Developing the space ecosystem in India: focusing on inclusive growth

October 2022

INDIAN SPACE ASSOCIATION
Bhumandal Se Brahmaand Tak

EY
Building a better working world

Foreword

राजनाथ सिंह
RAJNATH SINGH

सत्यमेव जयते

रक्षा मंत्री
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DEFENCE MINISTER
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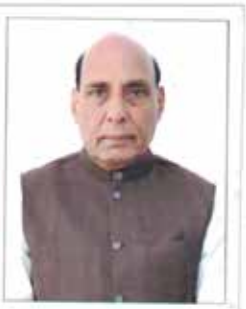

MESSAGE

I congratulate the Indian Space Association on the release of the 'Thought Document' which I am told discusses the aspects related to achieving inclusive growth through space.

The vision of the Hon'ble Prime Minister to address the Space reforms has opened up the space economy which promises a lot of opportunities along with challenges of treading the uncharted territory.

I convey my best wishes to the Indian Space Association in their efforts towards making India a strong space power.

"Jai Hind"

(Rajnath Singh)

Place: New Delhi
Date: 7th Oct, 2022

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अश्विनी वैष्णव
Ashwini Vaishnaw

रेल, संचार एवं इलेक्ट्रॉनिकी और
सूचना प्रौद्योगिकी मंत्री
भारत सरकार
Minister of Railways,
Communications & Electronics and
Information Technology
Government of India

MESSAGE

On the occasion of the first-anniversary celebration of the Indian Space Association, I heartily congratulate the team for their consistent efforts to contribute to manifesting the vision of our Hon'ble Prime Minister.

The launch of the thought document on 'Developing the space ecosystem in India: focusing on inclusive growth' holds a value of great insight. I am sure the book will give us interesting details to have a better understanding of the aspects related to the necessity of a space ecosystem.

Space communications in the future will be a critical co-traveler with terrestrial communication and I am hopeful that both will develop in synergy. The requisites for the same require a first-hand corpus that acts as a directing perspective that aims at inclusive growth.

The report here gives an overview of the research conducted in developing a space-oriented ecosystem that throws light on various areas related to manufacturing, marketing, and application of the satellites and related services. This report also underscores aspects of the Space start-ups investments and skill development in the same domain.

6.10.22

Ashwini Vaishnaw

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Foreword

डॉ. जितेन्द्र सिंह
राज्य मंत्री (स्वतंत्र प्रभार),
विज्ञान एवं प्रौद्योगिकी मंत्रालय,
राज्य मंत्री (स्वतंत्र प्रभार) पृथ्वी विज्ञान मंत्रालय,
राज्य मंत्री प्रधान मंत्री कार्यालय,
राज्य मंत्री कार्मिक, लोक शिकायत एवं पेंशन मंत्रालय,
राज्य मंत्री परमाणु ऊर्जा विभाग तथा
राज्य मंत्री अंतरिक्ष विभाग
भारत सरकार

सत्यमेव जयते

DR. JITENDRA SINGH
Minister of State (Independent Charge),
of the Ministry of Science and Technology,
Minister of State (Independent Charge)
of the Ministry of Earth Sciences,
Minister of State in the Prime Minister's Office,
Minister of State in the Ministry of Personnel,
Public Grievances and Pensions,
Minister of State in the Department of Atomic Energy and
Department of Space,
Government of India

MESSAGE

I extend my heartiest congratulations to ISpA on their foundation day and taking note of their worthy contributions in the space sector of India. I applaud the members for being there as a trustworthy and result-oriented team. The release of the thought document on the occasion of the foundation day celebration, titled 'Developing the space ecosystem in India: Focusing on inclusive growth' undoubtedly speaks of the insightful approach that the team has at its core and is the epicentre of the deliverables by them.

The strategic overview of the Indian Space industry gives an insight into the importance of having a policy framework that captures the best of the capabilities to make India a self-reliant nation in the space technologies sector. The coordination among the various stakeholders can be facilitated through extensive research-oriented models. Technological advancements in the space sector give way to ease of use owing to their diverse applicability hence it becomes of the utmost importance to draft ways and construct frameworks that cater to the need. The requirement of having a sustainable space ecosystem holds wonderful opportunities for all key players in drafting policies and backing the space infrastructure.

The report gives an idea about various aspects of the space domain that hold vital positions in its implementation and covers views and research inputs that can facilitate regulation and give a holistic view of the directions to be followed. The report has highlighted the particulars of the space lifecycle that can usher growth at a sustainable rate.

(Dr. Jitendra Singh)
MBBS (Stanley, Chennai)
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Jayant D Patil

Chairman-ISpA, Member of the Board of IN-SPACe, Member of Executive Council of Management & Advisor (Defence & Smart Technologies) L&T

"I am delighted with what ISpA has accomplished during its maiden year having witnessed a dream launch by the Visionary Prime Minister of India, Shri Narendra Modiji, who believes in the potential the Space Sector holds and that with India's prowess in Tech Services sectors, Scientific Temper & Talent, ability to Innovate and demographic dividend the country is blessed with to take a prominent position in the Global Space Arena. As we celebrate ISpA's first anniversary, I congratulate each member of the ISpA team for their undaunted efforts throughout this year-long journey. It is highly commendable to witness the position of prominence that ISpA has gained to be a thought partner to Dept of Space, Dept of Telecom, ISRO, and regulators such as TRAI, IN-SPACe.

As India entered the "Amrut kal" with eyes focused on India@100, it is in the fitness of things to unfold a "thought document" that takes stock of where we are, what has been accomplished, envision futuristic perspective on the development of the 'Space Ecosystem' and building a position of prominence with the long-term vision at the backdrop of our thoughts. Releasing such a document on the eve of the Association's maiden anniversary reflects our intent to promote global research in policy making and provide thought guidance for actions in various segments of the space sector.

The Space as a business is still in the infancy as far as Indian entrepreneurs are concerned as sectoral policy is still under clearance. Our initiatives and actions at policy advocacy would shape the business models and reach while underscoring enterprise and B2B setups as India awaits to build a significant presence in the global space market. There are underlying challenges to overcome, especially for the start-ups but the Government has resolved to provide these enterprises with necessary policy support and handholding to grow and accomplish their missions.

The report sums up the concerted efforts and inputs gathered from space regulatory bodies as also extensive research pertaining to the domain. The resultant recommendations advocate "adoption in policy framework to take care of the interests of the investors and stakeholders."

Foreword

Lieutenant General Anil Kumar Bhatt (Retd) PVSM, UYSM, AVSM, SM, VSM

Director General, ISpA

My heartfelt best wishes and felicitations to the amazing team of ISpA on the first anniversary, I feel honored to be a part of this exuberant association. It gives me utmost happiness to witness the release of the thought document that unfolds a great vista in the domain of the space technology industry.

The nation beholds a paradigm change which is an outcome of the historical decision of the Honorable Prime Minister to open space to the private sector. The Indian space ecosystem, which was entirely led by Indian Space Research Organization (ISRO), has now transformed itself into an 'ISRO Enterprise' which includes ISRO, private industry, and new startups.

With the scientific legacy of ISRO, the enterprise of our industry, the zeal of our startups, and the resolve of our government, we are sure to create a global class space ecosystem in India.

Taking note of the new Indian Telecommunication Bill 2022, we are sanguine that the aspirations and the interests of our nascent space industry are taken into consideration given the vital role that Satellite Communication will play in meeting the national aspirations of bridging the digital divide, especially in the remotest of geographies.

This report has compiled inputs from the industry and outcomes of the research on satellite space in India. The recommendations quoted through examples can guide the policy directives and hence provide deep insights needed for the decisions to be taken in the future.

Prashant Singhal

Emerging Markets TMT Leader, EY

By connecting the unconnected, space-based communication will be one of the primary mechanisms to narrow the digital divide in India. The sheer reach of satellites and the ability to quickly establish connectivity make it extremely versatile in areas where terrestrial communication is difficult to reach. India's overall tele-density stands at 85.1% at the end of July 2022, with rural tele-density just crossing the 58% mark. Satellite connectivity, in conjunction with a terrestrial communication network, can help to improve tele-density significantly. As we have witnessed globally as well as in India, high-quality broadband connectivity is vital for economic growth and prosperity. Satellite connectivity is key to enhancing digital inclusion by opening-up access to the online world. Today, space-based connectivity is seen as a viable alternative for consumers and businesses alike.

The importance of the space industry in India is ratified in its role in enabling services and applications across several domains, including media and entertainment, weather forecasting, disaster management, agriculture, geological and oceanographic studies, navigation, broadband services, and remote sensing. The opening up of the space economy to private participation across all phases of activities heralds an era of growth, innovation, and accelerated investment in the sector. This is truly game changing. Now is the time for private companies to move up the value chain and catapult India on the space innovation bandwagon.

The satellite manufacturing space offers significant potential for growth, riding on the back of the 'Make in India' initiative and increasing demand for small satellites. Development of spacetech parks will be crucial to build the manufacturing ecosystem and help to improve unit economics of satellite manufacturers by using shared resources and facilities. By 2025, satellite manufacturing will be the second fastest growing segment in the Indian space economy, with launch services growing the fastest. Indian companies have developed considerable expertise around satellite launch solutions. This segment is fast becoming a hotbed of activity for startups and SMEs.

The satellite services and application market in India will be driven by greater demand for high bandwidth and lower latency data requirements, connect the unconnected with voice and data communication services, and increase in IoT and autonomous systems. In addition, an increase in demand for military and defense satellite communication solutions is likely to spur the market forward. From an end-user industry perspective, media and entertainment to account for 26% of the total services market by 2025, followed by retail and enterprise at 21% and Defense at 20%. The remote sensing segment is expected to register one of the highest CAGR through 2025, driven by an increase in resolution of commercially available imagery and adoption of new-age technologies.

Currently, India boasts of over 100 spacetech startups. The year 2021 was a watershed year for spacetech startups, with investments reaching US$68m, a y-o-y increase of 196%. There were a total of 47 new spacetech startups established in India in 2021 alone. Key drivers for investment in the Indian space segment are involvement of private players, lower costs for developing and launching satellites, promise of substantial Return on Investment (RoI) and technological advancement in the space industry.

A conducive regulatory and policy framework will go a long way in building a robust ecosystem. At the same time, promoting ease of doing business is critical for investments to flow in the space domain. For instance, a single window approval process will significantly reduce time for decision making. The overall attractiveness of the sector needs to improve for greater private participation. For this to happen, a collaborative approach and inclusive engagement between the government, regulatory bodies, national and international organization, and other stakeholders is required.

I would like to congratulate ISpA for their contribution to the space industry in India and congratulate them on their first anniversary. I hope this report helps to further shape the dialogue in building the space economy in India and transform the lives of Indians.

About the report

The Indian Space Association (ISpA), in collaboration with EY, developed the report, titled "Developing the space ecosystem in India: focusing on inclusive growth". The report focuses on developing a holistic space ecosystem in India. It covers the outlook of the space economy in India and its potential to accelerate the socio-economic development of the country. It includes the global space economy and its growth drivers. From India's standpoint, the report focuses on the entire lifecycle of the space economy, including manufacturing, ground and launch segment, startups and end-user services. This report also provides regulatory landscape and inputs from industry to propel growth in the Indian space industry.

Methodology

The report is a compilation of industry inputs and secondary research. Members of ISpA have provided key inputs on the satellite space in India. The inputs have been backed by extensive research, analysis, and insights provided by EY. The report substantiates its recommendations through examples and prevalent practices for policymakers to consider.

