Confederation of Indian Industry

Propelling India into a new era of space and innovation

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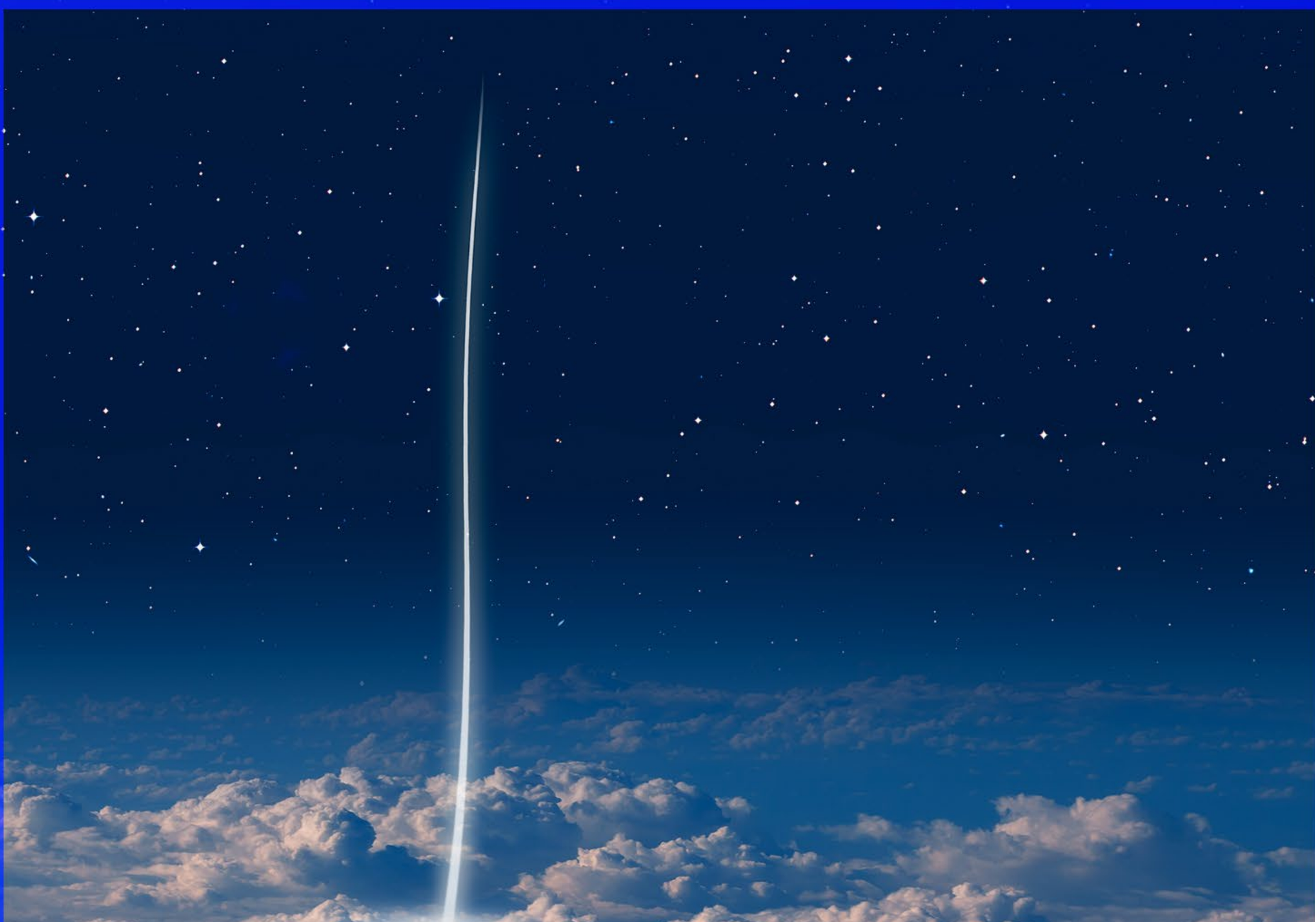

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Foreword-CII

India's space sector has undergone a transformation, evolving from a mission-led programmes to an innovation-driven economy anchored in satellite-enabled services and applications. With significant number of private entities now engaged in space-tech, the sector is witnessing rapid growth in areas such as satellite communication, earth observation, navigation, and space-based analytics, contributing significantly to national development and global competitiveness.

As Chairman of CII's National Committee on Space, I am pleased to introduce this Thought Leadership report that explores the emerging opportunities shaping India's evolving space landscape.

The report focuses on the rising significance of observation, communication, and navigation technologies powering digital infrastructure whilst supporting delivery and enhancing national preparedness. It highlights the critical role of institutional reforms, public-private collaboration, and data-driven service models in scaling real-world impact, which are aligned with India's long-term vision for self-reliance and global leadership, CII recognises the imperative of building a robust and service-oriented space economy through innovation, investment, and ecosystem coordination.

We extend our appreciation to all contributors for their insights and support. Special thanks to KPMG in India for partnering with us in the development of this important publication.

