



DECADAL VISION AND STRATEGY FOR INDIAN SPACE ECONOMY

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Indian National Space Promotion and Authorization Center



**“When the strength of government space institutions
and the passion of India’s
private sector will meet, not even the sky will be the limit”**

Hon'ble Prime Minister Shri Narendra Modi



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FOREWORD

This report on India's decadal vision for a thriving space economy is presented with an optimistic outlook for the future. The development of this comprehensive document involved the synergistic efforts of the Indian Space Research Organisation (ISRO) and the Indian National Space Promotion and Authorization Centre (IN-SPACe), thereby bringing out a holistic decadal vision for Indian space economy.



India's journey in space has been truly inspirational, marked by milestones such as the historic Chandrayaan-3 moon landing and the successful launch of the Aditya L1 solar missions. These achievements underscore our nation's prowess in space science and technology.

The global landscape of space activities is dynamic, witnessing the emergence of new players and innovative collaborations that contribute to a more inclusive and economically viable space sector. This necessitates the encouragement and support of new entrants in the space industry through innovative initiatives. The report envisions an ecosystem that aligns with the shared aspirations and strategic goals of all stakeholders, with NSIL broadening its operational scope, and both ISRO and IN-SPACe promoting increased involvement of Non-Governmental Entities (NGEs) in the growing space economy.

As we embark on this journey of new space enterprise, filled with promises and challenges, our resolve is to transcend boundaries, harness space resources, and capture sizeable market share of the global space economy. For the Indian space sector, the sky is not the limit but rather the beginning of an exciting and promising era.

Date: December 16, 2023


(सोमनाथ एस / Somanath S)

डॉ. पवन कुमार गोयनका
Dr. Pawan Kumar Goenka



अध्यक्ष, इन-स्पेस
Chairman, IN-SPACe

Foreword

I am privileged to present this seminal report laying out India's decadal vision for its space economy. This document is a result of a collaboration between IN-SPACe, the Indian Space Research Organisation (ISRO), and Non-governmental entities (NGE) in the Indian space sector. I am also thankful to PricewaterhouseCoopers (PWC) who as a knowledge partner helped develop the decadal vision and compile this report.



Space is a sunrise sector and holds immense potential for the country and for the world. The announcement of Space sector reforms in 2020, marked the beginning of a new era in India's space economy. We have witnessed, significant momentum in the private space sector since then; new entrants from the private Industry, the likes of Skyroot Aerospace, Pixxel, Dhruvaspace, Digantra, Satsure have already begun to make their mark and gain global attention; Number of space start-ups have gone up significantly and the number is approaching 200; Traditional vendors to ISRO and MSMEs are diversifying by going up the value chain, L&T and HAL through a consortium have come forward to take a giant step to manufacture ISRO's workhorse the PSLV. Investment in space sector is increasing, in CY 2023 the total investment reached USD 125 Mn, crossing last year's figure. The world is now looking at India as the next big destination for Space Business. Hence, fostering a conducive ecosystem for NGEs and creating a harmonious synergy with ISRO to harness India's space resources and strengthen the infrastructure is crucial to enable this transformation of India's space industry.

This decadal vision builds a framework for space sector growth driven by a collaborative ethos with private sector participation and international cooperation. The vision document lays down the foundation for nurturing innovation, building a skilled talented workforce, and driving technological advancements essential for realizing our space aspirations. The report recognizes the importance of creating a vibrant ecosystem for start-ups and private enterprises, promoting cutting-edge research and development, and ultimately contributing to India's global standing in the space domain. Successful implementation of the roadmap laid out herein will take the value of the Indian space economy to US\$ 44 billion by 2033 and catapult us to an 8% share in the global space economy, a significant leap from the current value of US\$ 8.4 billion and 2% share in the global space economy.

The importance of the decadal vision is not just about reaching the stars but ensuring a positive socio-economic impact on society as a whole. It will guide us in building a robust space economy that resonates with the broader goals of national development.

The journey ahead is challenging yet exhilarating. It demands a "whole of Nation" approach with collective endeavour by all stakeholders, guided by a visionary plan, to embrace the infinite possibilities that space unfolds. It is my sincere hope that the ensuing pages will provide a blueprint for a future that elevates India to new horizons in the global space community.

December 18, 2023


(Dr. Pawan Goenka)



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1

Executive Summary

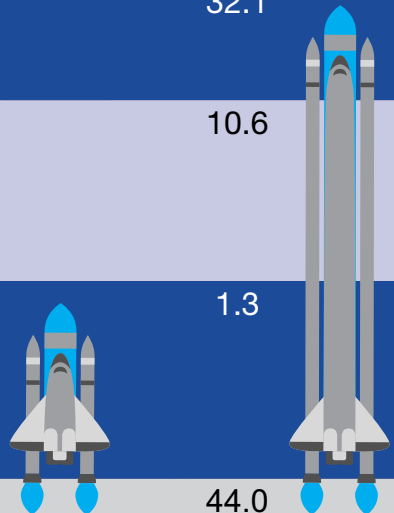
The 'Decadal Vision and Strategy for the Development of the Indian Space Economy' represents a visionary blueprint crafted to steer India's space industry and economic prospects for the next ten years. This strategic document outlines a roadmap aimed at fully realizing the potential of space technology to drive economic growth, foster innovation, and enhance global competitiveness. At its core, this vision is about harnessing the transformative power of space technology to deliver substantial socio-economic advantages to the 1.4 billion people of India in the forthcoming decade.

The decadal strategy defines the vision for India as “a dominant Space power, which accelerates India’s growth through space applications on Earth, strengthens capabilities in Space, creates socio-economic benefits and capabilities for growth” to meet its ambition of realising the USD 44.0 Bn market potential, including USD 11.0 Bn in exports, by creating an ecosystem where private, public and start-ups collaborate through a “Whole-of-nation” approach. The recently promulgated Indian Space Policy 2023 and implementation of the formulated strategy will enable the private sector to contribute in achieving the vision and ambition.

The space ecosystem is broadly classified into three groups – Space-for-Earth, Access-to-Space and Space-for-Space, comprising of Eight key domains. This study does not account for the use of space in defence applications. It also does not delve into scientific missions and planetary expeditions in any details.

In 2022, the Indian space market is estimated at USD 8.4 Bn (+/-5%). This market is estimated at ~2% of the global space market.

Groups	Space domains	Market size estimate, 2022 (USD Bn)	Market size estimate, 2033 (USD Bn)
Space-for-Earth	• Earth Observation (EO) • Communication • Navigation	7	32.1
Access-to-Space	• Satellite manufacturing • Launch Service • Ground segment	1.3	10.6
Space-for-Space	• Space situational awareness • In-orbit economy and Space Exploration	0.1	1.3
Total		8.4	44.0





Over the coming 10 years, as the Indian space sector realizes its full potential at USD 44.0 Bn, it would become ~8% of the estimated global market and would provide enormous developmental support to the Indian economy. This potential will be realised by achieving a growth rate of 16% for the sector, through demand generation as well as capacity and capability building in the Indian ecosystem.

Among the three groups, Space-for-Earth domain has the highest market potential of USD 32.1 Bn in 2033. It will drive growth of the Indian industry in the downstream segment for next 10 years, while contributing to country's socio-economic development. Access-to-space, including upstream and mid-stream segments, is another area poised for rapid growth and can capture a market potential of USD 10.6 Bn over the coming decade, considering satellite manufacturing, launch segment, and ground segment will be the infrastructure backbone to achieve the growth in downstream.

Strong Information Technology (IT) capabilities of private sector can contribute in driving growth in downstream and extending benefits of space applications to the population of India. EO applications will impact sectors like agriculture, transport, marine, energy & mining, healthcare, education etc. Communication will serve as the backbone for growth, enabling data and information transfer with value propositions across banking, healthcare, education and entertainment. Navigation services will continue to cater sectoral requirements including strategic needs.

The envisaged growth can be unlocked through implementing this strategy, which is based on four pillars of action - i) Build platform, ii) Create industrial ecosystem, iii) Enable industry, and iv) International Outreach. The four pillars encompass 10 key strategic and enabling capabilities to create, what is referred to as a 'Right to Win' for realising the vision. The Right to Win will be earned through appropriate market stimulations, capability building as well as a Whole-of-Nation Approach, which will give India a distinguished position globally as well as serve the country's needs.

2

Space Marketplace & Ambition

India has always acknowledged the potential of space to power Indian economy and society, democratizing development by making data available through the concept of space to all.

In line with this vision, India has developed the necessary indigenous capabilities such as launch vehicle technologies, and innovative space science missions. Such strides, make it critical for India to define its decadal ambitions for space economy and invite the industry to contribute towards it.

2.1. Space as a Multi Layered Marketplace

To re-envision and boost the Indian space economy, a holistic picture of what constitutes space is important. Traditionally, the space industry has been seen as the domain of rockets and satellites. However, for an integrated view of space that delivers benefits to the masses, Space can be seen in three broad groups – Space-for-Earth, Access-to-space, and Space-for-Space (further elaborated in Chapter 3). The flow of data through these assets or domains is the essence of the space economy. This re-imagination of Space ecosystem into eight key domains, with the flow of data, creates an integrative view of space as a Multi layered marketplace, as shown in Fig 1.