Key contributors			
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EY report development team: Kaustav Bandyopadhyay, Parul Malhotra, Vikash Kukreti

Four pillars for growth in the space ecosystem

Hon'ble Prime Minister of India Shri Narendra Modi's Vision – "India is introducing pioneering space reforms which will provide an opportunity for both industry and academia. Time has come for private and public sector should emerge and fly. India in its 75th year of independence has opened the private sector as a gift to India. In this sector, after many reforms suggested, this initiative has been launched. In a short time ISPA has been conceived and launched. All stake holders are attending this today. This will make a difference to the poorest person in the country. The enthusiasm toward this initiative is remarkable, and I am looking forward."

"Hope space and telecom sector reach out to remote areas where digital technologies could not reach via conventional methods **- Ashwini Vaishnaw, Minister of Railways, Communications and Electronics & Information Technology**

"Advances in technology on both ground and space segment specially through high satellites and low Earth Orbit (LEO) and Medium Earth Orbit MEO satellites, are able to provide solutions for many applications, be it low latency, higher bandwidth and enhanced speeds. These features can be leveraged for social economic benefits across multiple sectors" **– K Rajaraman, Chairman DCC & Secretary (T) Department of Telecommunications, Ministry of Communications**

"There is a need, more urgent than before, to go for policies which attract investment, allow use of space technology for common man and ensure flexibility and ease of doing business" **– PD Vaghela, Chairman, Telecom Regulatory Authority of India**

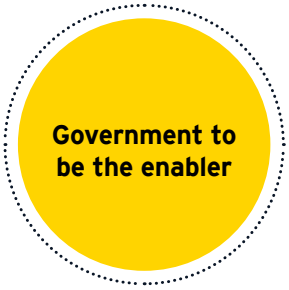
"We have to work through ISpA and other bodies on how we can enhance capital adequacy to all SMEs, skill development and research with academic institutions to create our own intellectual property" **– Chirag Doshi, MD & CEO Walchandnagar Industries**

"ISpA should engage further with students, start-ups, academia, engineering and research institutions, think tanks in order to spread awareness, skills and build a human resource pool of a wider nature and not get tied down in silos" **– Dr. Jitender Singh Ministers of State (IC) of Earth Sciences, Science and Technology, Minister of State of Atomic Energy, Space, Prime Minister Office, Personnel, Public Grievances and Pensions**

"Over the last six to seven years, there is no degree or competency in systems engineering — which is very important in producing complex space systems. We need to build in experimentation and failures as part of growth strategy" **– Mr. Lakshmesh B, Head Missiles & Aerospace, L&T**

"Advances in technology in ground and space segment both specially through high through put satellites and low LEO and MEO satellites are able to provide solutions for a large number of applications be it low latency, higher bandwidth and enhanced speeds. These features can be leveraged for social economic benefits across multiple sectors" **- K Rajaraman, Chairman DCC, & Secretary (T) Department of Telecommunications, Ministry of Communications**

"Hope space and telecom help to reaching out to these sections and remote areas where conventional methods could not take digital technologies" **– Ashwini Vaishnaw, Minister of Railways, Communications and Electronics & Information Technology**



"The present regulatory regime needs to be made conducive to launch of Indian Satellites and there is a need for as simple licencing framework which needs to be technologically agnostic rather than having separate rules for similar applications based on underlying communication technology" **– Amitabh Kant, CEO, NITI Aayog**

"Request you to work allow us to work jointly with the Ministry of Finance (MoF), Department of Space (DOS) and your office to create an opportunity for small and medium firms (like us) to get access to cost effective capital and potential subsidies for expansion. Similar to those given to other manufacturing industries under Performance Linked Incentives (PLI)." **– Chirag Doshi, MD & CEO Walchandnagar Industries**

"We need to have a clear vision for the next five years which has been laid out by ISRO, INSPACE, NSIL and ISpA... and that is the in the next five years should be amongst the top ¾ players in the global space domain" **– Col HS Shankar, Chairman & MD, ADTL**

"Hon'ble Prime Minister of India has initiated a three-pronged initiative to transform India into a strong space economy Set up of INSPACe to perform the regulatory and monitoring functions, on policy front– many initiatives such as national space policy, segment specific policies related to remote sensing space communication, satellite navigation, human in space, FDI in space, space transport technology transfer etc. Some have been put in the public domain to seek the views of stakeholders and public. The third focus has been to have an industry led body which echoes the voice of the industry – to have an interphase and hence formation of ISPA – a landmark event" **– Dr Jitendra Singh, Minister of State in the Department of Space, Minister of State (Independent Charge) of the Ministry of Earth Sciences**

"Suggestion is to make the satellite cell responsible as a single window for everything related to satellite rather than a single window with multiple agencies behind" **– K Krishna, Senior Manager International Regulatory Affairs, Amazon**

"The DoS can also come up with technology development fund from co-development of technologies which could fuel India's growth as per national strategy"

"I would request the Government of India to open up Department of Scientific & Industrial Research (DSIR) tax exemptions for dedicated aerospace R&D centers" **– Mr. Lakshmesh B H, Head Missiles & Aerospace, L&T**

"Support start-ups for free testing for space products in space and on ground and request government agencies to be anchor customers to space tech start-ups" **– Neha Satak, CEO, Astrome Technologies**

"Request you to please announce the new space comm policy as soon as possible, as it will help tremendously to plan and expand our horizons. Secondly, when a new policy or license comes in, the impact to the people and industry takes time. Also request the government to open the flexibility to all the satellite comm providers to use any frequency band which is available." **– PJ Nath, MD & CEO, Nelco**

"Control regulatory costs – are they fair and are they comparable to global price benchmarks" **– Rahul Vatts, Director OneWeb India**

Source: Inauguration of Indian Space Association ceremony and webinar, October 2021


GSLV MKIII
ISRO
INDIA
DISASTER MANAGEMENT
INDIAN LAUNCH VEHICLES
India developed two experimental satellite launch vehicles, SLV-3 and ASLV
Polar Satellite Launch Vehicle (PSLV) commissioned in 1997
Geosynchronous Satellite Launch Vehicle (GSLV-Mk I) commissioned after its second successful flight in May 2003
GSLV-Mk II will use indigenously developed Cryogenic Upper Stage
GSLV-Mk III is under development

Contents

Executive summary

Today, India stands at the cusp of a technology-led transformation, and the space economy will play a crucial role in making this happen. India has a well-developed space program, boosted by the realization of indigenous technology, facilities, systems, and rollout of services in a systematic manner. The space industry has played a key role across several application areas, including weather forecasting, geological and oceanographic studies, disaster management, and agriculture to name a few. Satellite broadcasting services have been the mainstay of the Media and entertainment industry in India, benefitting a large part of the population.

So far, the space industry in India has been largely under the purview of the government, with limited private participation. Given the advancement in technologies, proliferation of data, and the onset of the platform economy, there is a need for greater private participation and driving further commercialization. Developing a self-sustaining industry model will enhance the attractiveness of the industry greatly.

Satellites have the potential to bridge the digital divide in India. Apart from providing basic connectivity and broadband services, satellite communication is likely to impact various industries in India. For instance, satellites can provide connectivity for teachers and students to access resources in rural and remote areas. The ubiquity of satellite communication, quick access, and cost-effective features make it an attractive proposition in the education sector. Offering digital health solutions in remote areas through satellites is likely to open up nascent opportunities. On the other hand, equipping fishing vessels with satellite-based communication systems will go a long way in disseminating effective information on disaster warning, Potential Fishing Zones (PFZ) and other ocean-related advisories. Further, satellites will play a critical role in the proliferation of the IoT sector and help to realize the full potential of interconnected devices. Hence, the government should promote the significance of satellite-based communication services in the nation's broadband agenda and other-satellite based applications. Holistically, educating the public and other stakeholders about space-based technology and capabilities will invoke a lot of interest.

It is important to adopt globally harmonized policies for space domain systems and satellite services. government of India should implement a light-touch regulatory framework that promotes innovation, investment, and growth, and which protects satellite systems from harmful interference.

A conducive regulatory and policy framework will go a long way in building a robust ecosystem. At the same time, promoting ease of doing business is critical for investments to flow in the space domain. The overall attractiveness of the sector has to improve for greater private participation. Policies should advocate affordability, and efficient and optimal utilization of satellite spectrum, network, and services. For this to happen, a collaborative approach and inclusive engagement between the government of India, regulatory bodies, national and international organization, and other stakeholders is required.

Role of Private Equity (PE)/ Venture Capital (VC) firms may serve crucial for investments in new infrastructure and R&D to make India a space manufacturing hub. In addition, startup incubators focused on the space domain can help to catapult the sector on the innovation domain. Currently, there are over 100 spacetech startups in India. The year 2021 was a watershed year for spacetech startups, with investments reaching US$68m, a y-o-y increase of 196%.

Ultimately, a platform that promotes the development of the entire space ecosystem — design and manufacturing of satellites and payloads, launch vehicles and launch services, ground and space segments, space communications, satellite communication, space-based services, spectrum management and operations, space applications, navigation applications and navigation equipment design and supply — is the need of the hour.

Key considerations for creating an enabling space economy in India

Functional areas	Key considerations
Regulation / policy	▶ Under current framework, regulatory approvals are required from multiple agencies such as DoS, DoT and/or MoIB for the establishment of upstream/downstream space activities. A single window approval process through a nodal body focused on space economy shall aid and ease the process of having in place requisite authorizations that shall further help ease of doing business. ▶ A comprehensive space policy covering upstream and downstream activities will help formulate vision and provide policy predictability to bolster investment climate ▶ The government may permit satellite operators to set-up their own earth stations and deliver services to the license holders who in turn will render service to the end-users ▶ Regulatory framework should evolve to take advantage of the latest technology
Satellite manufacturing	▶ Introduce Production Linked Incentive (PLI) scheme for satellite manufacturing, like mobile handsets and telecom equipment ▶ Satellite manufacturers should be able to access ISRO's testing facilities
Launch vehicles	▶ Promote independent launch solutions of Indian private companies for satellites and other spacecrafts
Access to capital	▶ Facilitate access to cost effective and early-stage capital for startups ▶ More clarity is required on FDI in the space sector
Improve access to technology	▶ The industry should be able to access satellite technology, as cost competitiveness and price are important. ▶ ISRO can act as an enabler for boosting R&D by way of technology transfer, collaborations, and sharing of infrastructure that shall help achieve wider participation from the industry ▶ ISRO can charge a very nominal fee for technology transfer to the industry ▶ Collaboration between ISRO-academia-industry on satellite technology
Skills development	▶ Develop competency of systems engineering for space segment ▶ Conducting training on how to operate satellites skillfully – currently private sector is not running satellites ▶ Need to develop technology associated with special alloy for launch vehicles

Source: ISpA, EY analysis

1

Global space economy to reach US$600b by 2025

The global space economy is primarily driven by a record number of satellite launches, technology innovations, low-cost of manufacturing, evolving end user requirements and growing communication needs. Innovation across the space value chain is driving growth in the space industry. The commercial space economy is set to grow in future amid interest from private players and collaboration with various governments.