Mallavarapu Apparao
Chairman
CII National Committee on Space

Foreword-CII

India's space economy is entering a new phase defined not only by launch and mission success, but by the integration of satellite-based capabilities into governance, development, and national resilience. Today, majority of India's operational satellites support applications in agriculture, disaster management, communication, and infrastructure monitoring. Initiatives like Bhuvan, GAGAN, and RISAT have enabled real-time data access for ministries, improving decision-making and delivery of public services. This shift signals the transformation of space from a scientific frontier to a critical enabler of socio-economic growth and strategic self-reliance.

As we embark on this new phase of India's space sector, the Confederation of Indian Industry is pleased to present the report on Propelling India into a new era of space and innovation'. This Thought Leadership publication examines how Earth Observation (EO), Satellite Communication (SatCom), and navigation solutions are finding widespread application across priority sectors.

The report explores how space-based services are being adopted to address challenges in disaster response, urban planning, logistics, secure communication, and environmental monitoring. It also highlights the importance of interoperable platforms, public digital infrastructure, and outcome-focused procurement in scaling adoption.

As India looks ahead to its Vision 2047 goals, it is essential to embed space applications into operational systems, backed by policy certainty and institutional readiness.

We thank all stakeholders who contributed to this effort and express our appreciation to KPMG in India for their partnership with CII.

Rohan Ganapathy
Co-chairman
CII National Committee on Space

Foreword-CII

India's space programme is significantly enhancing the nation's scientific, economic, and strategic stature, as demonstrated by milestone achievements such as Chandrayaan-3 and the recent NISAR mission. Presently, the Indian space sector is valued at USD8.4 billion, representing approximately 2–3 per cent of the global space industry. Projections suggest that by 2033 the sector will expand to USD44 billion, with exports contributing USD11 billion[1], further solidifying India’s role as a prominent participant in the international space arena.

Driven by ISRO, a growing private sector and nearly 200 emerging startups , the sector is witnessing rapid innovation in satellite manufacturing, launch vehicles, and downstream services[1]. The ecosystem is now at a turning point and moving beyond scientific milestones to mainstreaming space-based services across sectors such as infrastructure, agriculture, logistics, disaster management, banking, finance & insurance and defence.

This report, "Propelling India into a new era of space exploration and innovation," has been prepared by the Confederation of Indian Industry (CII) to provide an overview of recent developments in India's space sector. The publication outlines this transition and identifies major factors that may influence the future of space-enabled development in India.

The report highlights the increasing role of space-based services in infrastructure planning, disaster resilience, agriculture, and public services, noting their growing integration with sectoral transformation.

As India aspires toward global leadership by 2047, building a vibrant, inclusive and innovation-led space service ecosystem will be essential.

We acknowledge KPMG in India for their valuable support as our knowledge partner and extend our appreciation to all contributors whose efforts have been instrumental in advancing this significant initiative.

Chandrajit Banerjee
Director General
Confederation of Indian Industry

[1] Decadal Vision and Strategy for Indian Space Economy, October 2023, India’s share in global space economy to rise 4 times by 2030: MoS Department of Spacecraft, PIB, June 2024

Foreword-KPMG in India

India stands at a pivotal juncture in its space journey where the foundations built over decades are enabling a leap towards scale, integration, and global leadership. This phase is characterised by an expanding role in the global space economy, the diversification of applications across national priorities, and the growing participation of industry alongside government-led programmes. With advancements spanning launch infrastructure, satellite manufacturing, and mission design, combined with the transformative potential of space-derived solutions, the imperative is to translate vision into an integrated strategy that advances both capability and adoption.

This report examines how space-based assets, services, and data are becoming essential enablers of governance, economic growth, and security. It captures the sector's shifting landscape from strengthening launch and satellite capacity to the increasing integration of space-enabled solutions in domains such as infrastructure management, environmental stewardship, disaster resilience, and defence preparedness.

Realising this potential requires coordinated action among policy-makers, industry, academia, and international partners. The emphasis should be on fostering innovation, ensuring interoperability, building resilient infrastructure, and strengthening value chains that connect space capabilities with the needs of diverse user communities.

Through this thought leadership, KPMG in India seeks to provide an evidence-based perspective on the sector's growth pathways, drawing on a detailed analysis of capabilities, demand drivers, and adoption imperatives. The aim is to support decision-makers in aligning policy, investment, and partnerships to deliver sustained national and global impact.

As India navigates this new chapter in its space journey, collaboration, strategic foresight, and a shared commitment to excellence will be critical to securing its position as a trusted and influential player in the evolving space economy.

Gaurav Mehndiratta
Partner and National Head
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Nipun Aggarwal
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Executive summary

India's space sector stands at a pivotal point in its evolution where decades of scientific and technological progress have converged with expanding global opportunities and strategic imperatives. Recent milestones such as the Chandrayaan-3 South Pole landing, launch of the joint NASA-ISRO NISAR satellite for advanced earth monitoring and the development of a next generation heavy lift rocket underscore both India's capability for breakthrough science and the accelerating tempo of space activity worldwide. The global space economy, valued at USD596 billion in 2024, is projected to exceed USD1.8 trillion by 2035, growing at nearly 9 per cent annually. India's current share of nearly 2 per cent is expected to expand to around 8 per cent in the coming decade, driven not only by cost-effective launch systems and satellite manufacturing but, critically, by the operationalisation of downstream services that embed space-based capabilities into governance, economic development, and security[1].

