriting.	• KaleidEO: It is a subsidiary of SatSure, where they plan to launch a fleet of four high-resolution, optical, multispec-tral satellites. • An innovative Al-on-the-Edge processing capability will drive satellites. • Expanding business opportunities across North America, Latin America, Africa, and Asia Pacific	
Space Kidz India Founded in 2012 in Chennai	• Nanosatellite bus manufacturing • Hosted payload platform • Ground station tracking • Complete nano satellite subsystems	• Micros-satellite buses • Higher orbit capabilities with on-board propulsion • Mission to lunar orbit • Space rikshaw	

Source: IN-SPACe Coffee table-handbook & CII

Representative & Non-exhaustive

Company name	Present capabilities	Plans	Website
The Spacelabs Founded in 2021 in Trivandrum, Kerala	It has software products that cater to the aerospace industry • ASTRA - Aerospace trajectory optimiser • SARAS6 — Simulator for aerospace applications - 6 DOF • SARAS6-RT- Simulator for aerospace applications -6 DOF real-time ASTRA	• ERP-based data management and big data analytics for the aerospace industry	
Skyroot Aerospace Founded in 2018 in Hyderabad	Flight proven avionics, solid propulsion, structures, thermal, aerodynamics, trajectory, navigation, and control systems • Proven suborbital space launch capability • Composite launch vehicles • 3D-printed cryogenic and earth storable engines • AI and ML based indigenous software development	• Regular orbital launches • Assembly to launch in 72 hours • Modular upgrading of launch vehicles • Establishment of world-class integrated manufacturing, testing, and qualification • Facility interplanetary missions	
Tathya **Founded in 2019 in Mumbai**	Current set of products: • Monitoring mining production open pit mines	Flood monitoring • Deforestation • C02, SOx, NOx emission monitoring • Commodity price forecasting • Supply chain risk management	
Transcend Satellite Technology Founded in 2019 in Bengaluru	• Payload development • Communication payloads based on SDR and IOT • Quantum encryption payload for satellite communication • Earth observation payload design for flood monitoring • End-to-end satellite design (ICJ to 270; 100-200 Kg satellites) • Student satellites (IUt03U) • Student CubeSat kit for training and workshops • 12U cube satellite design with deployable solar panels	• Constellations of Earth observation satellites for military, defence, and social purposes • Design satellites for Earth health monitoring • Satellite to demonstration secure quantum communication	
Xovian Aerospace Pvt. Ltd. Founded in 2018 in Bangalore	• RF-based nano satellite • RF monitoring payload 100MHzto 18 GHz • Satellite bus and subsystems	• Satellite constellation • GEOINT and SIGINT decision intelligence platform • Full-scale spectrum monitoring	
YADS Technologies Pvt. Ltd. Founded in 2017 in Bangalore	• Aircraft and UAVs mission planning satellite communications analysis • Telemetry, Tracking and Communication (TT&C) • C41SR • GIS solutions • Artificial Identification System (AIS) • Space Situational Awareness (SSA)	• Equipping India with an indigenous solution in the space sector by establishing an integrated ground station to carry out SSA operations and support space industries with essential data for their space operations	

Source: IN-SPACe Coffee table-handbook & CII

List of abbreviations

Acronym	Definition
AEC	Costa Rican Space Agency
ASA	Australian Space Agency
BOM	Geoscience Australia, Bureau of Meteorology
BSX	Bangalore Space Expo
CAGR	Compound Annual Growth Rate
CII	Confederation of Indian Industries
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DOS	Department Of Space
DSTG	Defence Science and Technology Group
EGSA	Egyptian Space Agency
FDI	Foreign Direct Investment
GDPDC	Geospatial Data Promotion and Development Committee
GIS	Geographic Information System
GKI	Geospatial Knowledge Infrastructure
IIST	Indian Institute of Space Science and Technology
INCOSPAR	Indian National Committee for Space Research
INR	Indian Rupee
INSAT	Indian National Satellite System
IN-SPACe	Indian National Space Promotion and Authorisation Centre
ISRO	Indian Space Research Organisation
ISS	International Space Station
LSA	Luxembourg Space Agency
MOU	Memorandum of Understanding
NARL	National Atmospheric Research Laboratory
NSIL	New Space India Ltd
POLSA	Polish Space Agency
PRL	Physical Research Laboratory
PTSPACE	Portugal Space
RESPOND	Research Sponsored by Department of Space
SAC	Space Applications Centre
SATCOM	Satellite Communications
SSA	Space Situational Awareness
SSC	Saudi Space Commission
TSA	Technology Safeguards Agreement
TUA	Turkish Space Agency
USD	United States Dollar

About CII

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society, through advisory and consultative processes.

CII is a non-government, not-for-profit, industry-led and industry-managed organization, with around 9,000 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 300,000 enterprises from 286 national and regional sectoral industry bodies.

For more than 125 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. CII charts change by working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness and business opportunities for industry through a range of specialized services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes. Partnerships with civil society organizations carry forward corporate initiatives for integrated and inclusive development across diverse domains including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

As India strategizes for the next 25 years to India@100, Indian industry must scale the competitiveness ladder to drive growth. It must also internalize the tenets of sustainability and climate action and accelerate its globalisation journey for leadership in a changing world. The role played by Indian industry will be central to the country's progress and success as a nation. CII, with the Theme for 2023-24 as 'Towards a Competitive and Sustainable India@100: Growth, Inclusiveness, Globalisation, Building Trust' has prioritized 6 action themes that will catalyze the journey of the country towards the vision of India@100.

With 65 offices, including 10 Centres of Excellence, in India, and 8 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with 350 counterpart organizations in 133 countries, CII serves as a reference point for Indian industry and the international business community.

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