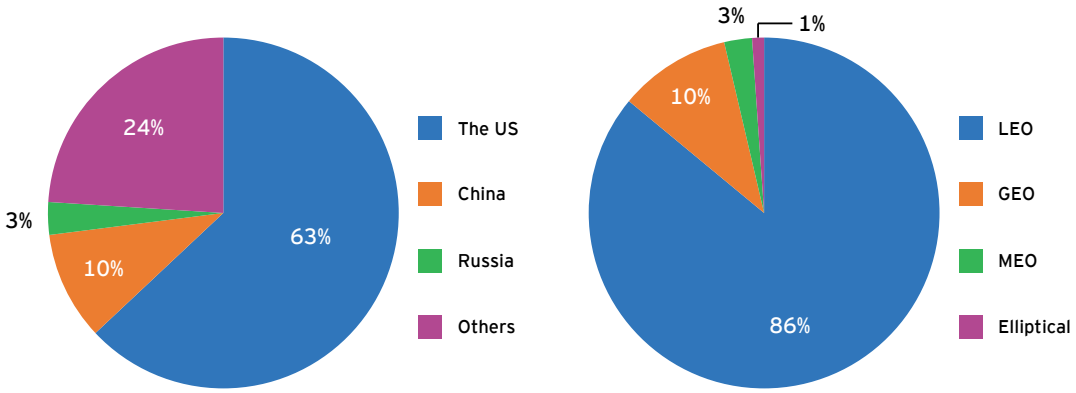
The global space economy in numbers

Global space economy	**US$447b** In 2020
	US$600b In 2025, CAGR of 6% between 2020-25
Ground equipment	**US$163b** In 2020, (36% of space economy)
Satellite services	**US$142b** In 2020, (32% of space economy)
Satellite manufacturing	**US$14b** In 2020, (3% of space economy)
Launch	**US$6b** In 2020, (1% of space economy)
Government space budget and commercial human spacecraft	**US$122b** In 2020, (27% of space economy)

Source: Space Foundation, Satellite Industry Association, EY analysis

The US accounts for the highest proportion of operating satellites; LEO satellites form the majority of operating satellites

Number of operating satellites	**5,465** By the end of Apr'22



Source: Union of Concerned Scientists; Note: Geosynchronous (GEO), Medium earth orbit (MEO), Low earth orbit (LEO)

The satellite ground equipment forms the largest segment of the space economy comprising network equipment (gateways and VSATs, network operations center) and consumer equipment (Sat TV, radio, broadband equipment, navigation). The satellite services segment is witnessing a hotbed of activity owing to the demand for high bandwidth and lower latency, and new services driven by LEO satellites. The rise of small satellites is leading to the adoption of new business models and opening-up revenue streams for the satellite industry. The market is driven by increasing demand for data, broadband, and voice communication services due to rising demand in the consumer services, including direct-to-home (D2H). Several downstream industries increasingly use satellite applications. In addition, there is a rise in demand for high-resolution imagery services in industries such as defense and intelligence, agriculture, transportation, and construction. They use satellite imaging in applications including topographic mapping, natural disaster management, monitoring vegetation, and traffic management.

Most of the satellites manufactured in 2020 (84%) were used for commercial communications. Other applications included remote sensing, military surveillance, and scientific and navigation. Scale economies in manufacturing, lower-cost terminals, and improved capabilities add to an improving supply-side environment. The satellite launch segment is evolving globally and offers an immense opportunity for growth and innovation. More affordable launches, increased choices and capacity have led to a substantial rise in launch activity. In 2020 alone, 1,283 satellites were launched, which is the highest in a year. The increase in the number of satellites is primarily due to the development of the smaller CubeSat, allowing many small-sized satellites to launch at the same time, in contrast to one or two satellites launched at a time earlier. The commercial space launch industry has by far seen the most disruption in the past decade compared to all other areas of the overall space sector. The continued cost declines will further open up new markets expected to attract new companies.

From a regional perspective, the US, China and the European Space Agency (ESA) collectively accounted for approximately 81% of government space spending in 2020.[1] It is not surprising that the US leads in the share of total active operating satellites at 63%.

Changing dynamics of the global space economy

Space segments

Ground segment

Consumer equipment – Sat TV, radio, and broadband; GNSS* stand-alone units and in-vehicle systems

Network equipment – gateways and VSATs

Enablers

- Mega constellations are increasing the demand for ground stations (vertically integrated companies building their own ground stations)
- Increase in Global Navigation Satellite System (GNSS) enabled smartphones, other devices
- Increased on-the-move connectivity
- Broadband and satellite radio installations on the rise
- Integration of terrestrial and satellite networks

1 "Global space economy rose to US$447b in 2020, continuing five-year growth", Space Foundation, July 2021.

Space segments	Enablers
Satellite manufacturing LEO (are closest to users between 300-1,200 miles) MEO (are located between LEO and GEO satellites at 6,300 to 12,500 miles GEO (orbits at 22,236 miles and rotates at the same speed as the Earth's rotation)	▶ Technological advancements are facilitating the miniaturization of electronic components results in reducing the satellite size and mass over time ▶ Advanced manufacturing techniques (e.g., 3-D printing) and use of Commercial-off-the-shelf (COTS) components have facilitated vertical integration, faster production speeds, and cost savings ▶ Increasing demand from civil/government, commercial, and military sectors
Satellite launch US launches – 40%; Non-US launches – 60% 114 orbital launches in 2020	▶ Affordable and more frequent launches; increased launch activity propelled by LEOs (1,322 launched in 2021) ▶ Growth in the small satellites segment has increased demand for smaller and more cost-effective launch vehicles (e.g., re-usable launch vehicles, ridesharing and small launch)
Satellite services Voice communication, broadcasting, and data communication	▶ Increase in IoT and autonomous systems ▶ Greater demand for high bandwidth and lower latency data requirements ▶ Increased focus on SATCOM to overcome constraints associated with traditional transmission system. Minimize digital divide – connect the unconnected with voice and data communication services ▶ Rise in demand for military and defense satellite communication solutions
Satellite applications Remote sensing (agriculture, change detection, disaster mitigation); space-based navigation; geospatial; situational awareness; space infrastructure; security and protection; scientific explorations; astronomy; testing and certification	▶ Improved capability and innovative application of small satellites ▶ Increase in resolution of commercially available imagery ▶ Increased adoption of new-age technologies such as 5G/IoT, smart city proliferation, driver assistance and autonomous vehicles and fleet management to drive satellite navigation ▶ Satellite-based insurance gaining traction ▶ Advanced analytical techniques for better data processing

Source: Satellite Industry Association, EY analysis

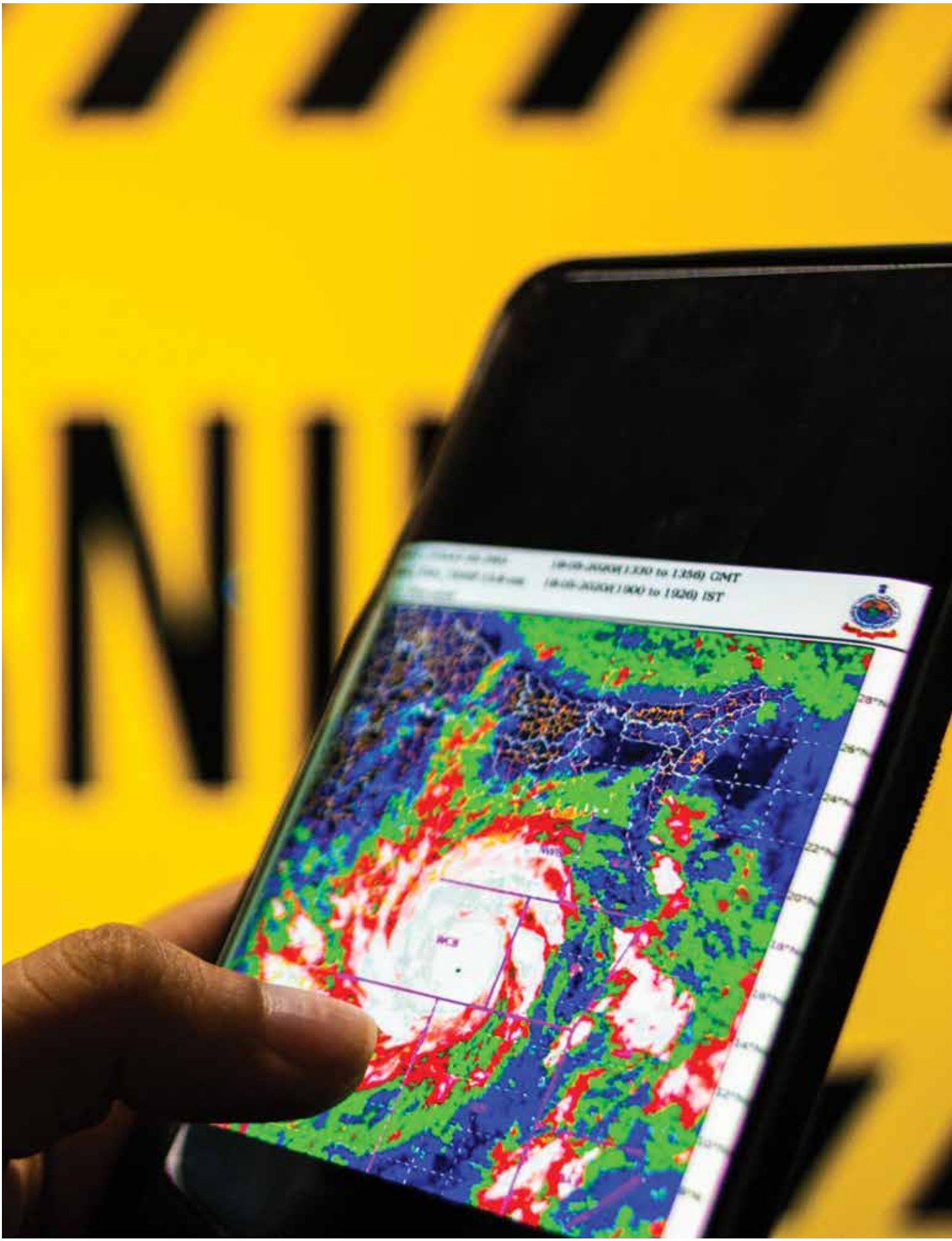
Space for SDGs – driving the sustainability agenda

The United Nations has developed the 2030 Agenda for Sustainable Development to address challenges in the form of 17 Sustainable Development Goals (SDGs) with 169 associated specific targets.[2] The space industry is expected to play a crucial role in achieving the United Nation's Sustainable Development Goals (SDGs).

SDG no.	SDGs	Satellite application areas
1	**No poverty**	Natural disaster forecast; Crop productivity optimization
2	**Zero hunger**	Crop productivity optimization; Livestock management optimization
3	**Good health and wellbeing**	Prevention of vector diseases; Disability assistance; Air quality monitoring; Reduction of air pollution through road traffic optimization; eCall emergency response service; Wearables for health promotion and disease prevention
6	**Clean water and sanitation**	Water quality monitoring; Meteorological forecasting
7	**Affordable and clean energy**	Infrastructure monitoring; Power grid synchronization; Seismic surveying; Solar and wind energy production forecasting
8	**Decent work and economic growth**	Supporting global economies; GDP growth; Lone workers monitoring
9	**Industry, innovation, and infrastructure**	Infrastructure mapping and monitoring; Construction surveying; Smart mobility
11	**Sustainable cities and communities**	Urban planning; Infrastructure monitoring; Improvement of city services; Air quality monitoring; Disaster management; Search and rescue operations
12	**Responsible consumption and production**	Natural resources management; Food and dangerous goods traceability
13	**Climate action**	Climate change monitoring; Disaster management; Search and rescue operations
14	**Life below water**	Mapping and monitoring of natural and protected areas
15	**Life on land**	Bio-geophysical land surface monitoring; Animal tracking

Source: UNOOSA

2 "Space Supporting the Sustainable Development Goals," UNOOSA, https://www.unoosa.org/oosa/en/ourwork/space4sdgs/index.html, accessed 23 September 2022.


(1330 to 1356) GMT
(1900 to 1926) IST

2

Indian space economy - set for accelerated growth

India has a well-developed space program, boosted by the realization of indigenous technology, facilities, systems, and rollout of services in a systematic manner. The space industry has played a key role across several application areas, including weather forecasting, geological and oceanographic studies, disaster management and agriculture, to name a few. Satellite broadcasting services have been the mainstay of the Media and entertainment industry in India, benefitting a large part of the population. India accounted for approximately 2.1% of the global space economy in 2020 amounting to US$9.6b, which was 0.4% of gross domestic product (GDP) in the country.