This thought leadership emphasises that the decisive lever of growth lies in translating space infrastructure into mission-grade services. Earth Observation, Satellite Communication, and Navigation (PNT) are already integrated into diverse national missions from disaster management, urban planning, and agriculture to secure communications and transport logistics. The imperative now is to systematise this integration, ensuring interoperability, reliability, and adoption at scale.

India's downstream space ecosystem is transitioning from fragmented adoption to structured service delivery. Achieving this requires not only infrastructure readiness but also institutional maturity and programmatic alignment that place space services at the centre of national workflows. Digital Public Infrastructure (DPI) provides the rails for this transformation, linking space-based inputs seamlessly with governance platforms, financial systems, and citizen-facing applications.

Strategic priorities for operationalising downstream include:

- Demand aggregation through anchor projects in flagship programmes, creating predictable markets for EO, SatCom, and PNT services.
- Interoperability and open standards to ensure seamless integration of space-derived inputs across ministries, states, and enterprises.
- Service-oriented procurement and financing models that shift focus from asset acquisition to outcomes, supported by risk-mitigation mechanisms.
- Capacity building across states, municipalities, and enterprises to enable adoption and institutionalise usage.
- International collaboration and standards harmonisation to strengthen credibility, interoperability, and India's regional role.

[1]"Annual Economy Overviews" Archives, The Space Report, 2024, Economic Survey, IN-SPACe, accessed in July 2025

Additionally, the need for liberalised regulatory framework (incentivizing private sector, finalisation of draft policies and notification of proposed FDI norms) and sustained investments to support mission-grade services.

Strategic domains such as defence, disaster management, and governance set the benchmark for mission-grade adoption. Low-latency Earth Observation pipelines, secure communications, and resilient navigation systems are shaping operational continuity in these sectors. At the same time, integration with digital public infrastructure is catalysing adoption across agriculture, health, logistics, and financial services embedding space-based services into India's growth architecture.

The report highlights that, India's downstream space ecosystem is thus shifting from an innovation-led phase to a foundational pillar of resilience, development, and strategic advantage. By operationalising downstream embedding services into governance systems, aligning procurement with mission needs, and building capacity across stakeholders, India secures its trajectory to expand its global share and shape the future contours of the international space economy .

1 Space economy

The space economy encompasses commercial and scientific activities for utilising space resources for the benefit of the human race. It's more than just rocket launches and astronauts; it's about harnessing the power of space to improve life on Earth and create new opportunities for growth and innovation. This includes the development and use of space-based technologies, products, and services, such as satellite communications, Earth Observation (EO) data, and space related manufacturing. Furthermore, it encompasses all the supporting industries in the up/mid/downstream such as advanced materials, engine manufacturer, data analytics and Artificial Intelligence (AI) etc. Globally, space sector is playing a key role in enabling companies across industries to generate revenues across the entire spectrum of the space value chain. As India's space programme continues to mature and diversify, it is poised to seamlessly integrate with the broader international network of partnerships, scientific breakthroughs, and visionary initiatives.

1.1 Global space eco-system

The global space economy was valued at an estimated ~INR51 lakh crores (USD596 billion) in 2024, with an average annual growth of 5 per cent to 8 per cent over the last decade. It is projected to reach ~INR155 lakh crores (USD1.8 trillion) by the year 2035 growing at an average annual rate of 9 per cent[1].

Then	Now
Digital domain	Space domain
The internet, 1990s	The Space industry, 2020s

As per the statistics available on space assets[2], a record number of launches took place in 2024 with a total of 259 launches i.e., an average of one every 34 hours, which is five hours more frequently than in 2023. The launch pace is likely to further grow in 2025, with launch operators planning site improvements as well as more frequent launches owing to the requirement of building and updating the communications satellite constellations. Increasing launch activity
is allowing more nations to enter the space industry: Senegal and Croatia deployed their first satellites in 2024, bringing the number of nations with an active satellite in orbit to 92[3].

[1] "Annual Economy Overviews" Archives, The Space Report, 2024.
[2] Orbital launches in 2024, SpaceStats, accessed in August 2025
[3] "Annual Economy Overviews" Archives, The Space Report, 2024

1.2 Emerging trends in space exploration[4]

Emerging trends

Commercial space ventures, Significant private investment and potential government collaboration on critical missions.
- SpaceX, Axiom, Sierra Space, Blue Origin, and Virgin Galactic are advancing commercial spaceflight and research.

As space becomes accessible to non-astronauts, this sector is poised for significant **commercial growth**.
- Sub orbital **space tourism** market size ~ **USD 396 Mn** by **2031**, Orbital space tourism revenue to reach **USD 555 Mn** by **2030**.
- **Major players**: Virgin Galactic, SpaceX, Blue Origin, Space Adventures, Zero 2 Infinity

The **small satellite** revolution represents a shift in the space industry towards smaller and more cost-effective satellite designs. EnduroSat's Balkan Constellation, a constellation of More than 120 small satellites will provide data to support maritime and civil security, and humanitarian and environmental monitoring, aiding agriculture, climate, and urban planning

Satellite based internet: Satellite internet is a technology that leverages constellations of satellites to provide global internet coverage which is vying to compete with terrestrial networks.
- Mega-constellations by Project Kupier, Starlink, China Guowang, Oneweb.