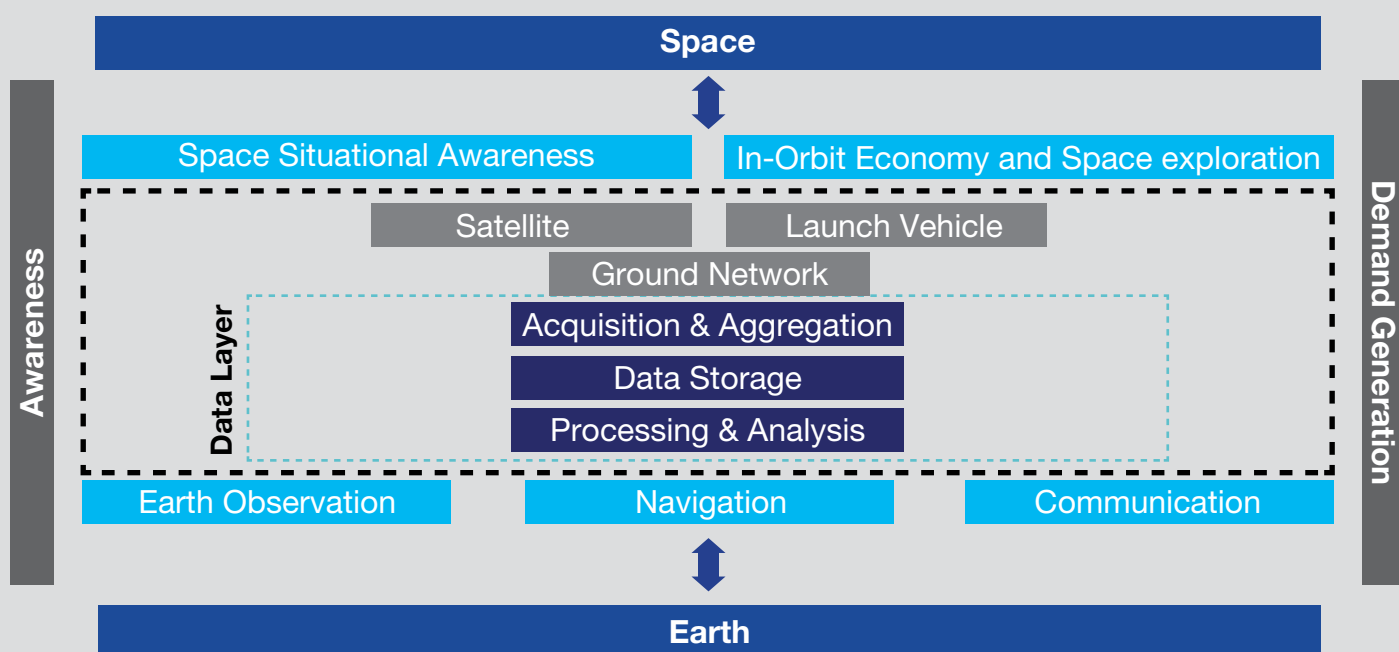


Fig 1. Indian space industry as a multi-layered marketplace

2.2. Vision

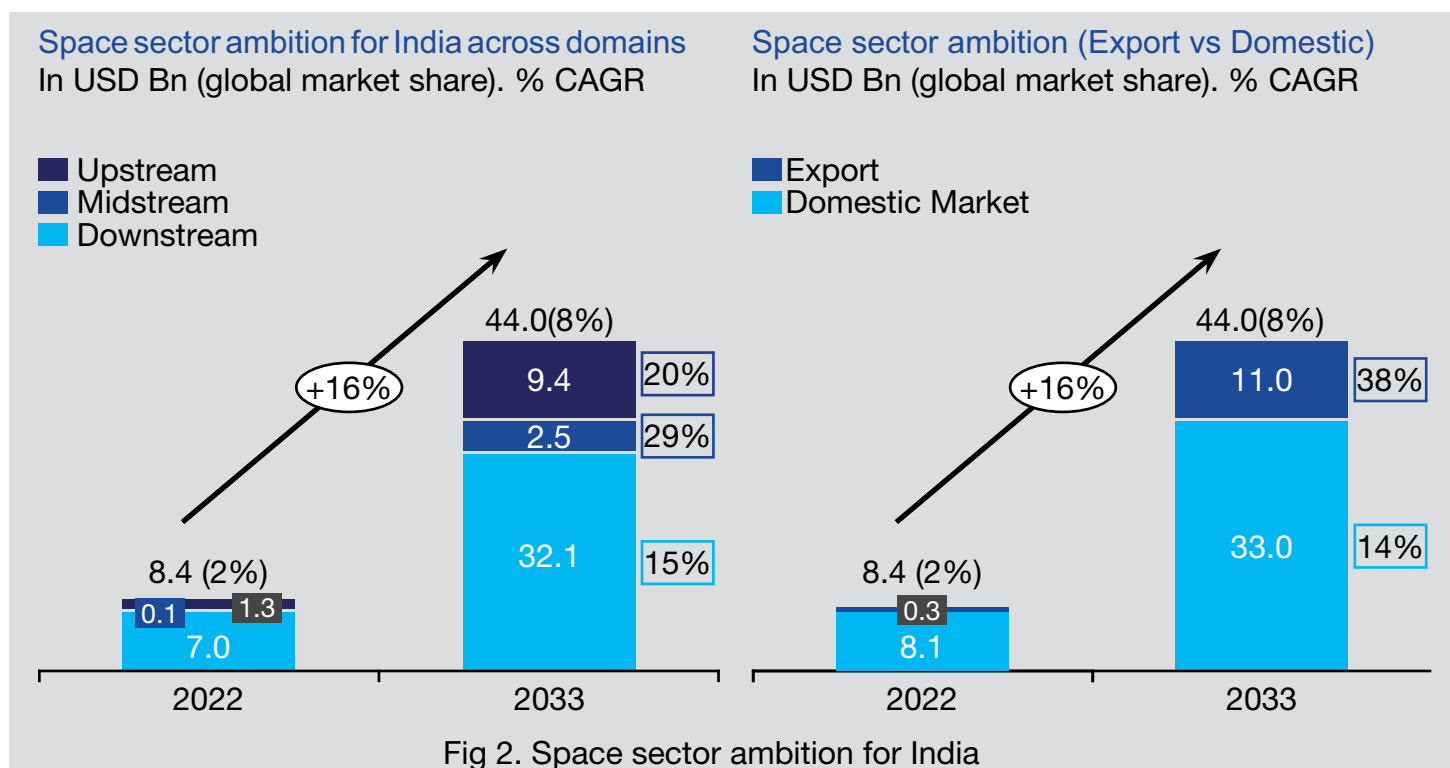
The Indian space program has progressed significantly over the years, primarily because of the strides that ISRO has taken in space exploration. However, for the Indian space economy to flourish, all segments of economy and society need to be engaged and enabled, while building on the well-established capabilities of ISRO. Accordingly, the vision is defined as:

“To make India a dominant Space power, which accelerates India’s growth through space applications on Earth, strengthens capabilities in Space, creates socio-economic benefits and capabilities for growth”

For India to reap the benefits of its space progress, a robust ecosystem that can fast-track her developmental progress is essential. This decadal strategy document envisions India to become a dominant space power, which accelerates India’s growth through space applications on Earth drives socio-economic benefits, strengthens space capabilities and builds strategic competencies, for long term growth.

2.3. Mission

Currently, the Indian space industry is estimated to be USD 8.4 Bn ($\pm 5\%$), viz. $\sim 2\%$ of the global market. Downstream and midstream segments constitute three-quarters of the total Indian industry. As depicted in Fig 2, the ambition is to grow the market size at a CAGR of 16% catering to $\sim 8\%$ of the global demand (i.e. USD 44.0 Bn) in the space sector by 2033. Of the USD 44.0 Bn, $\sim$ USD. 33.0Bn will represent domestic demand and $\sim$ USD 11.0 Bn is expected through exports.



To realize this potential, we need to create an ecosystem where private, public and start-up can collaborate through a Whole-of-Nation approach. Accordingly, the mission is:

“To realize \$44.0 Bn market potential in Space for India, including \$11.0 Billion in exports, and create an ecosystem where private, public and startups collaborate in whole-of-nation approach.”

Strategic Growth Plan

In order for India to achieve its goal of tapping into a market potential worth approximately \$44 billion, which includes around \$11 billion in exports over the next decade, it is imperative to establish a comprehensive ecosystem. Fig 3 defines the Vision, Mission, and strategic growth themes including EO, Navigation, SATCOM, Ground, Satellite, Launch Vehicles, Space Situational Awareness and Space Exploration as constituents of the strategic growth plan to build such a holistic ecosystem, which will be the foundation for realising the mission

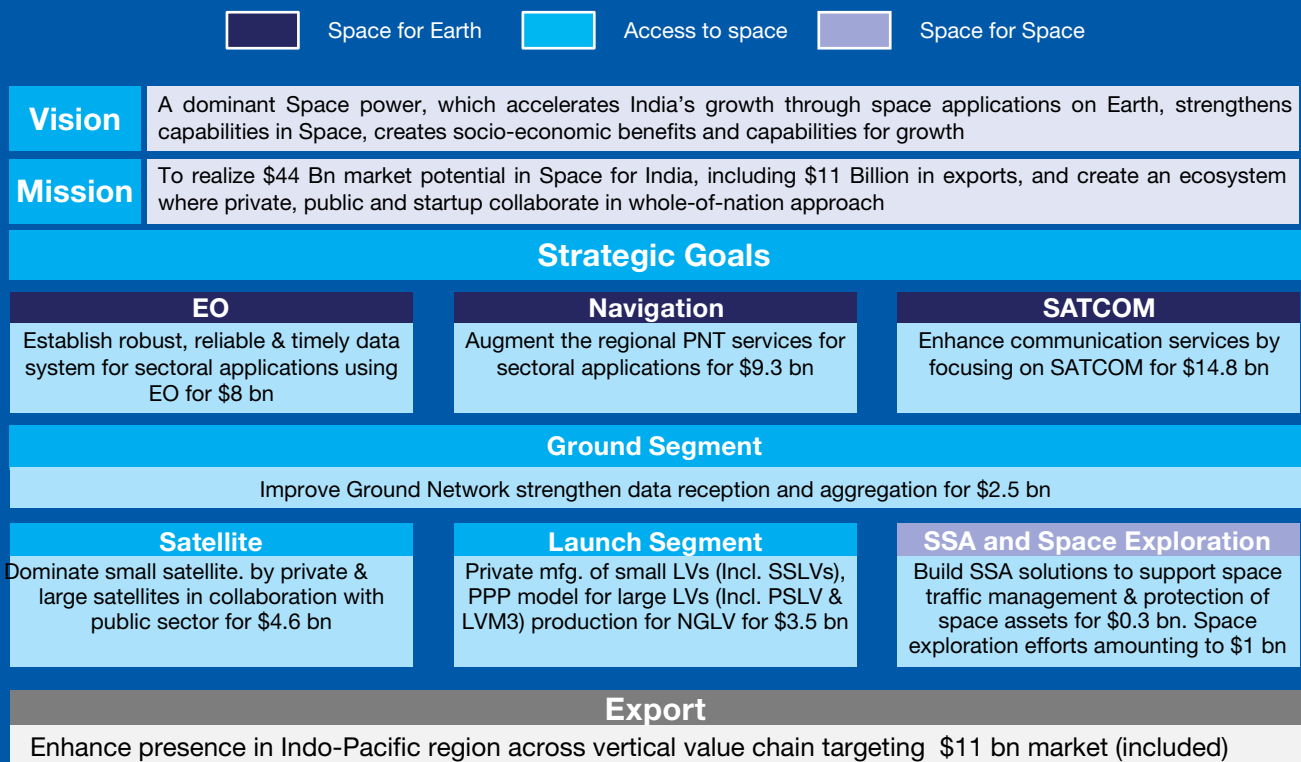


Fig 3. Strategic Goals for the Indian Space Ecosystem



3.1. STRATEGIC GOALS

The strategic growth themes are eight areas which are part of the Space Multi-layered marketplace where India should focus to attain the market potential of USD 44.0 Bn. Broadly, the strategic growth themes can be bucketed in four segments – Space-for-Earth, Access-to-Space, Space-for-Space and Exports.