Indian space segments

Upstream

Satellite manufacturing

Market value (2020/2025)
US$2.1b/US$3.2b

CAGR:8.1%

Launch services

Market value (2020/2025)
US$567.4m/1,046.6m

CAGR:13.0%

Downstream

Ground segment

Market value (2020-2025):
US$3.1b/US$4.0b

CAGR: 6.9%

Satellite services

Market value (2020-2025):
US$3.8b/US$4.6b

CAGR: 4.2%

End users

Maritime

Media and entertainment

Aerospace and defense

Transportation and logistics

Telecom

Agriculture

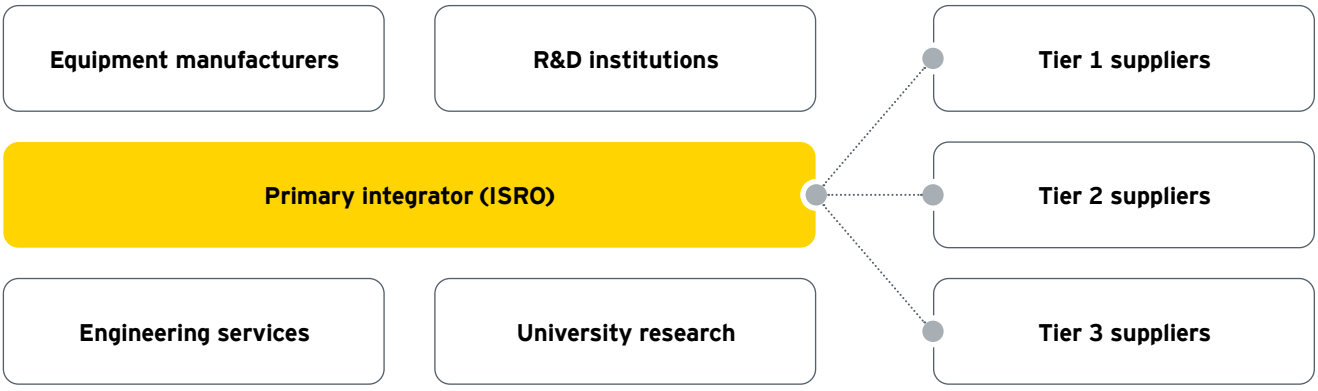
Others

Source: Mordor Intelligence, Allied Market research, EY analysis

Increased participation of private players in the space value chain

In India, the space segment has been largely under the purview of the government. The satcom business is regulated by the Department of Space (DoS) and the Department of Telecom (DoT). ISRO is the primary service provider focused on building rockets and satellites. At the same time, the private sector's participation has been around providing built-to-suit and other manufacturing/outsourced manpower supply tasks in the Tier-2/Tier-3 vendor category. With a steady increase in space missions in the last decade, there is a greater need for private companies to move up the value chain and evolve into full scale satellite/ launch vehicle manufacturers.

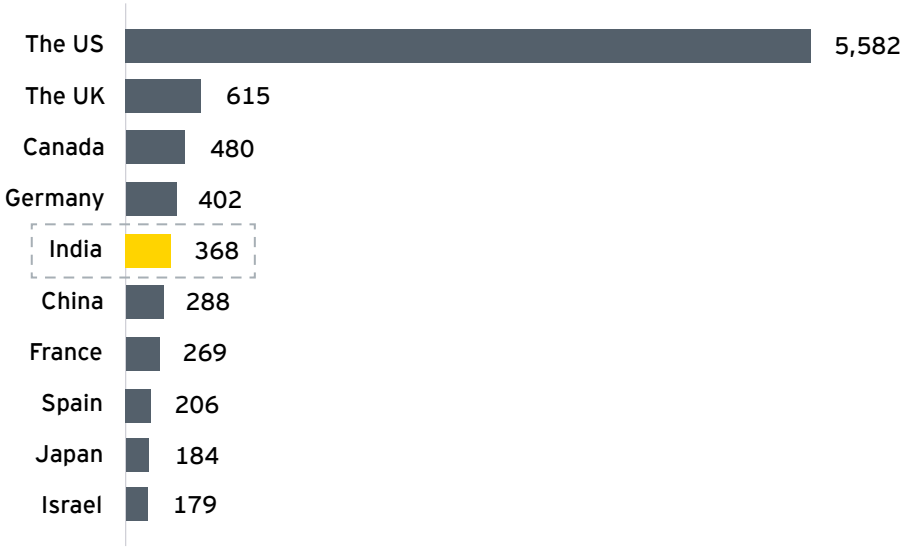
India space infrastructure value chain



Source: "New space in Asia", ESPI, February 2021.

India fares well in terms of spacetech companies. There were a total of 368 spacetech companies in India in May 2021, occupying 5th position among countries globally. This gives tremendous impetus to the space program in India and positions the country for accelerated growth.

Number of spacetech companies by country, May 2021



Source: "SpaceTech industry 2021 / Q2: landscape overview", SpaceTech Analytics, May 2021.

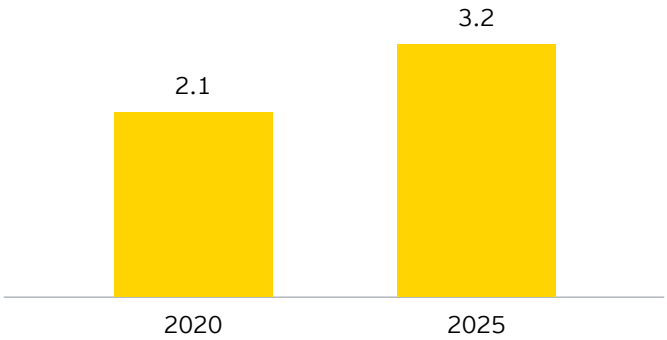
2.1 Satellite manufacturing: Make in India initiative to spur growth

The satellite manufacturing segment has largely catered to contract manufacturing of launch vehicles by the ISRO. Earlier, with a limited number of space missions, ISRO used to provide its Intellectual Property (IP) to the private sector players for getting manufacturing assistance in the form of manpower and machinery. It led ISRO to be the key service provider while the private sector's role was limited to non-IP manufacturing tasks.

With the advent of small satellites, the satellite manufacturing offers huge opportunities to many companies. New age LEO players are showing interest to leverage Indian companies for locally built satellite communications equipment. Foreign companies are looking to reap the benefits of satellite manufacturing services in India. Coupled with the government's 'Make in India' initiative, satellite manufacturers are ideally placed to capitalize on the growing demand for small satellites.

Currently, the Indian space ecosystem is well developed to manufacture the satellite bus system. However, manufacturing of critical payloads (e.g., high precision camera) is very nascent and has not taken off. In addition, testing of satellites plays a very important part in ensuring robustness and longevity. Rigorous testing is required for larger and critical satellites. Currently, the test facilities in India are with ISRO.

Indian satellite manufacturing opportunity (US$b)



Source: EY analysis based on market estimates

Spacetech parks to provide impetus to satellite manufacturing in India

Setting-up space parks across the country is likely to give a fillip to companies operating across the space value chain, especially manufacturing. It will be key to attracting global startups working in the space sector and help to incubate spacetech companies in India. Space parks will provide a ready ecosystem for SMBs and startups focused on component and sub-component of satellite manufacturing. In addition, space parks can significantly improve the unit economics of satellite manufacturers by using shared resources and facilities. Apart from satellite manufacturing, space parks can be a breeding ground for companies in the satellite application space. It will help to come-up with new business cases in the downstream segment and identify revenue generating potential.

Case study in Indian space – Ananth Technologies

Company	Overview	Offering
Ananth Technologies	Founded in 1992, Ananth Technologies manufactures critical aerospace systems and offers high-value geospatial services.	Ananth provides electronic systems engineering and manufacturing with both build-to-print and build-to-spec approaches.

Differentiator

In June 2022, Ananth Technologies launched India's largest private spacecraft manufacturing facility in Bengaluru. It is a 15,000 sqm facility containing four independent modules. The facility is located at the Aerospace Park of the Karnataka Industrial Areas Development Board. All the four components of the facility can perform end-to-end integration of processes in four different spacecraft classes.

Source: Ananth Technologies website, "India's first private spacecraft manufacturing facility launched in Bengaluru," The Hindustan Times, 2 June 2022.

Case study in Indian space – Azista-BST Aerospace

Company	Overview and offering
Azista-BST Aerospace	The company is a Joint Venture (JV) between Azista Industries (Azista) and Berlin Space Technologies GmbH (BST). The JV is developing a facility in Ahmedabad to manufacture small satellites in 50-150 kg range. The facility is expected to have an annual production potential of ~250 satellites.

Source: Azista-BST website

2.2 Space launch market – private participation is set to increase

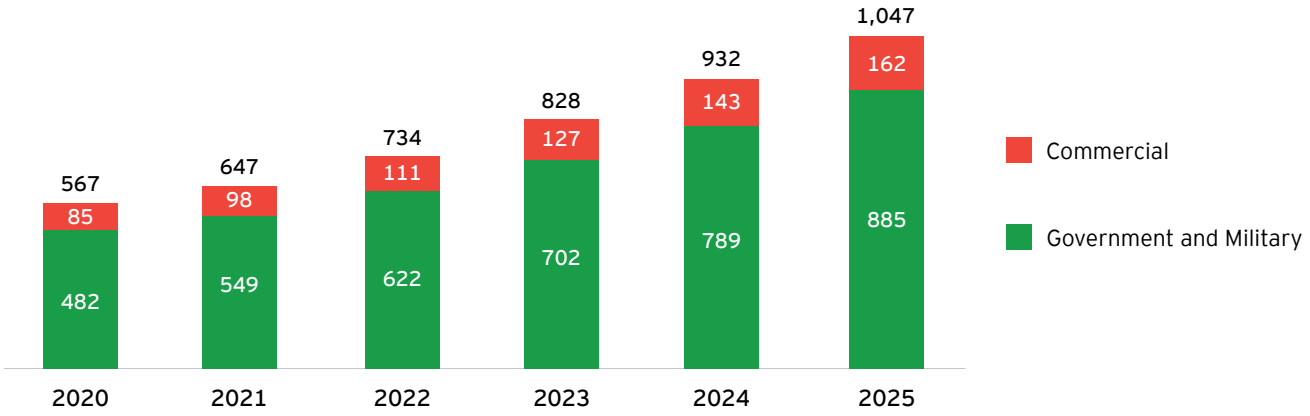
Over the years, India has become a leader in third-party launch services. India boasts of one of the highest launch success rates in the world for Polar Satellite Launch Vehicle (PSLV). During 2014 to 2019, ISRO generated more than US$167.5m revenue by the launch of satellites from 26 countries[3]. India launches satellites for nations such as the US, Canada, the UK, Germany, and Singapore.

India stands at the cusp of a technology-led transformation. Several companies are utilizing cutting-edge technologies to develop innovative solutions in the space domain. As such, supporting independent launch solutions of Indian private companies for satellites and other spacecrafts is in line with the 'Atmanirbhar Bharat' vision. They have built considerable expertise around the launch of LEO, MEO, and GEO satellites and orbit management solutions. The launch segment is fast becoming a key focus area for startups and small and medium businesses (SMEs) in India to drive the innovation agenda and make use of new revenue opportunities.

Emerging technologies such as reusable launch vehicles, two-stage-to-orbit (TSTO) rocket launch vehicle that provides propulsion consecutively, semi-cryogenic engines, etc., are compelling mechanical engineering industries to relook existing business streams and diversify into new avenues in the space domain.