Reusable launch vehicle technology is being pursued with the aim to reduce launch costs and increase launch frequency.

SpaceX's Starship, Blue Origin New Glenn, ISRO's NGLV, Firefly Aerospace MLV, Rocket Lab Neutron, Opus aerospace, PLD space

Advanced tracking and automated systems are crucial to manage increasing **space traffic** and avoid collisions.
- **57,000+** space objects regularly tracked.
- Space traffic management market is poised to grow at **~7.1%** CAGR.

Space ports: As space becomes more congested and competitive, organisations are looking further away and contemplating ambitions missions for exploration and commercialisation of **deep space objects**.
- NASA's **Artemis II** (2025), **Artemis III** (2028), **BepiColombo**: mercury flyby, **Dragonfly**: Titan (2028).
- **Venus Orbiter Mission** – India (ISRO) 2028.
- **ExoMars** rover, **Plato**: terrestrial exoplanets (2026), **Ariel**: exoplanets (2029) .
- **Tianwen -4**: Jovian system (2029).
- **Golden Dome project of the US** that aims to see the design and deployment of next-gen missile defence shield over the entire continental U.S to detect, track and intercept advanced aerial threats

Deep space exploration, **Space traffic management**.
Commerce in space is becoming increasingly congested, contested, and competitive. The same can be said for the ground-based assets, necessitating creation of spaceports and mobile **spaceports** for small satellites.
- ~ **50** spaceports worldwide, **30+** proposed new spaceports.

The space eco-system is likely to have a tectonic shift in the way it will be perceived in future[5] with:

- Increasing public interest and investment in space activities worldwide.
- Rising private investment in space ventures, linked to profitability and a growing Venture Capital (VC) market.
- Development of commercial activities worldwide.
- Integration of space into the society and economy leading to value creation along with socio-economic benefits.
- Rising commercial space ventures including the recent Axiom mission 4 aboard SpaceX Dragon 'race'[6] as well as the galactic research missions carried out by Virgin Galactic[7]. There may be many more such commercial ventures planned in future for the purpose of tourism, research and transportation.

[4] Artemis - NASA, SpaceX - Starship, What is 'Project Kuiper,' Amazon's New Satellite Internet Initiative? About Amazon (Official website), accessed in 2025
[5] Handbook of measuring space economy: What is the Space Economy? European Space Agency, October 2019
[6] Axiom-4 mission, ISRO, accessed in July 2025
[7] Research fact sheet, Virgin Galactic, accessed in July 2025

1.3 Indian space eco-system

In the Indian context, its space journey started with the establishment of the Indian National Committee for Space Research (INCOSPAR) in 1962, which was later reconstituted as the Indian Space Research Organisation (ISRO) in 1969[8]. From early 2000, space activities saw a rapid expansion with a focus on innovative missions and global outreach including the capabilities to manufacture an indigenous cryogenic engine used to power the upper stage of Geosynchronous Satellite Launch Vehicle (GSLV) used to launch satellites of foreign nations using its own indigenously built Polar Satellite Launch Vehicle (PSLV). In recent years, India has taken up marquee programmes for the advancement of its space ecosystem including the Chandrayaan2/3 mission, Geo Synchronous Satellites (GSAT) communication satellites, NavIC navigation system, Radar Imaging Satellites (RISAT) EO satellite series, among others.

India has emphasised the need to promote private sector activity in all high technology areas including space exploration to unlock its business potential. The space economy is growing with a renewed interest from the private sector, with diversified applications including space resource utilisation and space tourism also being considered.

Building on the success of the Indian space initiatives, including the recent Chandrayan 3 and Aditya L1 missions, India now aims for new and ambitious goals, including setting up 'Bharatiya Antariksha Station' (Indian Space Station) by 2035 and sending first Indian to the Moon by 2040[9]. There is now a growing belief amongst industry members about a clear vision and direction which has the potential to catalyse significant technological advancement in space exploration and related fields[10].

Technology advances have enabled lower weight payloads to meet customer requirements in communication, EO, and technology demonstration. These roles were traditionally fulfilled by heavier satellites in geosynchronous and medium earth orbits; however, they are now being fulfilled by small satellite constellations in Low Earth Orbit (LEO). The LEO constellations are generally planned up to a height of 1000 kms, which offers advantages of higher resolution, lower latency, and higher frequency of revisit. To keep pace with global technology trends, ISRO has developed a Small Satellite Launch Vehicle (SSLV) to launch LEO satellites. Furthermore, the rise in demand for small satellites because of its cost effectiveness, technological advancement, rapid deployment capabilities and innumerable commercial opportunities is likely to lead its serial production.