India's IT and software sector has developed and demonstrated strong capabilities at a global level, which can be harnessed to strengthen our presence in the Space-for-Earth market segments. In Access-to-Space group, efforts would be required to stimulate the private sector participation by leveraging technical knowledge & expertise available with ISRO and creation of an ecosystem. ISRO is expected to take a lead in the growth of the Space-for-Space segments, given its focus on space exploration and R&D.

The growth of exports will take place as India gains stature as a regional player in the Indian Ocean Region and serves emerging economies, which have similar use cases as in India, as a nation with ~1.4 billion people can demonstrate the benefits of space technology at scale, thereafter, promoting its use in other countries with similar economic and social conditions.

The market size of the eight domains in 2022 and the estimated market potential in 2033 are depicted in Fig.4. It is estimated that the maximum growth will be achieved in domains like Earth Observation, Navigation and Communications which together are estimated to have a market potential of ~USD 32.0 Bn. Domains of Ground network, Launch segment and Satellite manufacturing can contribute USD 11.0 Bn to market potential.

It is important to note that market potential outlined below is different from market size estimated. The realization of market potential is dependent on demand generation, building capacities and capabilities through a Whole-of-Nation approach. A conducive policy environment and strategic roadmap laid in this document can contribute in enabling the private sector and creating an ecosystem to achieve the mission.

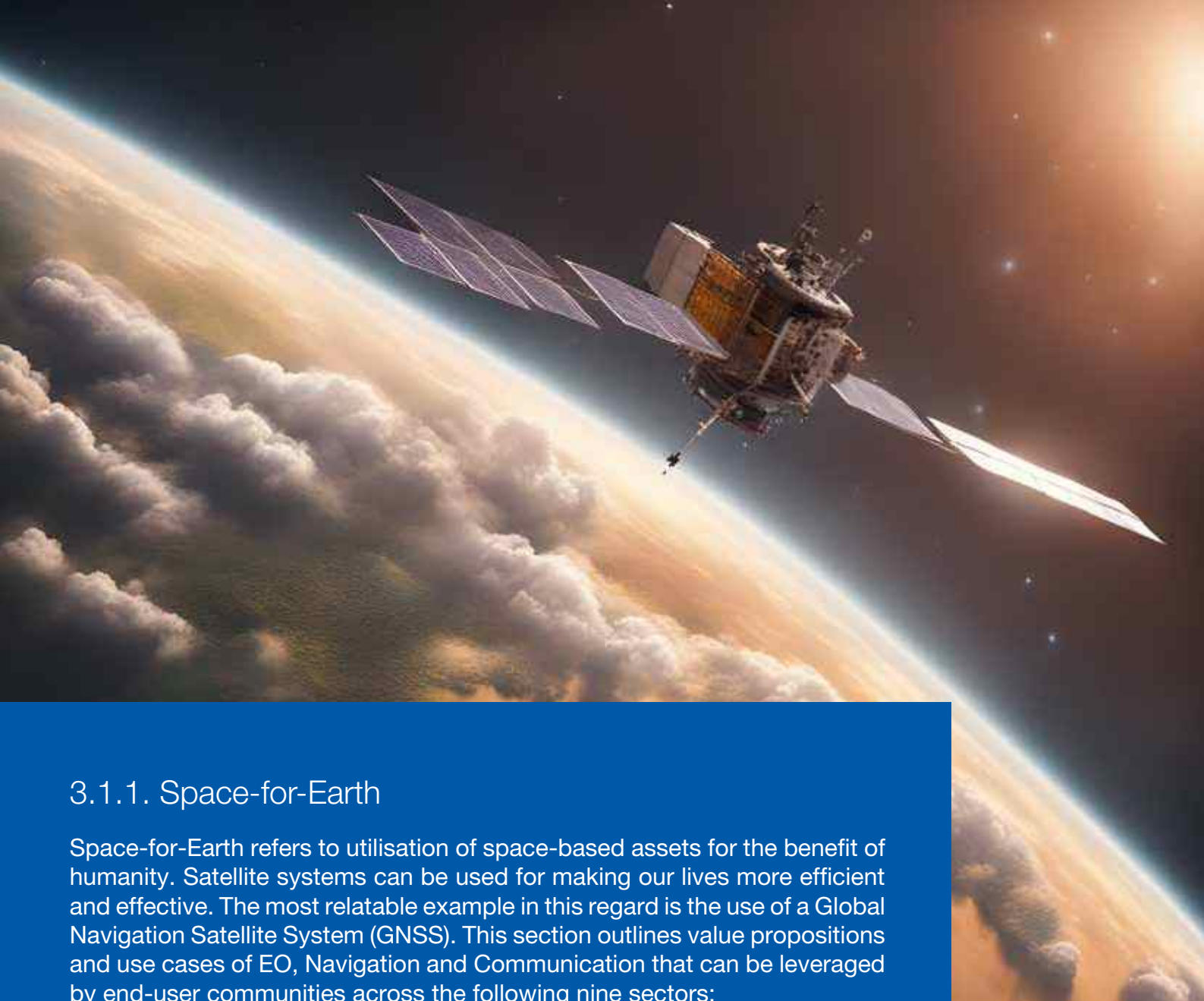
Growth Segments	Market estimate 2022 (US\$ Bn) ^	Market Potential 2023 (US\$ Bn)	CAGR 2023 (US\$ Bn)
1. EO	0.52	8	28%
2. Navigation	2.28	9.3	14%
3. Communication	4.19	14.8	12%
4. Ground Network	0.14	2.5	30%
5. Satellite Manufacturing	0.42	4.6	24%
6. Launch Segment	0.72	3.5	15%
7. SSA	0.001	0.3	--
8. In-orbit Economy Space Exploration*	0.13	1.0	20%
	8.4 (+5%)	44.0	16%

* Space exploration would be largely led by ISRO for the coming 10 years

^ Includes overall export of USD 280 Mn

■ Space for Earth ■ Access to space ■ Space for Space

Fig 4. Estimated market potential of the Indian space ecosystem in 2033



3.1.1. Space-for-Earth

Space-for-Earth refers to utilisation of space-based assets for the benefit of humanity. Satellite systems can be used for making our lives more efficient and effective. The most relatable example in this regard is the use of a Global Navigation Satellite System (GNSS). This section outlines value propositions and use cases of EO, Navigation and Communication that can be leveraged by end-user communities across the following nine sectors:

	Agriculture, Forestry and Marine		Disaster Management and Emergency Response		Insurance and Finance
	Transport (incl. Rail, Road, Aviation and Marine)		Infrastructure		Consumer Solutions
	Energy and Mining		Climate Services and Environmental Monitoring		Health and Education

3.1.1.1 Earth Observation (EO)

In 2022, Earth Observation (EO) is estimated to have a market size of USD 520 Mn. EO offers several value propositions across nine sectors, namely, Infrastructure, Energy and Mining, Agriculture, Forestry and marine, Disaster and Emergency management, Transport, Climate services and Environment Monitoring, Insurance and Consumer solutions. EO is estimated to have a market potential of USD 8.0 Bn by 2033 and requires establishment of robust, reliable and timely data systems for sectoral applications. It is estimated that a large share of this market potential will be realised in Infrastructure, Energy and Mining, Agriculture, Forestry and Marine sectors.



Infrastructure

From site selection through post-construction infrastructure to health monitoring, EO supports the various phases of the infrastructure life cycle. The ability of EO, to provide information on risk exposure and potential effects of climate change, should enable it to play a bigger role in the development of sustainable and resilient infrastructure.



Energy and Mining

While EO can be crucial at any step of the mining cycle, from exploration, discovery, and development, through production and reclamation, EO data related to renewable production is mostly linked with the planning and operation monitoring phases. Thus, EO based solutions can support in more efficient planning, operations and monitoring as against current equipment and approach used.



Agriculture, Forestry and Marine

In agriculture, EO data and information are crucial for sustainable nutrient management recovering soil health, and biodiversity preservation. This can contribute to improving, farming productivity, finding simulation solutions for decision support to increase crop yield, post agriculture supply-chain support, etc.

Marine and aquaculture outputs are considerably enhanced by specialised EO services and products that add value by offering insights into salinity, temperature, water quality, and other factors. These metrics are important for catch optimisation, aquaculture, site-specific management, etc.

EO is also becoming useful for keeping track of and preserving the sustainability of forests. EO is assisting with forest conservation through activities like carbon monitoring, fighting deforestation and degradation.

3.1.1.2. Navigation

Different satellite positioning systems, such as global and regional constellations (collectively known as Global Navigation Satellite Systems or GNSS) and satellite-based augmentation systems (SBAS), provide Radio Navigation Satellite Services (RNSS) signals for users to compute their position, velocity, and time. These systems are the backbone for navigation-based applications.

Transport sector including road, railways, marine & air transport, is one of the largest consumers of navigation-based applications. In 2022, the market size for the Navigation industry was approximated to be USD 2.3 billion. Navigation industry finds value propositions across the following sectors – Disaster and Emergency management, Healthcare, Energy and Mining, Transport, Consumer solutions, Agriculture, Forestry and Marine . Given these value propositions across sectors, Navigation is estimated to have a market potential of USD 9.3 Bn by 2033. It is required to augment regional PNT services to cater to sectoral applications across sectors with Consumer Solutions, Transport, Agriculture, Forestry and Marine being major beneficiaries in the years to come.



Consumer Solutions

GNSS is used more frequently to make our daily lives easier. Navigation and positioning data are essential for a variety of applications, such as context-aware apps that track busiest times of day, contactless delivery, and personal fitness apps (driven by wearables). Furthermore, it can be used to process payments based on real-time data on location or activity duration for public transport, theme parks, etc. It can also be used for broadcasting and entertainment, assisting in friend locators embedded in social networks to keep in touch and to share travel information.



Transport

Transport is a key sector where GNSS finds several use cases. From road to aviation and drones, GNSS finds applications in asset-management, enhanced command and control systems, etc. It finds value propositions in Enhanced Traffic Management and Regulatory Mechanisms, Fleet Management, Emergency Assistance, Passenger Information System, etc.



Agriculture, Forestry and Marine

The agriculture industry is being pushed to new heights by new technologies. These developments, which span traditional farming applications to the Internet of Things (IoT), blockchain, Agri-fintech, and value chain management, are seen to be significantly facilitated and driven by GNSS.