The Indian space launch services market will grow owing to economical launch services, rise in navigation satellites, and increasing demand for communication satellites. Also, Indian companies are putting efforts to make the country as a hub for small satellite launch. ISRO is also showing interest in the small satellite market as it is building a small rocket with a capacity to transport satellites 500 to700 kg to LEO.

India space launch services opportunity (US$m)



Source: Allied Market Research

Entry of private players will lead to more innovation in the space industry

Indian space launch is expected to get a boost due to the government's positive step towards the inclusion of private players in the Indian space ecosystem. The entry of private players will only help the industry to become competitive. The availability of low-cost satellite launch vehicles coupled with mass production will lead to demand from the customers around the world. Indian private companies are looking to exploit the space industry by using innovative technologies.

3 Proposed satellite launch raises 'Swadeshi' lobby's eyebrows, The Sunday Guardian, 20 February 2021

Case study in Indian space - Skyroot

Company	Overview	Offering
Skyroot Aerospace	Founded in 2018 by former ISRO engineers, it is an Indian aerospace company looking to develop economical launch vehicles	Manufactured a 3D printed Cryogenic rocket engine capable of running on Cryogenic propellants liquefied natural gas and liquid oxygen.

Differentiator

In comparison to conventional manufacturing of rocket engine, Skyroot **showcased 100% 3D-printed bi-propellant liquid rocket engine injector helping to lower the mass by 50% with a decrease in the total number of components and a reduction in lead time by 80%**

Source: "Start-ups to drive India's quest for a chunk of small satellite launch pie", Business Standard, 9 March 2021; "Top 10 Space Tech start-ups in India", VCBay, June 2021.

Case study in Indian space – Bellatrix Aerospace

Company	Overview	Offering
Bellatrix Aerospace	The company works on advanced rocket propulsion and in-space propulsion systems.	Developed electric propulsion systems – Hall Effect thrusters

Differentiator

In May 2021, the company has successfully tested India's first privately developed hall-effect thruster, an electric propulsion engine for micro satellites weighing 50-500 kg. The new thruster will provide a reliable propulsion solution to small satellite manufacturers.

Source: "Bellatrix Aerospace successfully tests India's first privately developed hall-effect thruster", The Economic Times, May 2021.

Case study in Indian space - Agnikul

Company	Overview	Offering
Agnikul	Founded in 2017, Agnikul is an Indian spacetech start-up based in National Center for Combustion R&D of IIT Madras, Chennai.	Aimed to develop and launch its small-lift launch vehicle 'Agnibaan' by 2022

Differentiator

Agnikul launched the world's first fully 3D rocket engine, the 'Agnilet' a semi-cryogenic rocket engine. The entire rocket engine is 3D printed from top to bottom and can directly be used in the rocket. It was India's first space start-up that entered into an NDA with the DoS, Department of Space under the newly established Indian National Space Promotion and Authorization Centre (IN-SPACe).

In July 2022, Agnikul opened a private rocket engine factory in Chennai. The company planned to use additive manufacturing technology to build 3D printed rocket engines. It will primarily be used for its own in-house rockets.

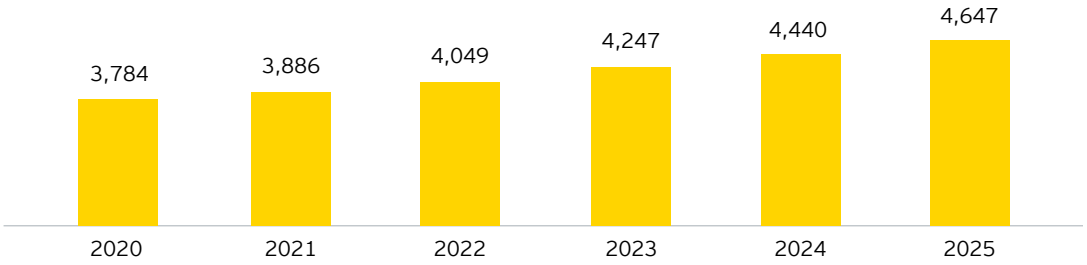
Source: "Top 10 Space Tech start-ups in India", VCBay, June 2021; "Spacetech start-up Agnikul Cosmos builds Made-in-India 3D printed rocket engine, Agnilet", Yourstory; "Agnikul Cosmos opens India's first private rocket engine factory in Chennai", Mint, 13 July 2022.

2.3 Satellite services and applications

Today, satellites have the potential to bridge the digital divide in India. Apart from providing basic connectivity and broadband services, satellite communication is likely to impact various industries in India. For instance, satellites can provide connectivity for teachers and students to access resources in rural and remote areas. The ubiquity of satellite communication, quick access, and cost-effective features make it an attractive proposition in the education sector. Offering digital health solutions in remote areas through satellites is likely to open-up nascent opportunities. Further, satellites will play a critical role in the proliferation of the IoT sector and help to realize the full potential of interconnected devices. The government should promote the significance of satellite-based communication services in the nation's broadband agenda and other-satellite based applications. Holistically, educating the public and other stakeholders about space-based technology and capabilities will invoke a lot of interest.

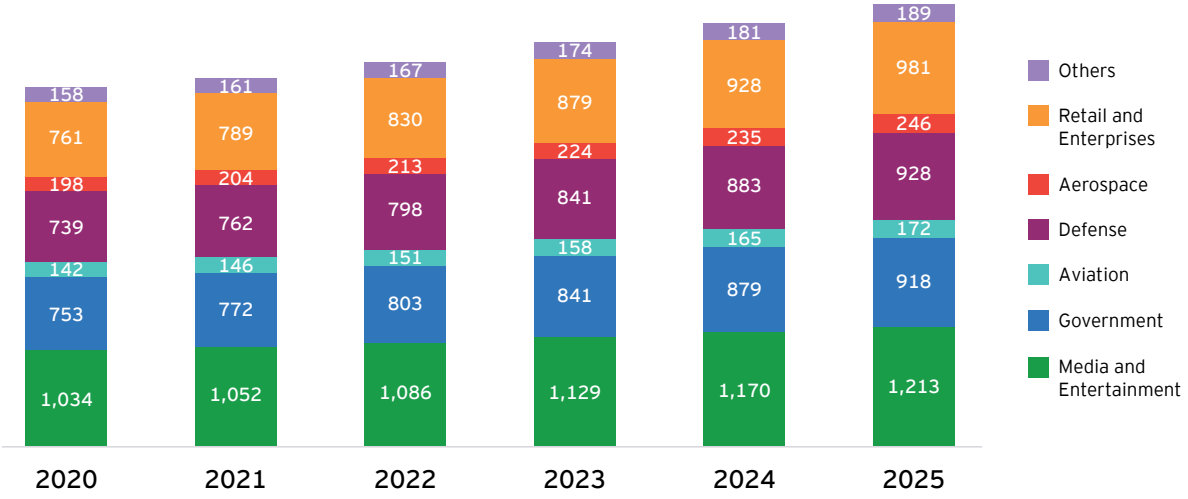
India is looking to leverage the satellite communication technology across various industries for multiple applications. For example, for monitoring the national/state borders, the technology assists the security and defense forces. Due to the rising national threat from ocean and land, the adoption of satellite communication is accelerating in the country for mitigating the threat. In March 2021, ISRO launched the Sindhu Netra satellite to monitor and track the movement around the Indian Ocean region.

India satellite services and application market (US$m)



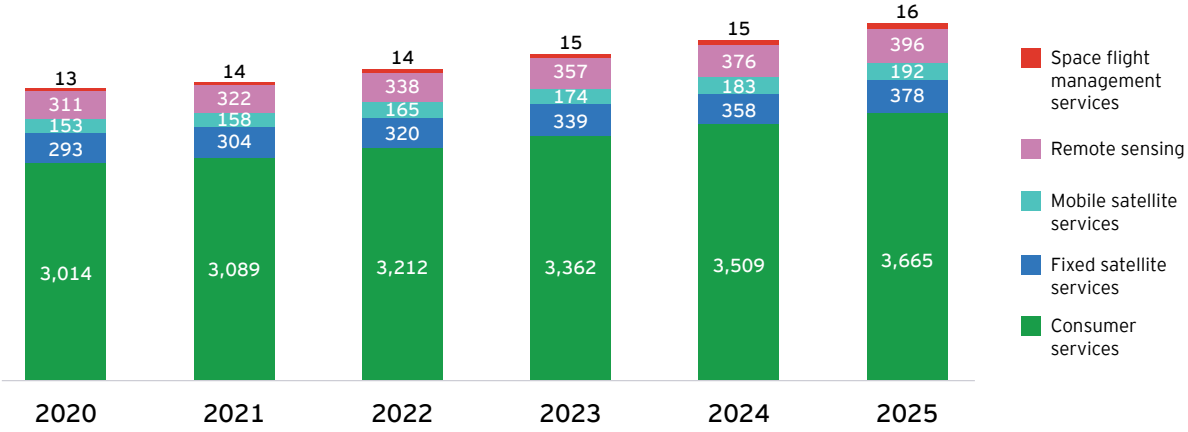
Source: Allied Market Research

Indian satellite services market by end-user industry (US$m)



Source: Allied Market Research

India satellite services market by type (US$m)



Source: Allied Market Research

Various satellite services and use cases

Services	Brief description	Services	Brief description
Consumer services			
Satellite TV	Transmitting video channels that are received by Direct Broadcast Satellite (DBS) or Direct-to-Home (DTH) companies. These companies leverage satellites to provide TV channels directly to the homes of service provider subscribers.	**Satellite broadband**	Satellite broadband offers network connectivity via low-earth-orbit or geostationary satellites. It provides services including voice over internet protocol (VoIP), high-definition TV (HDTV), and video on demand
Satellite radio	Satellite radio providers can use the service to broadcast audio channels to customers.	**Connectivity in remote areas**	Mobile satellite providers have the capability of providing vast coverage for mobile/broadband services particularly for people where terrestrial mobile network becomes inaccessible.
Fixed satellite services			
Transponder agreements	customers lease bandwidth capacity by a satellite operator, as the transponder leasing agreement transmit data from ground fixed station to end-user location.	**Managed network services**	These services are provided for multiple industries including maritime, aviation, enterprise, government, and telecom. It includes network interconnection, terrestrial connectivity, satellite terminals, and a management portal and APIs for service providers and customers.
Mobile satellite services			
Video	Satellite networks have the capability of offering video communications services to the land, aviation, maritime and M2M (machine to machine) markets.	**Voice**	Satellite networks have the capability of offering voice communication services to the land, aviation, maritime and M2M (machine to machine) markets.
Data	Satellite networks have the capability of offering data communications services to the land, aviation, maritime and M2M (machine to machine) markets.	**Tracking and monitoring**	Satellite communications help in monitoring and tracking of movement of goods (goods, oil and gas travelling by sea). Ocean surveillance is one the services provided by the satellite communications.

Services	Brief description	Services	Brief description
Remote sensing			
Aerial services and digital mapping	By using satellite imagery and client-provided geospatial data, data-rich maps are produced for various industry applications such as agriculture, disaster management, energy, and environmental monitoring	**Reconnaissance and intelligence missions**	Photographs captured using satellite and imagery are leveraged by government for various intelligence purposes and other defense applications.
Weather and terrain mapping	Satellites helps in providing surveillance observations of the Earth's surface by leveraging visible spectrum photographs and infrared imagery to observe atmospheric moisture and cloud. It allows monitoring of weather conditions.	**Agricultural monitoring and management**	Satellite remote imagery is being leveraged by farmers and ranchers for monitoring crop conditions to predict crop yields and soil moisture for irrigation management.
Disaster management	Satellites helps in offering various relevant information/observations of a natural disaster. This assists in better management and planning of a calamity. Satellite communication along with navigation systems play a critical role in disaster management.	**Border mapping**	Satellite imagery is used for the demarcation of states/nations boundaries helping in resolving border disputes.
Oceanography	By leveraging satellites, researchers can study the ocean. Also, data captured using satellites provide information on sea surface temperature, ocean colour, coral reefs, and lake ice. Data collection systems are used by satellites to relay signals by transmitters on the ground –used in applications including measuring tidal heights and the migration of whales.	**Meteorology**	Meteorological satellites offer a way of gathering weather data to accelerate ecosystem models. Meteorological satellites offer estimates of surface temperatures.