In order to meet the positioning, navigation and timing requirements of the country, ISRO has established a regional navigation satellite system called Navigation with Indian Constellation (NavIC). NavIC is designed with a constellation of 07 satellites[11] and a network of ground stations operating round the clock offering services i.e., Standard Position Service (SPS) for civilian users and Restricted Service (RS) for strategic users. NavIC SPS signals are interoperable with the other Global Navigation Satellite System (GNSS) signals. India has also developed GPS Aided GEO Augmented Navigation (GAGAN), a Space Based Augmentation System (SBAS) developed to provide the best possible navigational services over Indian Flight Information Region (FIR) with the capability of expanding to neighbouring FIRs. GAGAN is a system of satellites and ground stations that provide GPS signal corrections, giving better position accuracy. These two developments have been among the significant step towards reducing the country's dependence on foreign navigation systems.

On the communications side, the Indian National Satellite (INSAT) system is one of the largest domestic communication satellite systems in Asia-Pacific region with nine operational communication satellites placed in geo-stationary orbit[12]. INSAT initiated a major revolution in India's communications sector where the system provides services to telecommunications, television broadcasting, satellite newsgathering, societal applications, weather forecasting, disaster warning and Search And Rescue (SAR) operations.

[8] Genesis, Indian Space Research Organisation (Official website), accessed in August 2025
[9] Bharatiya Anthariksh Station (BAS): Our own Space Station for Scientific research to be established with the launch of its first module in 2028, PIB, July 2023
[10] Prime minister reviews readiness of Gaganyan Mission, PIB, October 2023
[11] Satellite Navigation Services, ISRO (Official website), accessed in 2025
[12] Communication Satellites, ISRO (Official website), accessed in 2025

The NISAR[13] (NASA-ISRO Synthetic Aperture Radar) mission, an Earth-observing radar satellite jointly developed by NASA and the Indian Space Research Organisation (ISRO) was launched on 30th July 2025 with an aim to collect unprecedented amount of information about our planet's environment.

India also has dedicated military satellite developed by ISRO currently catering to the requirements of the armed forces. GSAT-7 Rukmini an advanced communication satellite built by ISRO to provide wide range of service spectrum from low to high bit rate voice data communication. GSAT-7 communication payload is designed to provide communication capabilities to users over a wide oceanic region including the Indian landmass and is primarily used by the Indian Navy. In addition, during the recently concluded Indian DefSpace Symposium 2025 it was announced that India plans to enhance its military capabilities through space-based assets by launching 52 dedicated satellites for Intelligence gathering, Reconnaissance and Surveillance (ISR).

These technology advancements have been aided by gradual opening of the market to commercial players which has attracted multiple small satellite players in the industry to plan and launch small satellite constellations.

With the recent reforms announced by the Government, it is expected that there could be wider participation of the private sector in end-to-end space activities. As per government released data, the Indian space economy, which in 2022 was estimated to be ~2 per cent of the global space economy is likely to contribute to ~8 per cent of the global market over the next decade, thereby providing enormous developmental support to the Indian economy[14].

Key facts: Major space faring nations

Country/ Continent	Annual launches	Satellites in orbit	Launch sites	SAR capability	Deep space missions
India[15]	**10**	**136**	**2**	NISAR (Indo-US, 2025)	Aditya-L1(2023), Venus Orbiter (2025 planned), Mars Orbiter 2
U.S[16]	**75**	**8200**	**9**	Multiple Govt./commercial SAR assets	Lucy (2025), Europa Clipper (2025), Artemis ESCAPADE (Mars, 2025)
Canada[17]	**5**	**330**	**1**	RADARSAT SAR satellite series	RADARSAT missions
China[18]	**40**	**906**	**4**	Jianbing SAR constellation, High-orbit SAR "Ludi" satellite (2023)	Tianwen-2 (2025 asteroid), Chang'e-7(2026), Int'l Lunar Research Station
Russia[19]	**20**	**220**	**4**	Meteor/Resurs-P SAR satellites	Bion-M, Obzor-R radar satellites, deep space propulsion R&D
Europe[20]	**20**	**600**	**3**	Copernicus Sentinel and other SAR satellites	BepiColombo (mercury, 2025), JUICE (Jupiter)

[13] NISAR to revolutionise EO with precision, global data access, PIB, July 2025
[14] Economic Survey, IN-SPACe, accessed in July 2025
[15] ISRO (official website), accessed in July 2025, IEEE Space, accessed in July 2025
[16] NASA (official website), accessed in July 2025
[17] Canadian Space Agency (official website), accessed in July 2025
[18] International Journal of Aerospace Engineering, October 2023
[19] NASA, NASA Space flight (official website), accessed in July 2025
[20] European Space Agency (official website), SpaceX (Official website), accessed in July 2025

1.4 Emerging trends

The Indian space economy's growth and transformative trajectory is driven by a unique combination of purposeful government reforms, increasing private sector innovation, domestic demand, and a large talent pool. These forces are forging different patterns, establishing India as a strong force in the global space arena.

The key trends which are likely to further define the path for India's future space acumen include:

- International collaboration and knowledge sharing for space advancement including joint missions and technology partnerships with National Aeronautics and Space Administration (NASA), European Space Agency (ESA) among others.
- Developing an eco-system to achieve the sustainable development goals on Earth.
- Continuous innovation to improve productivity in traditional industries such as agriculture and medicine.
- More private sector participation with reduced government spending.
- Increased emphasis by armed forces for national security.