In marine, GNSS-enabled buoys can assist fishermen in both locating their fishing nets and equipment and identifying and locating fish stock with its estimated growth and health.

3.1.1.3. Communication

Technological developments have created a thriving satellite services industry that offers a range of communication services to broadcasters, Internet service providers (ISPs), and other agencies. In 2022, Communication services segment of space was estimated to have market size of USD 4.2 Bn. Communication services can be broadly divided into Broadcasting, Interactive communication services and Broadband connectivity. This domain is expected to have a market potential of USD 14.8 Bn in the next decade, primarily driven by Banking and finance, Energy and mining, Media and entertainment, Consumer solutions, Transport and Disaster and Emergency management.



Banking and Finance

Satellite-based financial services will play a critical role in years to come. Money transfers, digital wallets and crypto-currency based payments will fuel the need for the delivery of services to customers. Moreover, with globalisation making the world only smaller, global communication of financial data, monitoring of large-scale financial transactions and securing the storage of sensitive information will be easier and more convenient.



Energy and Mining

Communication services based solutions to reduce the response time as per changes in demand will enable energy companies to better monitor and manage their daily operations, in the remote areas.



Consumer Solutions

Increasing consumption of data through broadband internet, cellular backhaul and entertainment will lead to an increase in satellite communication penetration, over the coming years. With advancement in technologies and footprint of satellite internet, remote areas will become pockets for increased internet consumption, which will, in turn, promote delivery of digital education and health services. remote areas will become pockets for increased internet consumption, which will, in turn, promote delivery of digital education and health services.



3.1.2. Access-to-Space

Access-to-Space encompasses the terrestrial infrastructure, satellite components, and launch vehicle elements, collectively empowering us to leverage the capabilities of space for the delivery of terrestrial applications.



3.1.2.1. Ground Network

The ground system, which consists of earth stations/gateways, communications networks, and processing facilities does several functions that help in creating a range of consumer and end-user applications. These ground systems direct and control satellites, receive, route and process data. In 2022, Ground Network was estimated to have a market size of USD 140 Mn. The goal is to improve ground network strength, data reception and aggregation to realise a potential of USD 2.5 Bn by 2033

For EO, ground networks find use cases in satellite operations for data capture, assimilation, and usage. With upcoming EO programs, new ground stations will be required. In Navigation, development of hardware components including chipsets to promote adoption of NavIC based applications is critical. Potential increase in satellites for the NavIC platform will require increased focus on the strengthening of its ground network. In Communication, if India decides to have its own satellite constellation in the coming years, then the midstream for accessing that data becomes necessary.

3.1.2.2. Satellite Manufacturing

Satellite manufacturing has a huge growth potential for the country across different sectors – EO, Navigation, Communication, in addition to the manufacturing of alternate platforms and satellite sub-systems. In 2022, it was estimated to have market size of USD 420 Mn. Given need for satellite manufacturing, it is estimated to have a market potential of USD 4.6 Bn by 2033. The market estimates also include sub-systems such as space grade components, antennae and user terminals.

EO and communication segments are estimated to drive the demand for small and large satellites. Small satellites with higher revisit frequency are required for EO. These will contribute in enhancing image resolution for multiple passive and active imagery for EO data-based solutions. Moreover, diverse payloads including microwave, hyperspectral and optical payloads will enable an increased range in data types for EO to meet the demand for EO data. In the Communication segment, deployment of small satellites constellations is gaining momentum. This trend is expected to push the growth of small satellite manufacturing in near future. It is important to note that large satellites will be required for high-throughput broadband and telephonic communication.

The goal for the industry would be to dominate the small satellite segment and develop capabilities for manufacturing large satellites in collaboration with public sector.

3.1.2.3. Launch Segment

India's capabilities in developing cost-effective launch vehicles is expected to contribute in realising the market potential of USD 3.5 Bn in 2033, as against an estimated market size of USD 720 Mn in 2022.

Design and development of heavy launch vehicles, especially reusable vehicles are expected to witness high demand. Given increasing requirement for launching small satellites for replacement in constellations in expected to boost the demand for small lift vehicles. Transfer of technology of SSLVs to the private sector will help to create capacity for manufacturing of small launch vehicles. This will be needed to meet the requirements for deployment and replacement of small satellite in constellations. The development of vehicles for sub-orbital flights is expected to rise due to increasing interest for space tourism.

The private sector thus needs to focus on manufacturing small launch vehicles and work in collaboration with space agencies for manufacturing large launch vehicles.





3.1.3. Space-for-Space

Space-for-Space pertains to the deployment of spaceborne resources for the purpose of conducting research and venturing into the exploration of outer space. While space agencies such as NASA, ISRO, European Space Agency (ESA), etc. have been into space exploration for a long time, it is only recently that private sector entities have entered this domain, which has led to re-defining space exploration. Though Space-for-Space solutions are still in their nascent stage, we expect this domain to emerge as an exciting prospect in the future.



3.1.3.1. Space Situational Awareness (SSA)

There are numerous objects such as asteroids, space debris, etc. that pose significant threat to satellites and launches. SSA aims to keep a track, monitor and predict space debris so that there is limited damage caused by them. In 2022, SSA was estimated to have market size of USD 1.0 Mn, with a potential of USD 300.0 Mn by 2033.

For Space Traffic Management under SSA, the development of ground-based radars is crucial to detect space debris. The data from these space-based surveillance and tracking systems can also help develop Artificial Intelligence/ Machine Learning (AI/ ML) solutions for collision avoidance with the help of a Central Data Repository (CDR), which can be used by the private sector while launching satellites.

3.1.3.2. In-Orbit Economy and Space Exploration

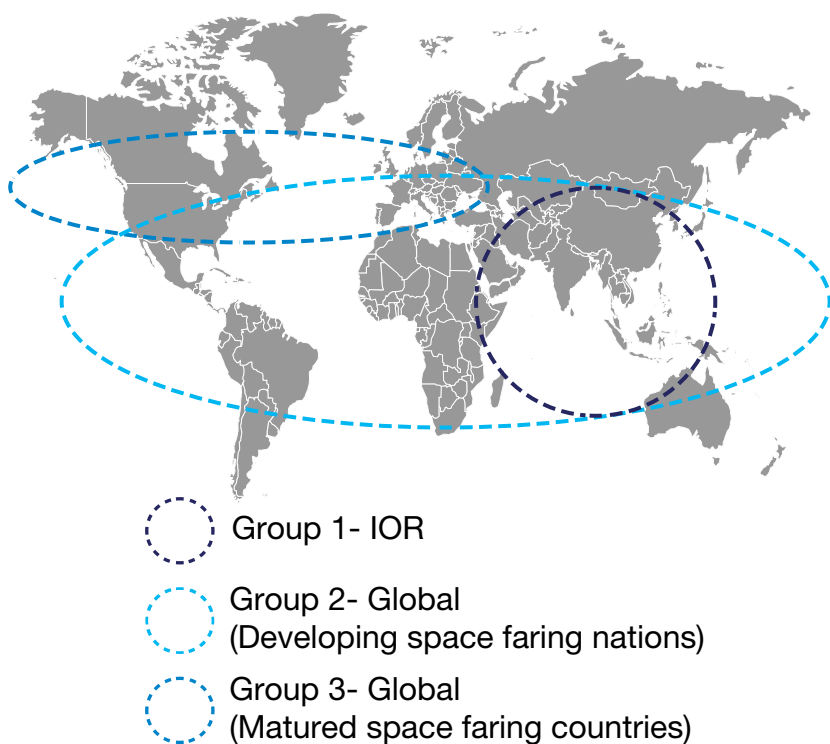
In-orbit economy, popularly called the Low-Earth Orbit (LEO) economy, is an emerging area wherein space research is conducted extensively to unearth offerings for Earth. In 2022, In-orbit Economy and Space Exploration was estimated to have market size of USD 134.0 Mn, with a potential of USD 1.0 Bn by 2033. The space agency given its technical capabilities and experience will lead the path for growth in this segment, working in close collaboration with the private sector for developing solutions for space traffic management and protection of space assets.



3.1.4. Export Capabilities

The Indian space-ecosystem has largely been self-reliant over the years. The advancement of technology, its ready-realisation and harnessing the same for Earth-based solutions has helped peg India in a unique position.

For exports, there are three groups, i.e., the Indian Ocean Region, developing space aspiring nations and mature space faring nations. Potential products and services for export for different geographical regions are shown in Fig 5. India needs to enhance its presence in Indo Pacific region across the vertical value chain to achieve the export potential of USD 11.0 Bn



Thrust Areas for Global Opportunities

Group 1: Indian Ocean Region

- Leverage EO, PNT and communication platforms
- Satellite & Ground Segment as a service
- Launch Segment as a service

Group 2: Global: Developing space aspiring countries

- Leverage EO, PNT and communication platforms
- Launch Segment as a service
- Satellite & Ground Segment as a service
- Global hub for small satellite Mfg. and small launch vehicle Mfg.
- Export of ground segment

Group 3 : Global: Matured space faring countries

- Global hub for small satellite Mfg. and launch vehicle Mfg.
- Downstream services
- Launch Segment as a service

Fig 5. Regions for the India to focus its space export products and services



3.2. STRATEGIC AND ENABLING CAPABILITIES

To foster the growth trajectory and develop space ecosystem, it is essential to possess the strategic and enabling competencies required to invigorate the private sector and develop marketplace. The strategic and enabling capabilities to be built have been depicted in Fig 6. The government, industry and academia need to work collaboratively to gain competitive advantage and achieve the mission.

Vision	A dominant Space power, which accelerates India's growth through space applications on Earth, strengthens capabilities in Space, creates socio-economic benefits and capabilities for growth		
Mission	To realize \$44.4 Bn market potential in Space for India, including \$10.6 Billion in exports, and create an ecosystem where private, public and startup collaborate in whole-of-nation approach		
Capabilities			
Strategic Capabilities			
Demand Generation Generation of demand nationally and internationally to drive space ecosystem as a vibrant marketplace	EO platform Establishing a long-term EO program enabled by PPP, focused on real-time and continuous availability of data of varying readiness	Comm Platform Augment comm & broadband connectivity through collaboration between Govt & private sector for telecom and data	
Nav Platform Build downstream capabilities for industry with existing constellation; Long-term, augment NavIC satellites	R&D Augment R&D capabilities in Downstream, Satellite, Launch and Ground segments for rapid space advancement	Ecosystem Create industrial ecosystem including government, public and private sector	
Enabling Capabilities			
Creation of Talent Pool	Access to Finance	International Synergy and Collaboration	
National Space Consciousness			

Fig 6. Strategic capabilities and enabling capabilities required to build a robust Indian space ecosystem

3.2.1. Demand Generation and Create Awareness

To bolster the capabilities of the Indian space sector and leverage the advantages of space-based technologies on Earth, it is crucial to stimulate demand among the end-user communities. Demand generation broadly involves:



a. **Demand Aggregation:** Identifying and consolidating existing problems that can be solved using space-based applications and services.



b. **New Demand Creation:** Identifying new problems that can be solved using space-based solutions to bring efficiency and effectiveness.