Source: EY analysis

Advancements in technology is driving new satellite services

Services	Brief description
IoT	Satellite IoT provides organizations with the capability to monitor and track their assets. Combining satellite technology with terrestrial IoT will be key for enterprises to ensure connectivity to their assets, no matter where they are.
Cybersecurity and data protection	Satellite companies provide cybersecurity and data protection services to protect confidential data by leveraging the communication satellite services.
Remote education / learning	Satellites are being leveraged for providing virtual education/learning experiences to children. During the Covid-19 outbreak, ISRO committed to provide satellite TV classrooms for rural India. It helps in bridging the gap in the rural parts of the country. As satellite classrooms offset the need for laptops, smartphones, or the internet for virtual classroom, it helps in overcoming the challenge faced in attending online classes.

Satellite navigation – growth in the position, velocity, and timing (PVT) services

ISRO offers satellite-based navigation services for meeting the demands of civil aviation along with the user needs for positioning, navigation, and timing based on satellite navigation system. For civil aviation needs, ISRO works in collaboration with the Airport Authority of India (AAI) for developing the GPS Aided Geo Augmented Navigation (GAGAN) system. For the consumer market, navigation and timing services, ISRO is working to set up a regional satellite navigation system known as the Indian Regional Navigation Satellite System (IRNSS).

IRNSS will provide position information offering to users in the country in addition to covering region extending up to 1500 km from its boundary. It will primarily offer two types of services: 1) Standard Positioning Service (SPS) – offered to all the users; 2) Restricted Service (RS) - an encrypted service for authorized users only.

Due to the rapid growth witnessed in the applications relying upon the position, velocity, and timing (PVT) services offered by space-based navigation systems, the Department of Space (DoS) is looking to draft a comprehensive plan for the satellite-based navigation system. As of now, globally, there are four Global Navigation Satellite Systems (GNSS) providing PVT services: GPS from the US; GLONASS from Russia; Galileo from European Union, and BeiDou from China. Also, NAVIC (operational name of the IRNSS) and QZSS from Japan provide navigation services within the prescribed area.

Case study in Indian space – Pixxel

Company

Pixxel

Overview

Pixxel is an Indian space-technology firm that plans to build and operate nanosatellites to collect, monitor and analyze data through imagery

Offering

The company plans to launch a series of satellite constellations that would contain a total of 36 hyperspectral satellites by the end of 2023.

Differentiator

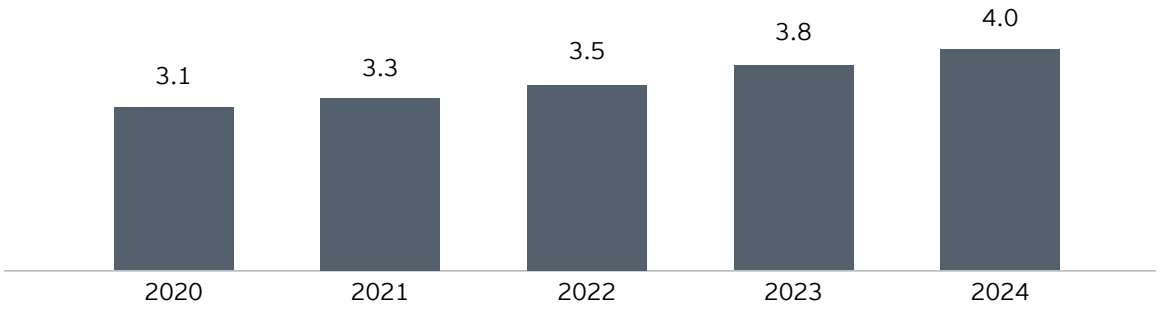
The company is planning to launch the world's highest resolution hyperspectral satellite constellation. Hyperspectral imaging is a specialized field of satellite-based imagery, which offers a significantly richer set of data by observing a wide spectrum of light — instead of just primary colors. The company also offers a data analytics platform that other companies can use.

Source: "Space start-up Pixxel readies satellites to relay data to help farmers, forests", Mint, 1 December 2021; "Space tech start-up Pixxel to launch 36 hyperspectral satellites by December 2023", The Hindu, July 2021.

2.4 Ground segment

The network operation centers and earth stations on the ground comprise a satellite communications system or network. Gateways and earth stations are leveraged to control satellites along with up-linking and down-linking of data from satellites. The ground segment is connected with an end user's equipment directly or via a terrestrial network.

Indian space ground station equipment market (US$b)



Source: BIS Research

Case study in Indian space – Astrome Technologies

Company	Overview	Offering
Astrome Technologies	Founded in 2015, Astrome is a deeptech startup focused on millimeter wave wireless communication technology.	Aims to launch a constellation of 198 satellites into LEO, each carrying next generation communication transponder

Differentiator

Astrome transponders operate in the millimeter wave frequency range that have better spectral efficiency and a large amount of unused bandwidth. The company is a pioneer in developing millimeter wave wireless technology for satellite communications. The patented technology offers 10X higher capacity transponders and high-capacity micro satellites.

Source: "5G deeptech start-up Astrome raises $3.4 million for US expansion", The Economic Times, September 2021; Astrome website

3

Regulatory landscape and challenges: liberalization of the Indian space industry

History of India space regulations

ISRO, formed in 1969 and later brought under the Department of Space, has been at the forefront of India's space industry and has been responsible for both upstream as well as downstream space activities in India. The Indian Space program has had three distinct elements as satellites for communication and remote sensing, the space transportation system, and application programs. Historically, India's space industry has been spearheaded by ISRO with limited participation and support from the private sector. It has been a long-standing demand of the private sector to liberalize the governing regulatory norms to open up the sector so as to realize the full potential of India's space capabilities.

Challenges in previous policies

India has historically relied significantly upon foreign satellite-operators for vital services such as broadcast communications and navigation. There is a shortage of communication / broadcasting transponders, gaps in remote sensing and navigation systems coupled with the growing need for orbital resources. There is a need to develop a decentralized space ecosystem with greater participation from the industry. Given that the space industry touches all domains of life and the downstream use-cases are increasing exponentially, a comprehensive regulatory policy framework was required to combine the drive of the private enterprises with their new age disruptive technologies with the strong legacy of ISRO and the continuous support of the Government.

To meet the growing communication needs for socio-economic development, improving access to remote regions, national security, enterprise and consumer services, the demand for satellite bandwidth is increasing rapidly. Emerging terrestrial technologies such as 5G, 6G and Internet of Things (IoT), etc., might result in larger demand for satcom capacity, leading to a need for comprehensive regulatory environment that aids in developing end-to-end capabilities for satellite -based communication systems and applications.

New proposed regulatory policies

- The Government has introduced new draft policies for space communication, navigation, and remote sensing with a view to usher and enable a regulatory environment, making it easier for private players to leverage their technology, innovations, and capital for the advancement of the industry. With the liberalization proposed in the new policies, India Space 2.0 has been given a significant push.
- The new draft policies introduced over the last year bring about a radical change in the approach of the government by way of providing for greater participation of private enterprise in the space industry.
- The draft Spacecom policy proposes to regulate the commercial use of satellites, orbital slots, and ground stations for communication needs.
- A new remote sensing policy has been framed with the objective of enhancing stakeholder participation and ease of data access. Under the new policy, remote sensing data having ground sampling distance coarser than 50 centimeters shall be easily available, leading to higher resolution data accessible for various users. Further, private enterprises can now undertake design development and realization of satellites and associated remote sensing systems.
- Given the substantial rise in applications relying on position, velocity and time services, the government has proposed a comprehensive policy for satellite navigation to strengthen the self-reliance for Indian Global Navigation Satellite Systems.
- Guidelines for acquiring and producing geospatial data and geospatial data services have liberalized of the mapping industry and democratized existing datasets to spur innovation, enable global competence and to boost blue economy in India, where geospatial data is expected to play a potentially important role.

Measures to simplify the regulatory landscape and propel the sector towards growth

- Under the current framework, regulatory approvals are required from multiple agencies such as DoS, DoT and/ or MoIB for establishment of upstream/downstream space activities. Such agencies have varied and different objects at times. A single window approval process through a nodal body focused on space economy shall aid and ease the process of having in place requisite authorizations that shall further help ease of doing business. In line with the TRAI recommendation, regulators may publish an approved list of foreign satellites from whom capacity can be directly procured by the buyers. This shall help expedite the licensing process.

- Under the present licensing regime, the service license holders are required to set up their own earth stations. However, with increasing complexity in the technologies being used, satellite operator shall be permitted to set up their own earth stations and deliver services to the service license holders who in turn will render to the end-users.
- There is a need for coordinated effort on part of the stakeholders and the regulators along with the government towards protecting India's interests in the international forums towards of orbital resources and slots.
- The enactment of the space legislation would help bring about clarity in the governing norms along with policy predictability and certainty, thereby boosting investor confidence leading to more investments and enhanced participation of non-governmental/private sector agencies. There may also be a need to align other legislations, such as telegraph laws, to avoid any jurisdictional overlap and regulatory ambiguities.
- A comprehensive space policy covering upstream and downstream activities will help guide the vision and provide policy predictability to enhance the investment climate.
- The space sector may have far-reaching benefits for a large and diverse geography such as India. Liberalized spectrum and licensing/authorization policies and regulatory framework would provide necessary agility to the authorities to address socio-economic needs.
- ISRO can act as an enabler for boosting research and development by way of technology transfer, collaborations, and sharing of infrastructure that shall help achieve wider participation from the industry. Further, the government acting as an anchor customer shall go a long way in helping startups in the industry.

Space insurance is yet to evolve in India. It has always been a sovereign subject. There is a lot of emphasis on the life cycle management of satellites. However, there is no specific emphasis on the de-orbiting of satellites. There is a need to look at how other countries have promoted space insurance.

Global regulatory approaches to space insurance

Countries	Law on space liabilities
The US	Section 16 of the Commercial Space Launch Act, 1984 mandates obtaining liability insurance under a license issued for an amount as is considered necessary by the secretary of the US.
The UK	Section 10 of the Outer Space Act 1986 mandates indemnification to Her Majesty's government in the United Kingdom against any claims brought against the government in respect of damage or loss arising out of activities carried on by the licensee.
France	Article 13 of the French Space Operation Act, 2008, mandates absolute liability for damage on ground and in air space for third party liabilities, while the liability is on a fault basis for damage caused in outer space. Further, there is a limitation for the term of liability up to one year from the date of fulfillment of obligations mentioned in the license. Article 14-15 limits the claim for compensation from the French Government to a fixed ceiling of €60m and the private space operator is liable to reimburse for indemnifications exceeding €60m
India	▶ Under the Draft Space Activities Bill, 2017, Section 8(2)(h) proposes third party insurance· Section 12 mandates indemnification of central government subject to a quantum to be decided by the Government. ▶ Section 13 proposes punishment with imprisonment of not less than one year but up to three years or with a fine of not less than one crore rupees and for continuing offences with a fine of INR 50 Lakhs per day for not obtaining a license. ▶ Section 25(2) proposes that any IP rights created onboard a space object shall be deemed to be a property of the central government

Source: Mondaq

Countries	Law on space liabilities
France	▶ Third-party liability (TPL) requirements cover both launch and in-orbit operations. TPL insurance or an equivalent financial guarantee is mandatory by law for an amount of €60m for launch operations and €50m to €70m for in-orbit operations. ▶ An operator may be exempted from the obligation to take out insurance or provide a financial guarantee for a limited duration if it is proven to be impossible to take out insurance because cover is not available in the insurance market. ▶ To benefit from this exemption, the operator must file a request with the Ministry of Economy and produce evidence regarding its financial standing as part of its request.