1.5 Building the foundation space infrastructure

Research towards product design and development is a critical step towards building the infrastructure required to carry out any space related activities. Any space-based services are rendered through the use of this support infrastructure including satellite manufacturing, launch vehicle manufacturing, propellant manufacturing, launch-based services including site preparedness and logistics, etc.

In India, majority of the Research & Development (R&D) of launch vehicles and satellites is primarily carried out by ISRO through its designated labs. However, there is growing interest from the private sector in undertaking R&D for launch vehicles as well as other payload systems. Traditionally, the launch vehicle assembly and associated services are primarily carried out by ISRO, however in recent times, the trends have been towards the involvement of private sector participation.

While ISRO continues to steer the investment-heavy space infrastructure in India, there is rapid rise in the contribution of the private sector towards strengthening the manufacturing eco-system in India and support ISRO and the government establishments towards making India self-reliant.

1.6 The delivery imperative: Strategic relevance and economic leverage

India is set to leverage the space sector to stay strategically relevant and counter the threat arising whilst utilising the space-based services to meet commercial and civil requirements.

Use of space for India's strategic sector

The emerging global conflicts provides an important learning for India to enhance its industrial military capability. The Indian armed forces need additional set of satellites with high resolution sensors and cameras that can assist them in detecting activities as well as identify other potential threats. India's need to utilise space for national security has become a necessity. With rapid developments in military technology, satellites is likely to become an integral part of operations and strategy building for the military. The modern warfare looks at space to establish a virtual theatre command and encourage private sector companies to develop solutions using niche technologies towards achieving this objective.

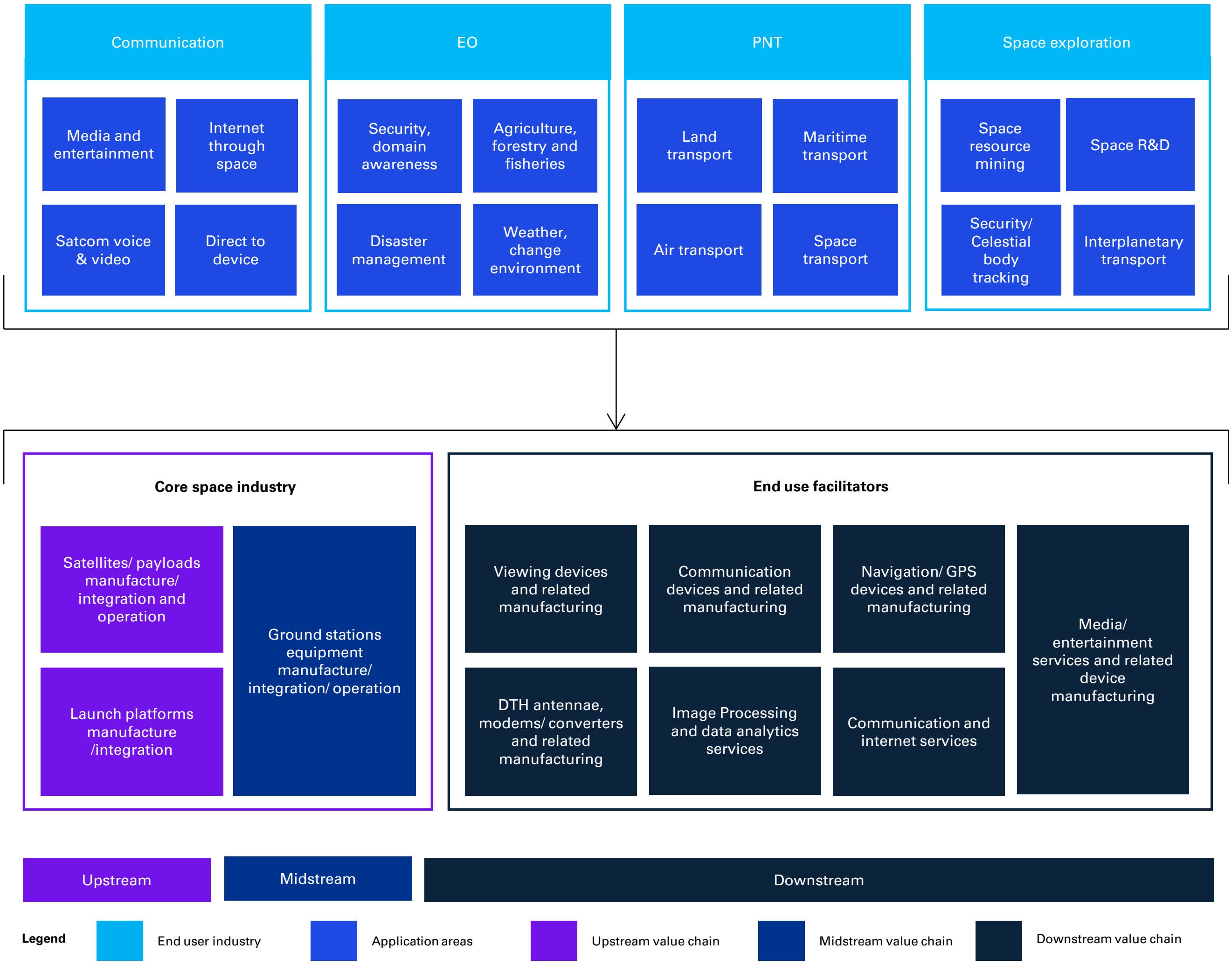
Use of space for India's commercial needs