In each, defining the stakeholders, identifying their roles and ensuring their synergy becomes relevant. Demand generation will be driven by three stakeholder groups:



a. **Government** comprising Department of Space (DoS), user ministries and States to take leadership in demand generation in respective sectors across EO, PNT and Communication.



b. **Businesses** that will generate demand within the ministries and raise awareness among consumers.



c. **Consumer Groups** that will be the interface between the businesses and the end-user segments to highlight emerging needs for space technology and to drive its usage.

Additionally, in years to come, the development of a Space Marketplace, ref. Fig 7, as a common platform for buyers and sellers across up, mid and downstream is necessary. This can evolve as a comprehensive digital platform solution for space companies across EO, PNT and Satellite Communication domains to host their space-based applications that can be accessed by end-user segments. The platform would aggregate use cases across domains and sectors which would be accessible by businesses and consumers. In turn, it will also capture inputs from the consumers which will help businesses shape their solutions and make them consumer oriented.

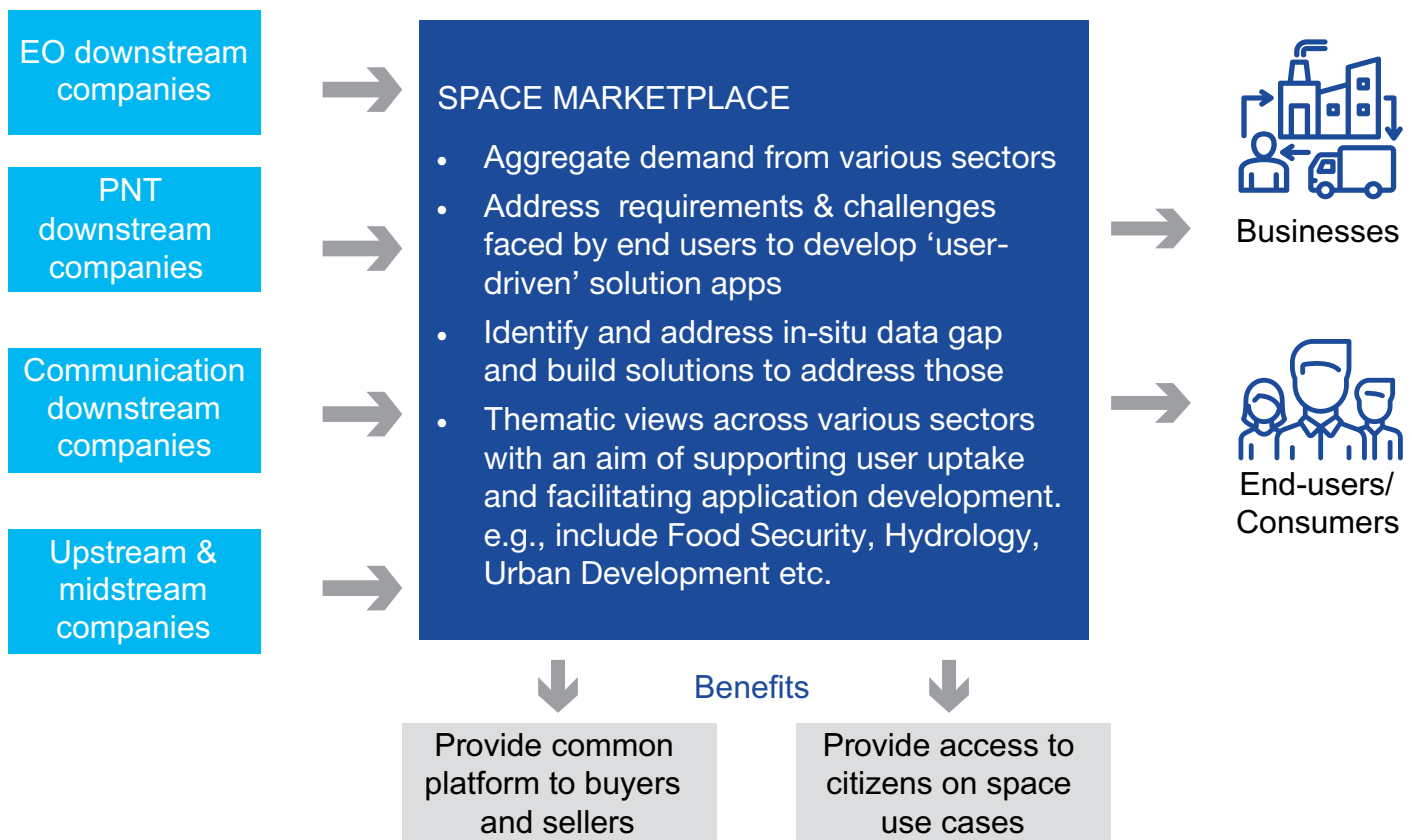


Fig 7. Space Marketplace and its description

Indian Space Outreach Wing

In order to stimulate the generation of demand and aggregation on both domestic and international fronts, establishing an Indian Space Outreach Wing within IN-SPACe is essential. This wing would collaborate with industry, investors, government ministries, and academia. The Outreach Wing will be responsible for conducting comprehensive market analyses across various sectors, organizing conferences and workshops, aiding in the aggregation of satellite demand and applications, and playing a pivotal role in fostering the growth of the space marketplace.

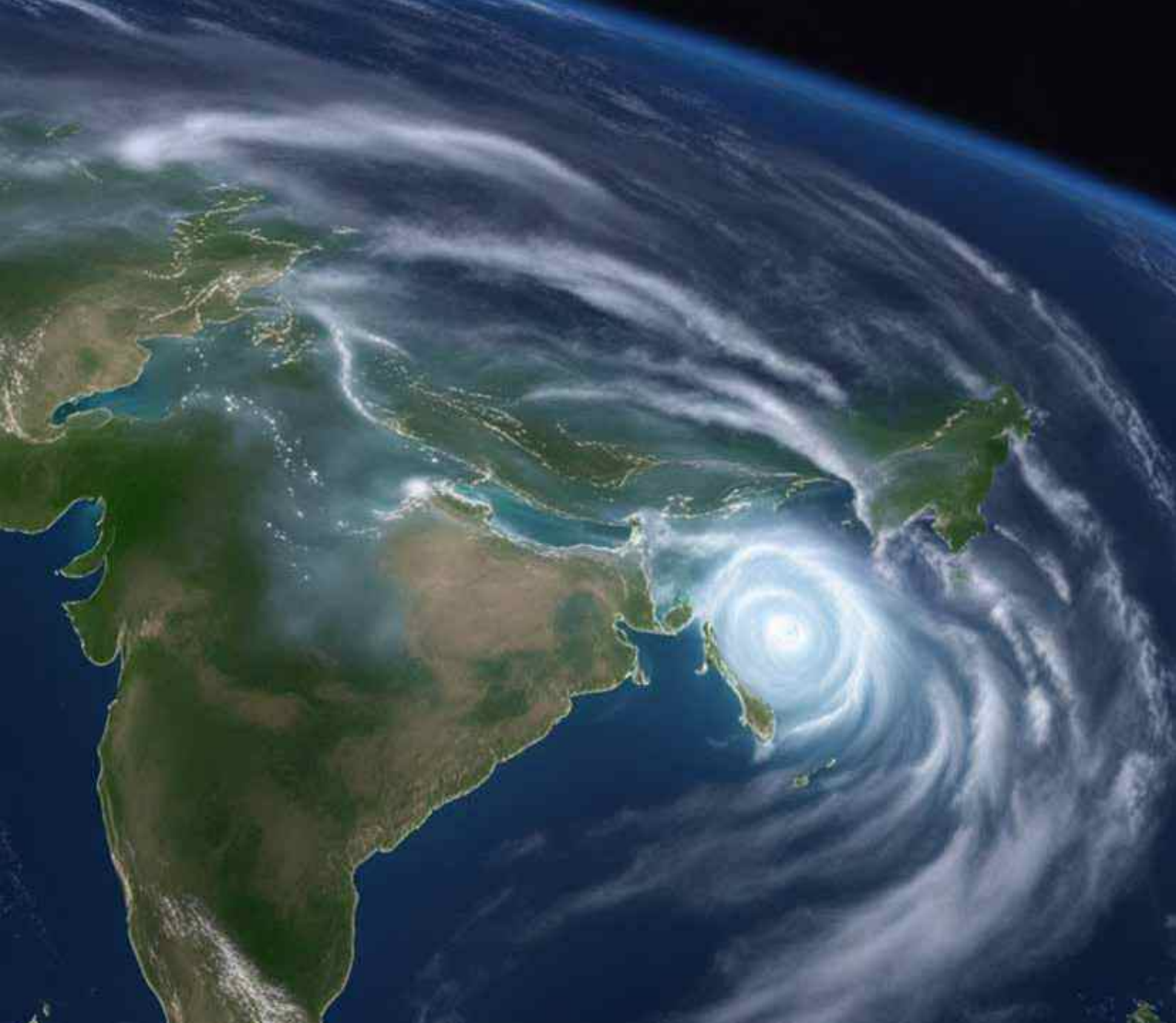
The following initiatives are being implemented for enhancing the capability for demand generation:

3.2.1.1 Creation of Space Outreach Wing within IN-SPACe - Creation of the Space Outreach Wing within IN-SPACe to undertake the below activities:

- a) Assessment of value propositions, impact estimation and prioritization for various sectors
- b) Demonstrate capabilities across EO, PNT and Communication with focus on benefits to the end users and commercial feasibility.
- c) Demand generation with the end-users by enhancing awareness and aggregate demand by building an interface between the end-users (e.g., farmers, builders etc.) and industry.
- d) Creating demand by developing unique applications from space-based data for government and consumers