Source: Lexology

4

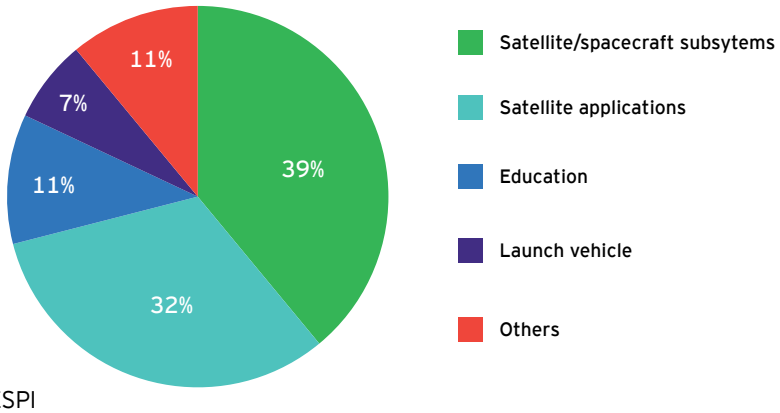
Space startup ecosystem and investment climate

4.1 Investment in space startups in India

In the last five years, the Indian space startup space has emerged strongly and is abuzz with activities. Currently, there are over50 space startups in both the upstream and downstream segment of the space value chain in India.[4] New age companies focusing on the upstream segment are engaged in making satellites, rockets, rocket fuel, and propulsion systems. While companies in the downstream are focusing on developing analytical skills to generate insights across industries and coming up with innovative applications.

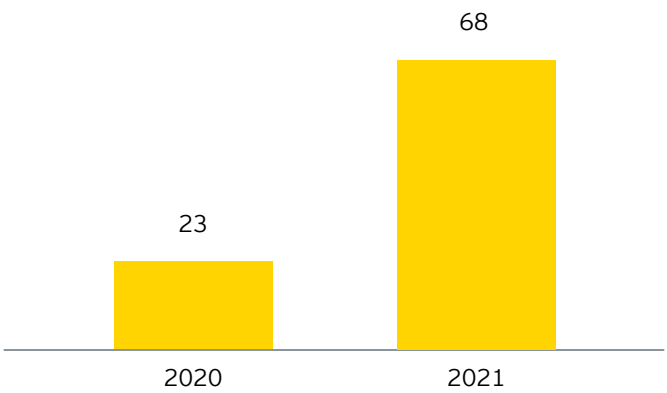
Local business conditions and capabilities are acting as a key catalyst for the development of the spacetech startups in India. A thriving Micro, Small and Medium Enterprises (MSME) ecosystem in India is the perfect bedrock for the spacetech startup to develop. Companies can take advantage of the already established supply chain of ISRO for manufacturing and testing of satellites and rockets. To add to it, startups will be able to greatly benefit from experienced space scientists in India who have significant mission experiences as well as leverage world-class academic institutions. Overall, the focus of the startups is on developing original IP for space-based products/services, capitalizing on the gaps in the local market, and inherent understanding of local issues and challenges. Spacetech startups in India can potentially scale-up the solutions/products across other emerging markets, where challenges and requirements are similar to India.[5] Increasingly, spacetech companies are looking for strategic partnerships to leverage and make use of each other's expertise.

New space companies' breakdown by segment in India

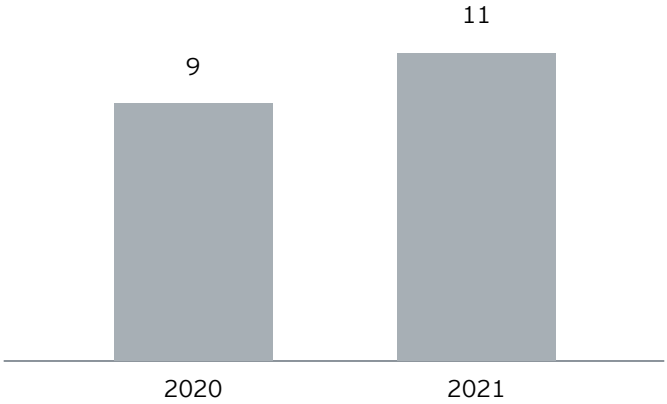


Source: ESPI

Investment in Indian space startups (US$m)



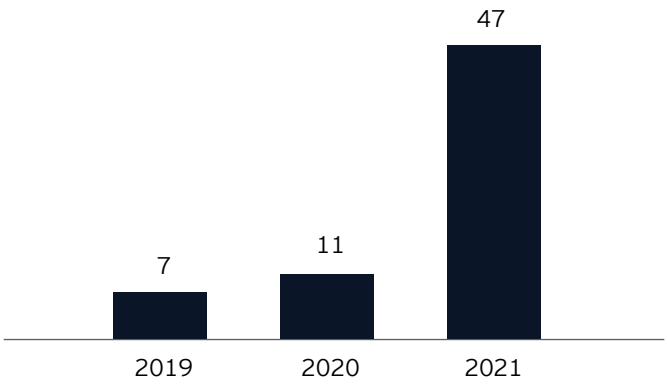
Number of rounds of investment in Indian space startups



Source: The Hindu Business Line

4 "New space in Asia", ESPI, February 2021.
5 "New space in Asia", ESPI, February 2021.

Number of new spacetech startups in India



100

Total number of spacetech startups in India at the end of 2021

Source: The Hindu Business Line

Investors are showing greater interest in the Indian spacetech sector owing to a combination of factors. It is in line with global trends as investors are finding the space sector attractive owing to the emergence of several success stories.

Key factors for investment in Indian space segment

- The government's push for inclusion of private players in the space segment
- Lower costs for developing and launching satellites
- Promise of substantial Return on Investment (RoI)
- Increased market demand for geospatial data
- Technological advancement in the space industry

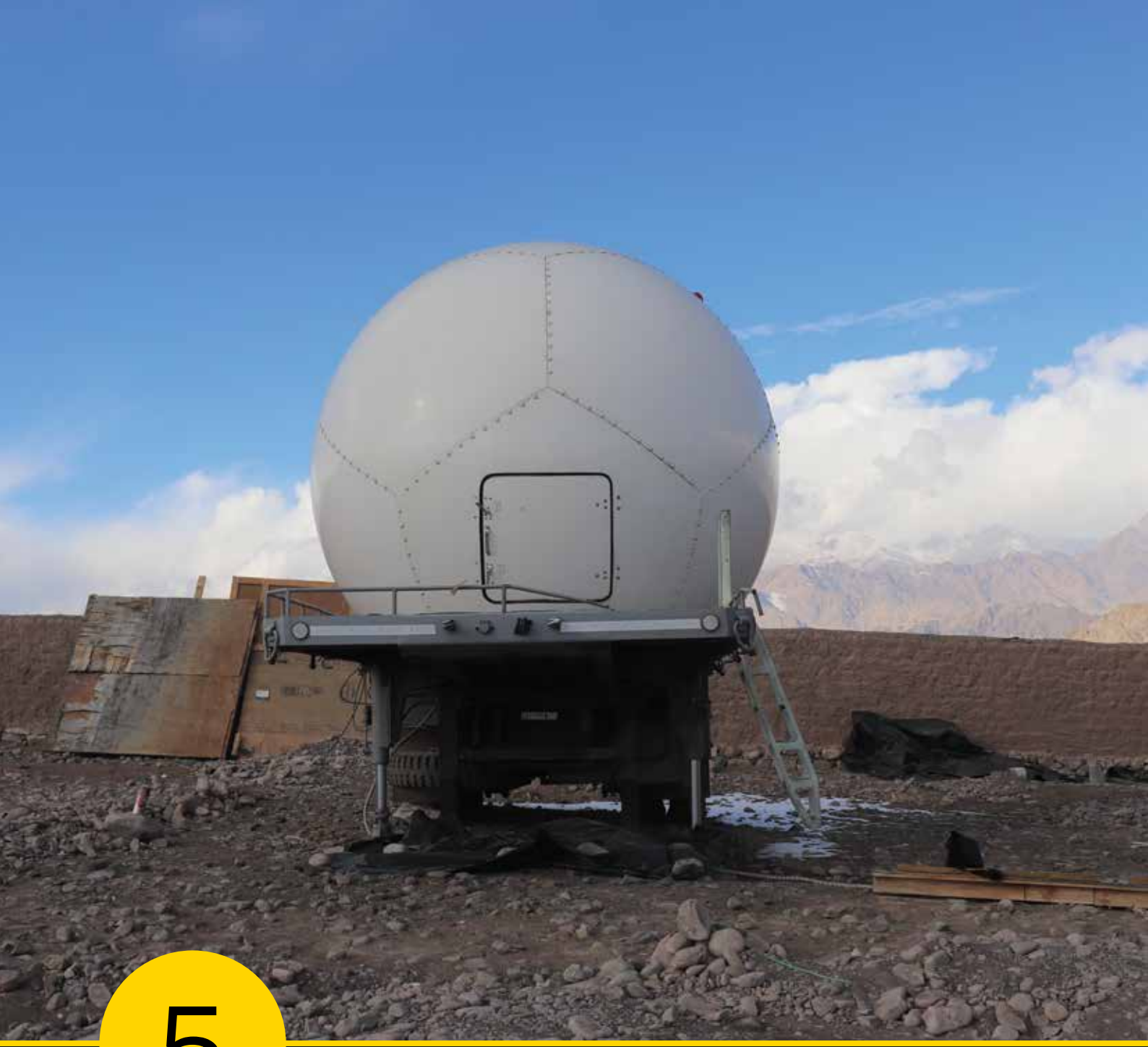
Source: "Investor interest in Indian spacetech start-ups takes off. Here's why", YourStory Media, May 2021; EY analysis

However, the startup ecosystem is not without its share of challenges. Access to capital is the biggest challenge today. Historically, investors have treaded with caution when dealing with the Indian spacetech start-up ecosystem. Lack of private participation in the space economy was clearly a major deterrent. Large-scale private investments in the upstream segment have been a challenge owing to higher barriers to entry, strict regulation, and a high risk of failure.

Key challenges/issues for startups in India

- Lack of access to capital
- Preference for investments in the downstream segments
- Perception of long gestation period of investment
- Lack of business models
- Lack of institutional support and policy

Source: EY analysis, ESPI



5

Enabling defense - space enterprise to lead global innovation

Space, the dual-use disruption, is fast emerging as the major multi-dimensional and multi-faceted force enabler for defense forces, globally. Cheap and easy access to space technology is fueling a global race to build military space capabilities which would enable them to ensure safe, secure and assured friendly use of space domain to serve their national interests, while also creating deterrence capabilities to disrupt the use of the same by their adversaries. India has established the Defense Space Agency (DSA) to address all defense space requirements including protection of all its space assets.

The Honorable Prime Minister's initiative to unlock the space sector by allowing private industry to undertake commercial space activities as well as supporting defense space capability is well timed and would significantly contribute to building a "credible and resilient Space Force". This Space Force would be a foundational component of our Comprehensive National Capability to ensure a decisive response whenever and wherever needed.