There is an upcoming market catering to services especially for satellite-based applications including remote sensing, space-based navigation, Earth Observation (EO), disaster management, testing, data analysis among others. Space technology along with other new generation technologies like AI, data analytics, quantum computing, robotics etc. will assist in accelerating the space economy operations in India. It is essential to promote demand-side activities like, industrial linkages, boosting of private & public investment, employment generation, creation of economies of scale, etc. which has the potential to further propel the space economy.

[4] ISRO, Artemis - NASA, SpaceX - Starship, What is 'Project Kuiper,' Amazon's New Satellite Internet Initiative? About Amazon, accessed in July 2025
[5] Handbook of measuring space economy: What is the Space Economy? European Space Agency, accessed in July 2025
[6] Axion-4 mission, ISRO, accessed in July 2025
[7] Research fact sheet, Virgin Galactic, accessed in July 2025

1.7 Segmenting the space economy: Space value chain

The space economy encompasses a broad spectrum of activities and industries, all contributing to the exploration, utilisation, and commercialisation of space. This web of interconnected sectors is referred to as the "space value chain." Understanding the space value chain is crucial for comprehending how the space economy operates and how various components interact. The space economy is broadly categorised into three segments: upstream, mid-stream and downstream.



- Upstream segment consists of the activities required to manufacture satellites and launch vehicles.
- Midstream segment consists of activities pertaining to functioning and maintenance of satellites through establishment and operation of ground station.
- Downstream segment is driven by four major application areas
  - Satellite based communication.
  - Earth Observation (EO).
  - Positioning Navigation and Timing (PNT).

2 Segment-wise assessment of India's space services

2.1 Earth Observation (EO) - Satellite imagery to actionable insights

2.1.1 Capability landscape

India's EO satellite constellation has evolved from modest beginnings to a sophisticated, multi-tiered system providing comprehensive coverage. With more than 20 operational EO satellites, spanning across range of orbits and sensor types, reflect significant technological progress:

- **High-resolution optical imaging: Cartosat Series**: Cartosat-3 delivers panchromatic imagery at a spatial resolution of ~0.28 metres, marking one of India's highest-resolution EO asset to date, enabling detailed mapping and monitoring[21].
- **Medium-resolution multispectral imaging: Resourcesat Series:** This capture's imagery in visible and infrared bands, with spatial resolutions ranging from 05 to 56 metres, across four spectral bands[21].
- **Synthetic Aperture Radar (SAR) imaging: RISAT/EOS Series:** Radar-imaging satellites such as EOS-04 (RISAT-1A) operate in C-band with resolution capabilities between 01 and 50 metres, enabling persistent observation irrespective of weather or lighting conditions[22].
- **Oceanographic and meteorological satellites:** Oceansat-3 (EOS-06), INSAT-3D, and INSAT-3DR provides ocean colour, surface wind vector, thermal, and humidity data, supporting both near-real-time and synoptic-scale observations.
- **Emerging capabilities and innovation[23]:** Advanced spectral imaging, improving revisit rates, and introducing cutting-edge sensor technologies, in participation with Public-Private Partnerships (PPP) for deploying dedicated constellations.

2.1.2 Use cases and demand segments

India's EO services are being embedded across strategic, developmental, and commercial domains. Select priority use cases include:

- **Strategic surveillance and border security:** High-resolution optical and SAR imagery is used by defence and paramilitary agencies for base monitoring, troop movement tracking, and situational awareness in terrain-sensitive regions. Continuous revisit capabilities from radar satellites enhance intelligence cycles in cloud-prone border zones.
- **Agriculture and crop monitoring:** Multi-season EO data is utilised for crop forecasting, yield assessment, and insurance claim validation. It also finds application in government programmes such as FASAL and KISAN through NRSC's geoportals.
- **Disaster management:** During floods and cyclones, SAR imagery enables near-real-time flood mapping, damage assessment, and relief planning especially when optical data is obstructed, thereby aiding in planning and relief logistics.
- **Urban planning and infrastructure**: Smart city planning, encroachment detection, and infrastructure audits are being supported using geotagged. Spatial analytics improve planning efficiency and reduce field survey dependencies.
- **Environmental compliance:** Remote sensing is used for forest cover estimation, mining surveillance, and emissions baselining aligned with environmental regulations. Integrated EO - GIS overlays are used by regulators to validate ground-level reports.

These use cases reflect both government and commercial demand, with EO data increasingly moving from raw imagery to decision-support tools.