3.2.1.2 Provision of global visibility of capabilities and offerings of Indian space sector

3.2.1.3 Creation of a global space marketplace, with support from the public and private sector



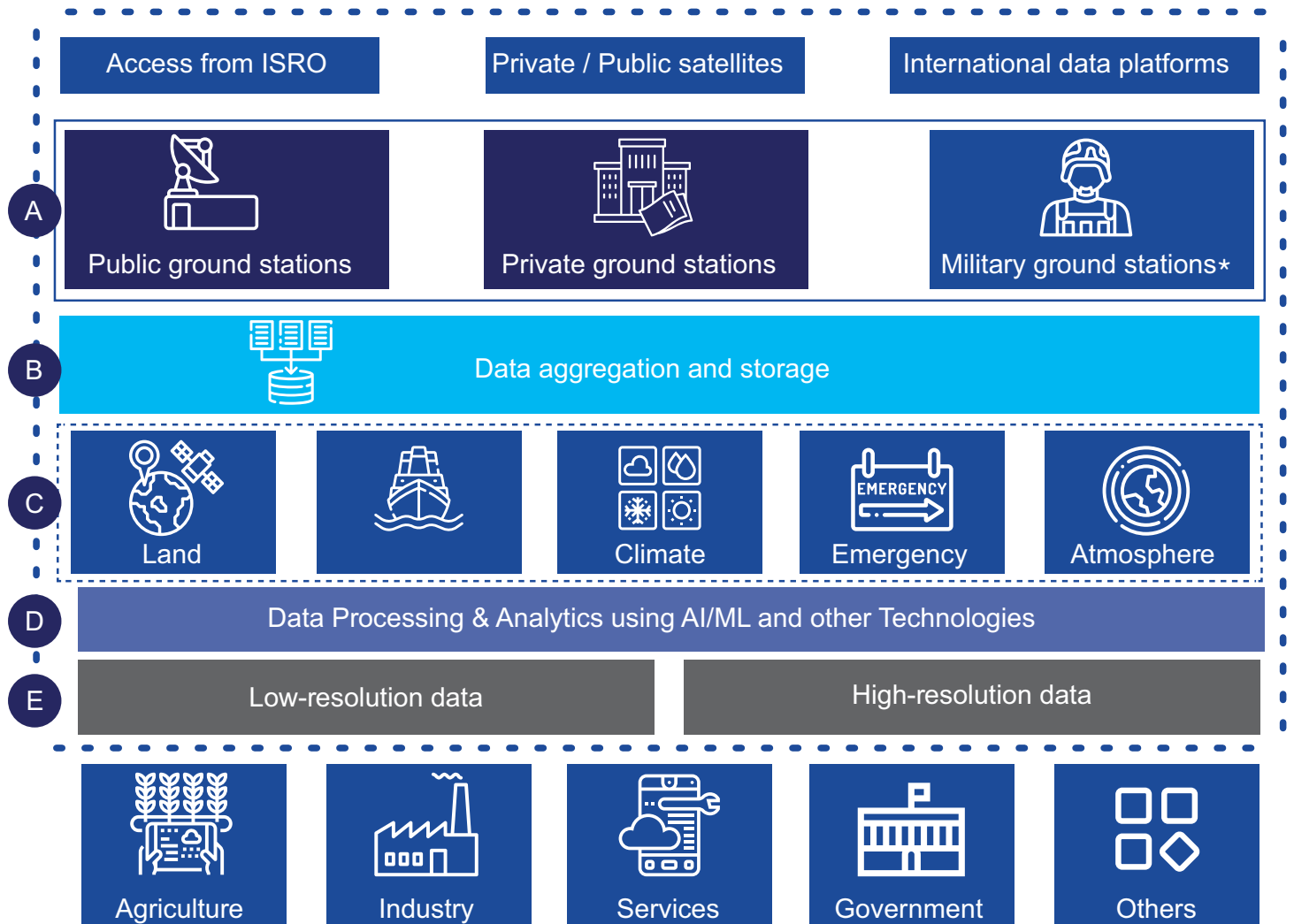
3.2.2. EO Platform

Earth Observation provides a distinct and timely data source from satellites, aeroplanes, drones, etc. that provides insights into environmental phenomena that are otherwise challenging to measure. This data can also be coupled with socio-demographic, economic, and public administration data to make indicators and analysis more pertinent and focused.

Ensuring high-quality data from an Indian EO platform is essential for downstream growth in the long-term. It will present opportunities for companies to develop space-based services that can harness the potential of this data across different industries. In this regard, having an indigenous platform will provide extensive benefits for the country in the long-term.

To design and implement a state-of-the-art EO platform, key guiding principles would include defining responsibilities for data collection, collation, aggregation & analysis, enhancing quality of data with high resolution and variety of EO data type, enhance frequency of data capture by reducing revisit time and defining data ownership and management structures, as depicted in Fig. 8.

EO Platform



*Military ground stations are not considered as they have been kept out of scope for the purpose of this study

Fig 8. Suggestive EO data platform

As seen in Fig 8, the platform is supported by the upstream which comprises access to data from space agency satellites, private and public entities and other international data platforms like Copernicus, Landsat, etc. The platform as such has five broad components:

- Ground Stations**, including those from the public sector, private sector and military facilities.
- Data Aggregation and Storage Layer**, which collects, aggregates and stores data from all the ground stations.
- Data Classification** includes Land, Marine, Climate, Emergency and Atmosphere data. A combination of data across these categories will be used for applications across industry sectors.
- Data Processing & Analysis** using AI/ ML and other emerging technologies will ensure that raw data is converted into a form in which it can be readily used.
- Data Availability** across different industry sectors

For this to become a reality, over the next few years, certain steps are being implemented.

The following initiatives are being implemented to enhance the capability for EO Platform:

- 3.2.2.1. Establishment of additional EO satellites to fill the data gaps, through public private partnership
- 3.2.2.2. Creation of EO data platform, led by the private sector
- 3.2.2.3. Managed services model for non-strategic ground segment operations
- 3.2.2.4. Accessibility of ISRO algorithms & APIs to NGEs
- 3.2.2.5. Establishment of CoE for algorithm development (including AI/ML)

Establishment of the EO platform would play a prominent role in consolidating demand from the end-user ministries, based on which the satellites will be launched for access to data.

3.2.3. Navigation

Over the last few decades, there has been a phenomenal growth in the number of applications that rely on data provided by space-based navigation systems.

The Navigation signals are offered free-to-air for a variety of applications across air, space, maritime and land applications covering location-based services, survey, mapping & Geographic Information System (GIS) and timing. The Government of India has therefore, established a resilient and independent system –Navigation with Indian Constellation (NavIC).

The following initiatives are being implemented for enhancing the capability for strengthening the navigation platform and value chain:

- 3.2.3.1. Strengthen the current NavIC constellation with capability to operate in L1 band
- 3.2.3.2. Demand generation for use of NavIC basis its value proposition in the downstream segment
- 3.2.3.3. Promote NavIC for IOR: Market NavIC in the Indian Ocean Region (IOR)
- 3.2.3.4. Feasibility assessment for expansion for global coverage



3.2.4. Satellite Communication

Satellite communication services can be divided into Broadcasting, Interactive communication services, and Internet. In the previous chapter, the value propositions under each of these subdivisions are listed and this section, builds a case for India's strategy concerning Satellite Communication services.

Broadcasting

With the emergence of the Over-The-Top (OTT) online streaming services, the traditional models of cable networks and Direct-to-Home (DTH) services are finding it challenging to retain their market share in user subscriptions. The increase in OTT subscriptions will further propel the consumption of internet data.

Satellite Internet

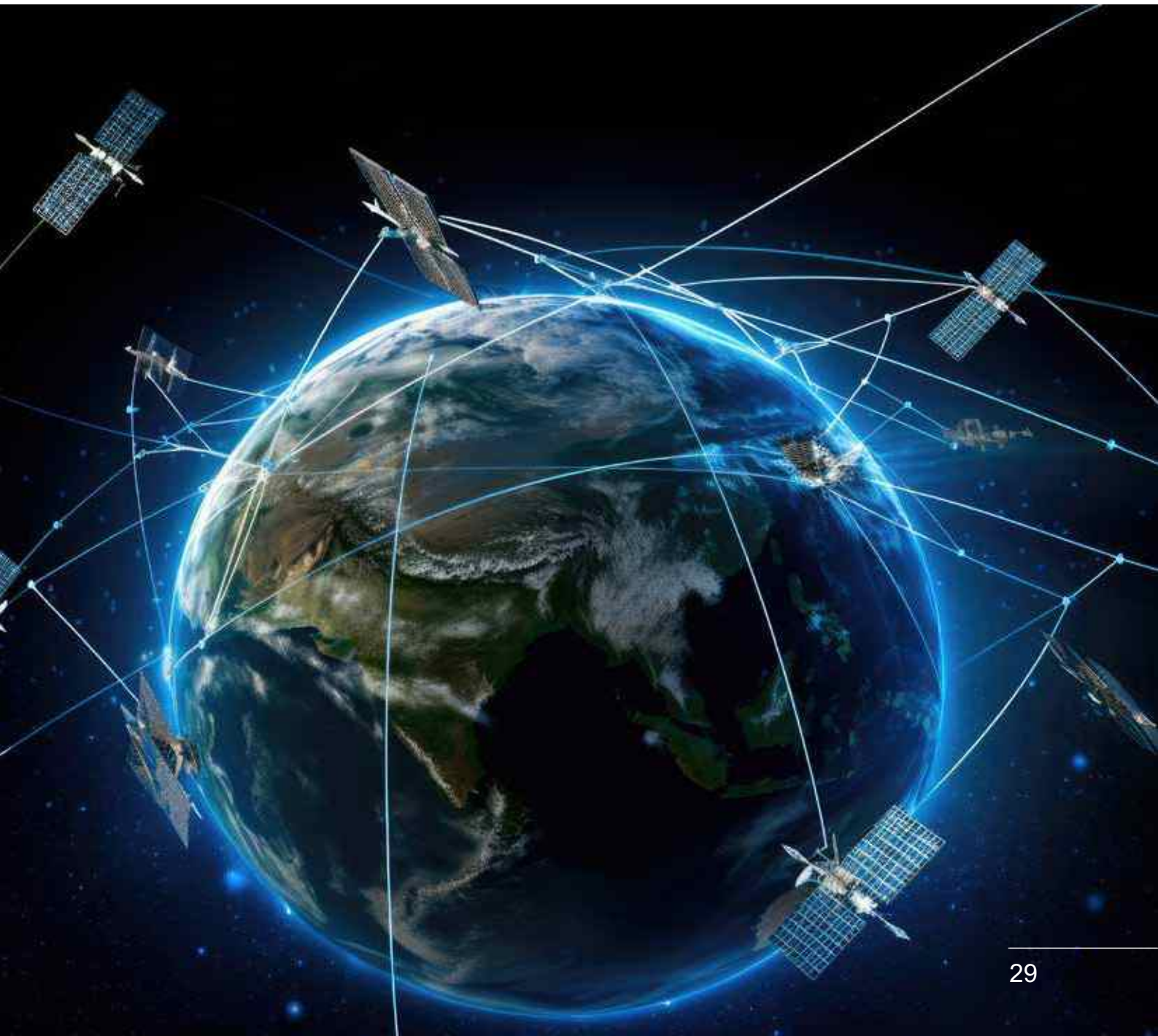
In recent years, the demand for high-speed networking is on the rise owing to expansion of internet. Satellite internet is gaining momentum in recent times to cater to this demand. The initial investment required for deploying satellite constellations is substantial and considering that the cost of terrestrial internet is low due to economies of scale, the current price of satellite internet in India is not viable. Enablement and facilitation through policy level support and encouragement of private sector to provide services to remote areas will be required.