Increasing role of spacetech startups in the defense space domain

Our space industry also has to deal with departments like DoS, DoT, ISRO, IN-SPACe, NSIL, DST etc. as well as other user government department. Further, the defense and security customers for our industry could include DSA, MoD, MHA, DoT, DRDO, Defense Services, DPSUs, NTRO, CAPF, police forces, disaster management agencies etc., as per use case.

We are now seeing many startups getting into the space domain, wherein some have shown encouraging achievements. They, along with the existing space industry companies, would form the backbone of the defense space industry enterprise. Many of them are building unique, innovative and disruptive solutions which could potentially be game changer for Military Space and Warfighting besides addressing the requirements of governance and socio-economic development to enable the common man.

Focused attention is needed to understand the nuances of the space ecosystem. Given the enormity, complexity and challenges of space domain, India will need a "whole of nation approach" to develop, deploy and operationalize cutting-edge industrial capability as per user needs as well as to make them successful as a global business enterprise.

Key considerations, applicable to multiple departments, need attention to strengthen the space sector, especially defense space in India

Functional areas	Key considerations
Need for an enabler mindset with a technical perspective	▶ Stronger push needed within the government system to improve adoption and absorption of technology and upgrade methods of working. ▶ Strong need to break through inertia of old methods and adopt new methods, process and SOPs needed to handle the dynamic and fast-moving technology cycles.
Enabling ease of doing business	▶ Enable single window handling with simplified processes and methodologies through a "Web-portal" to effect transparent/responsive processes for permissions, licensing, issues and grievances with time sensitivity (time-bound/automatic/deemed approvals or clearances etc., where feasible). Status update, auto-alerts for delays in resolving grievances, options for reverse feedback mechanism, automated escalation to senior officers beyond specified time limits could be some powerful enablers to strengthen the ecosystem system performance. ▶ Focused interventions to reduce/cut red-tape which result in time-delays. ▶ Establish a robust helpdesk to help startups/MSMEs in navigating through government processes (including inter-ministerial processes). ▶ Ensuring level play field for private industry vis-à-vis government PSUs/ Departments in terms of competition and processes. Industry needs to be considered as co-traveler and co-partner in all spheres including strategic domain.

Functional areas	Key considerations
Easy access to facilities (technical/testing/ certification)	▶ Single Window Web-Portal based converged Facility Availability & Booking System (FABS) to enable Easy Access to Facilities (Technical, testing and certification: managed by MoD, ISRO, DRDO, DST or any other government departments managed labs etc.). Web-Portal features could include, Lab facilities availability, rules/regulations, charges, dates/time of availability, instant payment calculator, payment gateway for instant booking, etc. ▶ Higher authorities may audit periodically the Facility Booking Management System
Timely payment of Dues	▶ Timely payment of dues to startups/MSMEs to reduce cash-flows challenges. ▶ Web-Portal based tracking (with query/reverse feedback mechanism); automatic escalation, monitoring and monthly follow-up of delays, in case delay of payments exceeds 30 days (post submission of invoice and grant of ATP clearance by User), could be helpful. A special mechanism/ Cell could supervise to monitor delays and help in addressing issues, where necessary. ▶ Provision of payment of penal interest to companies by departments for delayed payments.
Human resource capital	▶ Strengthening HR capabilities/capacities of institutions, agencies and departments handling defense space with skilled HR to deal with multi-faceted, multi-disciplinary and multi-dimensional issues. ▶ Skill areas would include: (1) Domain/technical experts; (2) Project management skills; (3) IPR and legal experts (including space law experts); (4) financial/investments experts. ▶ Creation of the potential talent Pool could include: (1) Experienced serving officers/veterans from defense and security establishment with hands-on experience; (2) Retired/on-deputation scientists from DRDO and ISRO; (3) Experts from industry, academia, and BFSI institutions. *Creation of talent pool by IN-SPACe, comprising retired scientists, is a positive step for emulation by other agencies.
Handholding, coordination and project management	▶ Longer fixed tenures for project managers (with domain expertise) handling projects for continuity and faster realization of projects. Consideration to give at least six months overlaps between dealing officers in Project Management and R&D role to ensure proper transition/handing over. ▶ Hand-holding Entrepreneurs in terms of constant guidance; regular feedbacks; and easy/direct connect with users. A robust coordination mechanism at directorate level managed through a Core Committee could be very helpful for defense space. ▶ Accurate articulation of user requirements, expected deliverables, deployment environment and operational utilization would be an important step. Skilled experts with domain expertise may be engaged to translate user needs for accurate engineering requirements.
Conduct of trails	▶ Space technology has long gestation period and has limited market budget allocations to facilitate trails and technology demonstration. No cost and no commitment (NCNC) system pose financial challenges and lacks accountability/commitment from user end.
Routing of foreign demands by MEA to industry	▶ Demands from friendly countries received by MEA may be shared with the Indian space industry for providing solutions. ▶ MEA may consider providing Lines of Credit (through EXIM Ban) to support projects in foreign countries being undertaken by the Indian private industry. ▶ Indian Embassies could promote products of Indian Companies in foreign countries (including defense attaches/ military attaches for defense space products). They could act as a bridge to connect Space Industry at either end. Webinars to Spread Awareness of Indian Technology in friendly countries, facilitated by embassies, could be good enablers.

Functional areas	Key considerations
National listing of companies and products	▶ A web-portal for national listing of companies (including startups/MSMEs) for technology and products developed along with details of patents applied/granted could be included. This would help avoid duplication, besides providing a credible database of national capability.
Strengthening investor interest in Defense space start-ups **Refinement in IPR terms and conditions for iDEX and TDF**	▶ Defense Space technology development is capital intensive with long gestation periods with low visibility on scale and scope of demand. Hence, there are limited investors in this space which is critical for startups. ▶ Refinement in iDEX/TDF terms and conditions would encourage more startups to opt for iDEX/TDF. This would invite investor funding in defense (Space) startups and make them scalable. Further, this would also help tide over funding challenges for Startups. ▶ Visibility/Predictability on demand would help in determining market potential and viability ▶ Improved investment friendly policies and guidelines would make it lucrative for private funding agencies and VCs to pump in funds to bring scalability and growth.
Funding mechanisms	▶ Adequacy of funding and easy access to available funding options still remains a challenge. ▶ Government may support setting up of public/private investor funds/ fund of funds to support strategically important companies. This would include both seed funding in Deep Tech areas as well as in level A, B and Cs. ▶ Mobilizing Indian business houses and investment firms/agencies would be key to ensuring critical technology startups remain Indian in terms of ownership.
Refinements in DAP/DPP to accommodate uniqueness of Space related products.	▶ Consideration may be made to add a special chapter for procurement of space related Technology/ products/solutions in the DAP/DPP by MoD to cater for the unique character and challenges of the space domain.

Business models	▶ Some of the models for consideration could include the following:
	  ▶ Industry engagement through consortium mode.
	  ▶ Allowing single consortium/single vendor to participate in niche specific areas.
	  ▶ Data as a Service (DaaS); Infrastructure as a Service (IaaS; Platform as a Service (PaaS)
	▶ iDEX/TDF/make-route supported dual-use startups/companies/consortiums could be scaled up by, (1) using private investments (enabling IPR conditions and guidelines); and (2) permission to offer services at both national/ global level (to whitelisted global clients); (3) assured buy back of satellite data and products by government departments placing consolidated demands (DaaS model) from such platforms.
	▶ Above steps would help Indian companies stand-up to global competitions (possible upscale to unicorns) in sectors like ISR, PNT, data analytics, communication, applications etc., to name a few.

Legal and policy frameworks	▶ A progressive space policy and space bill with enabling guidelines offering long-term stability, facilitating a responsive single window clearance mechanism is the need of the hour. ▶ Issues relating to Insurance and liability could be a major determining factor in space business viability. ▶ Consideration to create a contributory insurance pool for companies with government support. Cost of insurance subscription could be a major determinant for business growth in this sector.

Functional areas	Key considerations
Standards	▶ A standard driven approach towards technology development and procurement may be considered. This would strengthen quality; enable commonality and interoperability; and bring scalability as well as sustainability in the long run.
Financial enablers	▶ Supportive/ Liberal FDI guidelines. ▶ GST rebates, tax incentives, Import duty exemptions, PLI schemes and easy terms for bank guarantees. ▶ Low interest and long-term loans need to be enabled to improve financial viability of the sector. ▶ Waiver in LDs arising out of delays in receipt of components from foreign sources (chip/silicon issues).

Source: ISpA (gathered from feedbacks obtained from the Indian space industry stakeholders)

Wing Commander Satyam Kushwaha (Retd)

Director ISpA

6

Skills development in the space domain and empowering youth

Indian private universities are coming with programs/ initiatives toward the space research by training students on various aspects of the industry. The universities are introducing courses on multiple facets in the aerospace industry while providing training to students by former ISRO scientists. Skills development is crucial for the space economy to thrive in India.

Primary areas for skill development in space domain

- There is a need to develop the competency of systems engineering. It is currently not there in India.
  - No academic focus on systems development for the space segment
  - Companies are incurring a substantial cost in training people on systems engineering
  - There is a need to look at the entire space segment as one system
  - Remove gaps and streamline interdependence, interface and interactivity
- Adequate training is required on operating satellites skillfully. Currently, the private sector is not running satellites.
  - With newer software-defined satellites being launched, there is a need to train people on their operations
- Need to develop technology associated with special alloy used for launch vehicles
- Success in the space segment is dependent on rigorous skills development
  - There is a need to have a central system for training resources in the space segment
  - Setting-up a separate training body may be an option
  - ISRO has let out its facilities. There is merit in including training aspects as part of this program.

Initiatives / Programs undertaken by private institutes

- Amity University Mumbai, a private university in Central India, is looking to set up Planetary Science, education and experience station to run space biology research and the 'Earth and Space Exploration program allowing students and researchers to undergo training by space scientists. It has partnered with multiple local and foreign institutions for providing the research and training to students.
- Lovely Professional University, a private university in North India, established a Centre for Space Research with mission control facility allowing students and researchers to communicate with the International Space Station along with downloading satellite images in real-time. The purpose of the center is to conduct research projects in the space technology along with conducting awareness sessions related to space research and remote sensing. Also, the students will undertake technical and professional development training on different modules including installation of the ground station, satellite tracking till data set collection.
- Chandigarh University, a private university in Northern Indian, introduced Student Satellite Designing and Training program 'CUSAT', an advanced training program for the students in aerospace engineering. The program will include study of Integration of components, satellite designing, testing and simulation of launch process, collection and analysis of data from the satellite. Also, the students will undertake training from the former Indian and International space scientists. The university plans to design a multipurpose nano-satellite which will be launched by ISRO.

Case study – Indian Institute of Space Science and Technology

The Indian Institute of Space Science and Technology (IIST) is Asia's first space university. It was established at Thiruvananthapuram in 2007 with the objective of offering high-quality education in space science and technology to meet the demands of Indian Space Programme. The institute offers undergraduate, postgraduate, doctoral, and post-doctoral programmes in broad areas of space science, technology, and applications. IIST fosters state-of-the-art R&D in space studies and provides a think-tank to explore new directions for the Indian Space Programme.

Source: ISRO

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About ISpA

Indian Space Association (ISpA) is the apex industry body created to be the collective voice of the Indian space industry.

ISpA undertakes policy advocacy and engage with all stakeholders in the Indian space domain, including the government and its agencies to make India self-reliant and technologically advanced so as to enable India to become a leading player in the global space arena. Its member entities consist of prominent names from the Indian Space Industry.

ISpA echoes the Hon'ble Prime Minister's vision of Atma Nirbhar Bharat. It will work with all stakeholders, to create an enabling environment for strengthening the private industry in the Indian Space sector, to contribute to the National aspiration. ISpA envisions to propel India to the global forefront in the entire Space ecosystem.