The following initiatives are being implemented for augmenting the capability in satellite communication

3.2.4.1. Mid- and Long-term demand assessment for SATCOM capacity

- a) Formulation of an Implementation plan to provision the required throughput capacity
- b) Maintain space assets for broadcasting - future requirements to be addressed with new assets and services from both Indian & foreign players

3.2.4.2. Provide connectivity to remote areas through planned High-throughput Satellites (HTS) and enabling adoption of satellite broadband services through existing global LEO/MEO constellations.





3.2.5. Research & Development

Research and Development forms the backbone of any industry, especially the space industry that pioneers innovation. This underlines the importance of building strong R&D pipeline, within both public and private ecosystem to pilot innovative use cases.

- a. **For upstream**, private players should consider focusing on making India as a hub for small and medium lift launch vehicles. Further, the transition from Build-to-Print to Build-to-Requirement amongst the Indian domestic players is critical. Private players should also consider focusing on developing manufacturing technologies for satellites to make India a global hub for small satellite manufacturing and bolster collaborative R&D with ISRO in the design and development of satellite payloads. Private sector should also undertake R&D in the area of space exploration, space mining, in-orbit servicing and manufacturing in-space.
- b. **For midstream**, partnership agreements between ISRO and industry for co-development of technologies would be critical (e.g., Inter-linking of satellite networks, Quantum Communication, etc.). Further, private players would be encouraged to set up their own ground stations and will be given access to the ground stations setup by ISRO, subjected to availability.
- c. **For downstream**, ensuring the availability of sample data from different hyperspectral band for R&D and of industry-ready Application Programming Interface (API) based satellite data would be critical for the private sector. In addition, initiating programs to ensure the collaboration of ISRO with Indian private players and international partners would aid in development of joint capabilities.



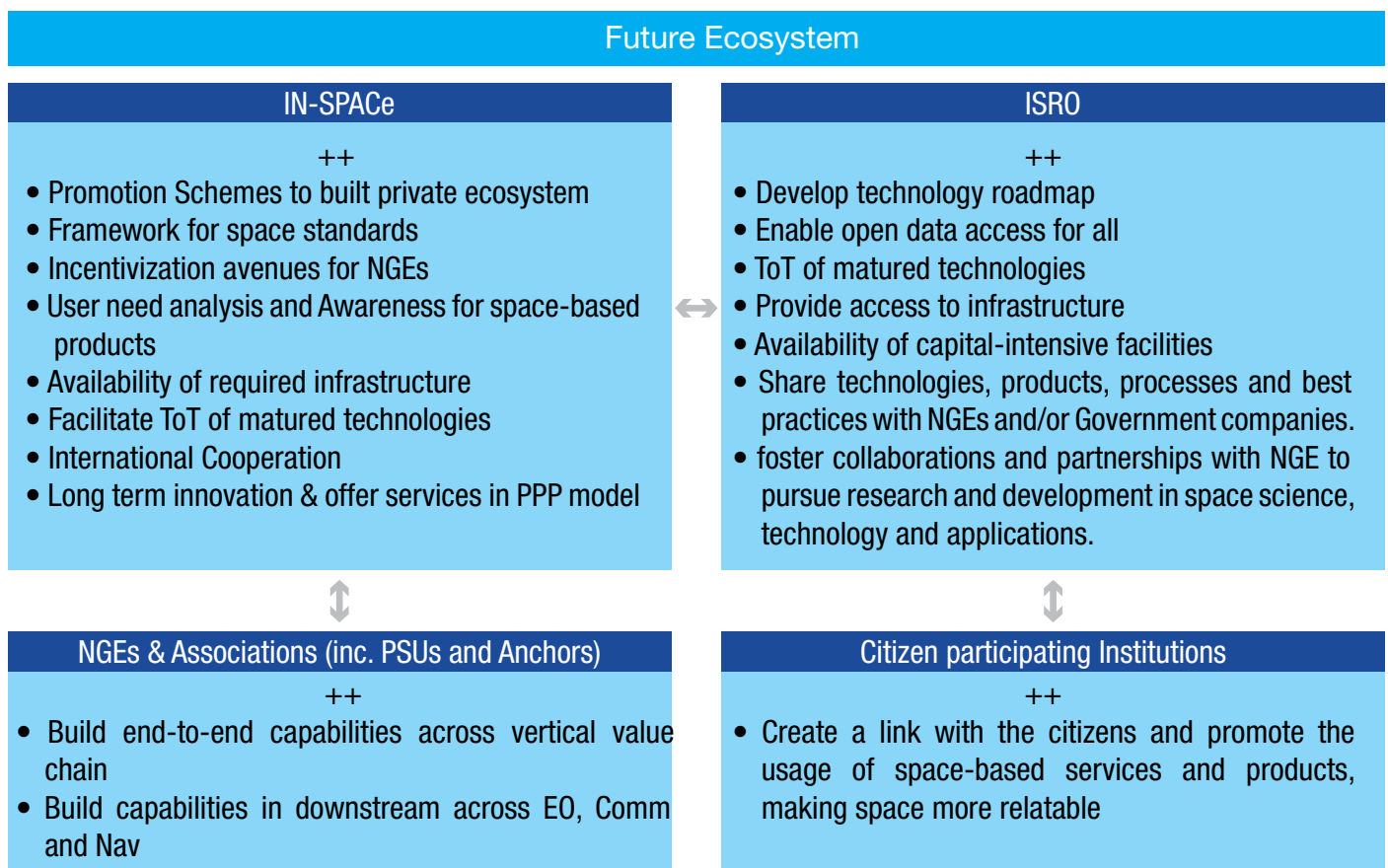
The following initiatives are being implemented for enhancing the research and development activities:

- 3.2.5.1 Create R&D roadmap with market-driven technologies
- 3.2.5.2 R&D funding to enable the private sector
- 3.2.5.3 Accelerating ToTs for matured and operational technologies to the private sector
- 3.2.5.4 Development of R&D platform for govt., academia, public and private sector with shared assets (incl. CoEs)



3.2.6. Develop Industrial Ecosystem

The space industry offers the potential for economic, technological, and strategic advancements within the nation, thereby contributing to enhanced growth and innovation. This prospect is supported by the an approach to build a democratized ecosystem, which aims to construct an inclusive and democratized space ecosystem in the future, as shown in Fig. 9.



++ = In addition to current charter

Fig. 9: Approach to build an ecosystem on the principles of Dhruv Tara

The ecosystem will be built on five key pillars with participation from the government, the public sector, and the private sector

a. Collaboration between National Space Agency and private players

- Enabled through shared technology expertise and infrastructure
- NSIL to be a customer with demand visibility by providing equal opportunities
- Partner for collaborations with defined roles and risk-reward management
- Collaborator with Industry-Academia-Government, playing an instrumental role in advancing research and in creating a skilled workforce

b. Creation of space clusters

- Co-location of industry, R&D organization and academia
- Ease of Access
- Common Facilities



c. Enhancing manufacturing capabilities and capacity

- Augment private sector capabilities in satellite and launch vehicles
- Redefine existing Foreign Direct Investment (FDI) norms to make it attractive

d. Develop Resilient supply chain

- Build the supply chain with a capacity to resist and recover during disruptions
- Indigenization of space grade manufacturing components such as space chips, power amplifiers, TWTAs (Traveling- wave tube Amplifiers) and space grid electronic components
- Focus on creating an insurance framework to become a high capital intensive and high-risk segment

e. Infrastructure availability

- Access-to-Space agency facilities & shared infrastructure

The following initiatives are being implemented to develop industrial ecosystem in the country:

- 3.2.6.1 Develop private sector capabilities with space agency acting as a mentor, enabler and customer
- 3.2.6.2 Ensure a level playing field to NGEs
- 3.2.6.3 Develop and augment private sector manufacturing capabilities for satellite manufacturing, LVs & ground segment in collaboration with States
- 3.2.6.4 Augment existing infrastructure, promoting use of shared platforms to aid private sector participation
- 3.2.6.5 Create space clusters to promote collaboration between ecosystem players & promote knowledge sharing, R&D
- 3.2.6.6 Build resiliency in value chain with focus on indigenization and reduced dependence on imports



3.2.7. Talent Creation

In 2020, Prime Minister Shri. Narendra Modi took the initiative to open up investments for India's space sector and expressed his belief that India's space expertise would reach the same level of success as that of IT sector.

The following initiatives are being implemented to create talent in space sector:

- 3.2.7.1 Establish Talent and Skill transfer programs, including leveraging expertise of ISRO retired scientists
- 3.2.7.2 Increase Space academic courses, including undergraduate, postgraduate and short-term courses to provide end-to-end knowledge in space technology, along with AI/ML and GIS courses
- 3.2.7.3 Create a Space sector skill development council under NSDC
- 3.2.7.4 Access to space knowledge platforms & forums



3.2.8. Access to Finance

In the last few years, new investments have fuelled dynamism and innovation throughout the space ecosystem. Global investment numbers reveal that a significant share of space investments was made in EO and launch segments. Indian space investments as of 2022 were ~USD 111 Mn, with most Indian space entities receiving Seed and Series funding mostly operating in the upstream.

The following initiatives are being implemented to encourage private investment in space sector:

- 3.2.8.1 Encourage Private Equity /Venture capital/ Angel investments to promote start-ups
- 3.2.8.2 Connect investors (Private Equity /Venture capital/ Angel investments) with space industry
- 3.2.8.3 Promote Debt Financing from Banks and NBFCs



3.2.9. International Synergy and Collaboration

Space is seldom marked by well-defined contours. It can be understood when collaboration takes place at national and international levels. Learnings from other space-faring nations are crucial to aid development of joint capabilities and promote space governance. For instance, continually participating in discussions at UN-COPUOS, collectively addressing global space governance, space safety and sustainability issues can be ways to promote collaboration on a global stage. In this regard, key areas and partners of collaboration have been highlighted in Fig 10.

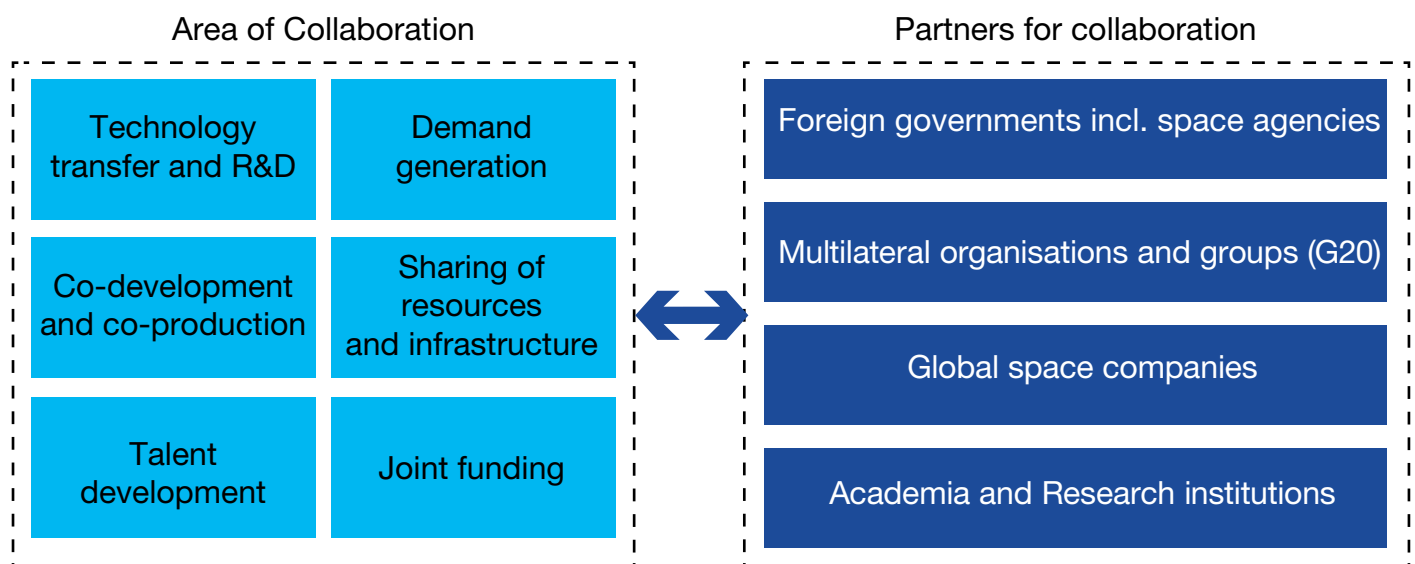


Fig 10. Areas of and partners for collaboration and synergy

The following initiatives are being implemented to encourage international collaboration in space sector:

- 3.2.9.1 Establish an international collaboration cell, within IN-SPACe, to give thrust to international cooperation and representation in commercial space sector.
- 3.2.9.2 Undertake demand generation and access to global markets for 'Made in India' space products and services
- 3.2.9.3 Promote co-development & co-production to accelerate development of niche joint-capabilities within the private sector.
- 3.2.9.4 Undertake International partnership programs with space-aspiring nations to enable private sector access to emerging markets



3.2.10. Develop Space Culture and Consciousness

India has a deep-rooted space culture that dates back to ancient times. The nation has consistently led the way in technological innovations and breakthroughs in the field of astronomy.

In this respect, for greater public participation amongst India's citizens, key initiatives in the areas of education, merchandise, entertainment, and tourism needs to be promoted. Within education for instance, a national workshop for teachers can be a way to find synergies using which teachers can seamlessly integrate space-related concepts to students. Merchandise also would be an effective way to advertise recent achievements and future launches to a larger audience and exposure to the space events, resulting in a considerable uplift. Music, movies and documentaries further may garner interest in space subjects. Lastly, Space centres, planetariums and museums are another way to promote space education among civilians.

The following initiatives are being implemented to accelerate development of space culture in the country:

- 3.2.10.1 Educational activities to promote space in daily lives of the civilians through space exhibitions, publishing of space magazines and workshops for teachers.
- 3.2.10.2 Promote reach to larger audience through use of merchandise
- 3.2.10.3 Utilise digital media through movies/documentaries/music, and space focused news for promoting space consciousness.
- 3.2.10.4 Undertake linking of space centers to state and central tourism drives as well as utilising space museums and student volunteers to explain space to public, effectively promote space awareness.
- 3.2.10.5 Promote programs focused on increasing girl child exposure to space to enable diversity in the sector

4

Creating Right-to-Win

From the amalgamation of initiatives spanning the essential strategic capabilities, four pillars of action emerge, encompassing ten guiding principles, all aimed at achieving the \$44 billion market potential for the space sector in India. The four pillars of expansion are elucidated in Fig. 11, as given below:

- a. **Build platforms.** Build Earth Observation, Navigation and Communication platforms focused on downstream growth and supported by creation of upstream capabilities.
- b. **Create ecosystem.** Create industrial ecosystem with collaboration across govt, public & private sectors and augment R&D capabilities in Downstream, Satellite, Launch & Ground segments for rapid space advancement.
- c. **Enable industry.** Enable access to finance, create a talent pool to address future skill requirement and promote a conducive policy environment.
- d. **International Outreach.** Bolster initiatives for demand generation and access to global markets. Promote space industry collaboration to support growth.

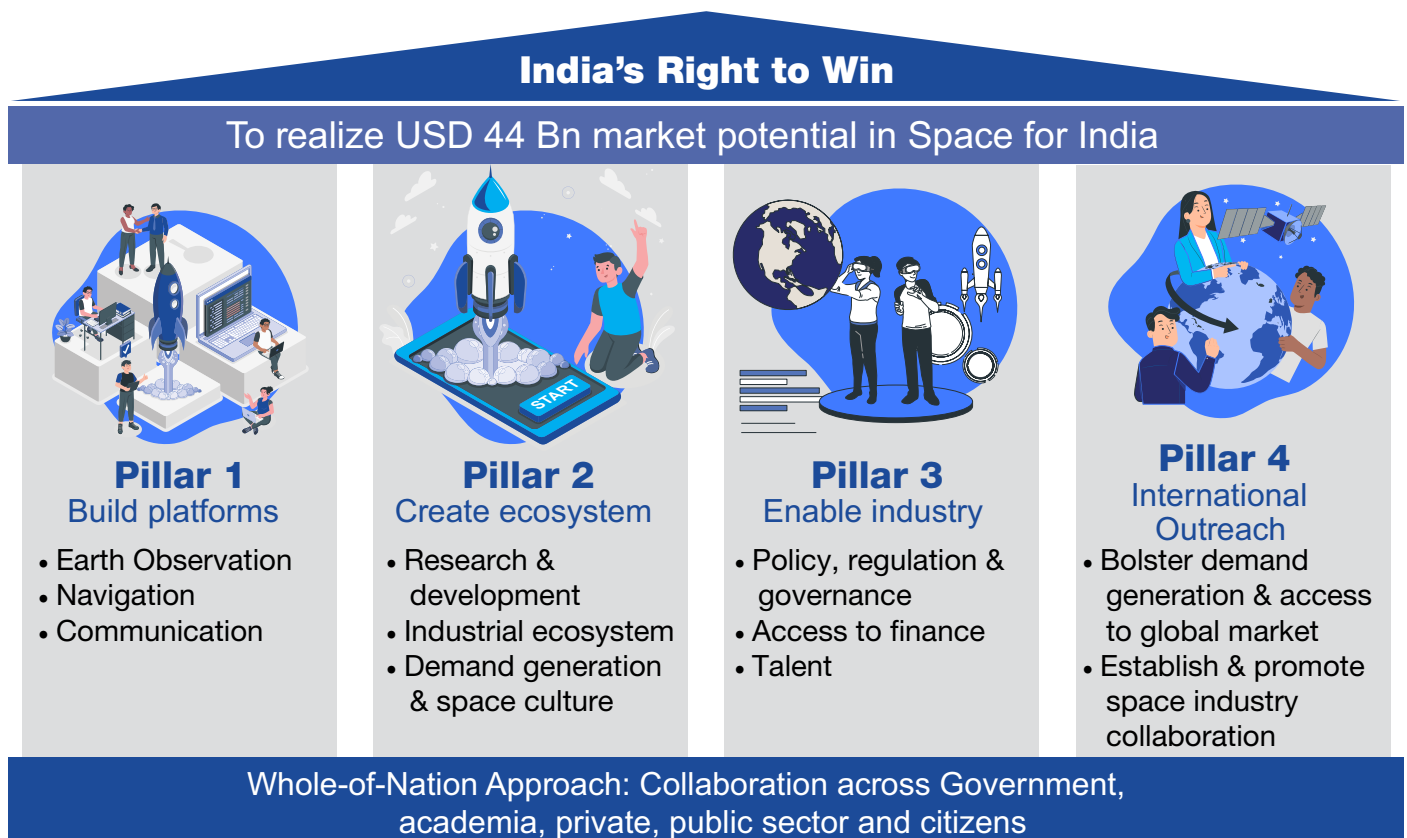


Fig 11. Defining the Pillars for Action

Conclusion



In conclusion, the decadal vision and strategy for the Indian space ecosystem represents a significant leap forward in our journey towards becoming a global leader in the space sector. It is not merely a roadmap but a comprehensive 'Right to Win' that sets the stage for India's ambitious foray into the competitive global landscape of space exploration and innovation.

By emphasizing a 'Whole-of-Nation' approach and aligning itself with growth themes, this strategy recognizes that the Indian space ecosystem's success is not only about scientific and technological advancements but also about fostering a robust collaborative environment. The ten guiding principles within the four pillars of action encompass the essential elements required to achieve success, such as innovation, collaboration, infrastructure development, and a strategic approach to international partnerships. This approach has the potential to take the value of the Indian space economy to US\$ 44 billion by 2033.

India's potential in the ever-evolving space sector is vast, and this decadal vision and strategy serve as a crucial tool to unlock and realize that potential. It lays the foundation for India to make a lasting impact on the global stage, contributing to scientific discoveries, economic growth, and societal development.

As we move forward with this vision, it is imperative that we remain adaptable and open to change, continually assess our progress, and build upon our strengths. With determination, commitment, and unwavering dedication, India is poised to play a defining role in shaping the future of space exploration, and this strategy paves the way for our ascent to greater heights.

**"There should be no space between the
common man and the space technology"**
Hon'ble Prime Minister Shri Narendra Modi







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