[21] Today India has a total of 53 operational satellites in space providing various identified services to the nation, PIB, February 2022
[22] Using remote sensing data for social development and disaster management, PIB, April 2025
[23] Strategic vision innovation boosting India space economy, World Economic Forum, January 2025

2.1.3 Delivery models

- **Public access channels:** ISRO's NRSC distributes open-access EO data through platforms like VEDAS, India EO, and Bhuvan Panchayat. These serve central ministries, research institutions, and state departments for planning and compliance, ensuring free or subsidised access for governance and research[24].
- **Commercial interfaces:** High-resolution and value-added EO datasets are licensed via NewSpace India Limited (NSIL), while private analytics firms develop custom SaaS tools and API platforms for sectors such as logistics and energy.
- **Public private collaboration:** PPP models, including IN-SPACe-led EO constellation partnerships, are emerging to expand capacity and offer EO services through hybrid public-private channels.

2.1.4 Challenges to scaled adoption

- **Awareness and institutional readiness:** A significant number of municipalities, panchayats, and SMEs are either unaware of EO's utility or lack trained staff to interpret satellite-derived data. Existing capacity-building programmes (e.g., ISRO IIRS, NITI Aayog's geospatial skilling) need to be scaled up with sector-specific curricula[25].
- **Underdeveloped commercial market**: While EO data availability has increased, private-sector monetisation remains limited due to low awareness among enterprises, limited innovation, and fragmented market demand.
- **Data accessibility constraints:** High-resolution imagery (sub-metre) and SAR data are often restricted or delivered with latency hence the fragmented metadata and lack of unified APIs reduce ease of access thus integration into operational systems.
- **Operational sustainability:** Continuous investments are needed to maintain constellation health, modernise ground infrastructure, and ensure high revisit cycles.
- **Tax and Regulatory uncertainty:** Tax ambiguities around GST, digital taxation, and PPP revenue sharing pose structural hurdles to scaling Earth Observation delivery models in India.

[24] NRSC: Bhuvan User Hand Book - Indian Geo Platform of ISRO – NRSC, accessed in July 2025
[25] Department of Science and Technology report, October 2022

2.2 Satellite Communication (SatCom)

2.2.1 Capability landscape

India's space-based communication infrastructure is anchored in the INSAT–GSAT satellite series, delivering pan-India coverage across multiple frequency bands and applications. The current capability set includes[26]:

- **Fixed and mobile communication satellites**: Operating in C, Extended C, Ku, Ka, and S bands, satellites such as GSAT-6, GSAT-10, GSAT-18, and GSAT-19 support voice, data, broadcast, and VSAT services. GSAT-6A, with its S-band mobile communication capability, supports mission-critical communication in remote regions.
- **High-Throughput Satellites (HTS)[27]**: GSAT-11, GSAT-29, and GSAT-19 offer large bandwidth capacity through spot-beam architecture, catering to digital connectivity in underserved regions. These satellites operate in Ka/Ku bands and are central to rural broadband delivery under the Digital India initiative.
- **Defence-dedicated satellites:** The GSAT-7 series (GSAT-7, GSAT-7A) ensures secure, encrypted communication for the Indian Navy and Air Force, enabling over-the-horizon command, surveillance, and UAV operations.
- **Upcoming expansion into Low Earth Orbit (LEO) constellations**: As per DoS and IN-SPACe directions, future architecture includes LEO satellite systems to support satellite broadband and direct-to-device services. Spectrum for satellite broadband is now allocated administratively, aligning with global practices.

2.2.2 Use cases and demand segments

India's SatCom capabilities are applied across key governance, development, commercial, and strategic sectors[28] [29] :

- **Rural connectivity and digital public services:** SatCom bridges last-mile connectivity gaps in regions where terrestrial infrastructure is unviable. It supports rural telephony, public service delivery (health, education), and emergency communications in geographies like the Northeast, Himalayan terrain, and island territories.
- **Broadcast and media distribution:** Direct-to-home (DTH) television, radio, and digital news feeds use satellite links to reach millions of households nationwide. SatCom also enables remote media uplinks and emerging use cases like direct-to-mobile broadcasting. The DTH services and FM/TV relay systems rely on INSAT/GSAT C/Ku band.
- **Enterprise and sectoral services:** Industries such as banking, oil & gas, railways, and aviation use SatCom for secure VSAT networks, asset tracking, and inflight connectivity. Public sector enterprises deploy SatCom for disaster warning, logistics, and field operations to enable connectivity, fleet tracking, and Supervisory Control And Data Acquisition (SCADA).
- **Public welfare platforms**: National programmes like e-education (via EDUSAT) and telemedicine rely on SatCom to deliver classroom sessions and remote diagnostics to underserved areas, especially tribal and high-altitude zones.
- **Strategic military communications:** Dedicated satellites such as GSAT-7 and GSAT-7A support India's tri-services with encrypted, resilient communication channels. These enable command coordination, UAV control, and ISR data relay in remote and maritime theatres, while also ensuring network redundancy during disruptions.

[26] Satellite Based Services, ISRO (official website), accessed in July 2025
[27] Year End Review 2022: Ministry of Communications, PIB, December 2022
[28] Space Applications, ISRO (official website), accessed in July 2025
[29] Growing importance of satellite communication, February 2025

2.2.3 Delivery models

- **Government-led service provision:** INSAT - GSAT services are delivered via DoS/ISRO entities to central ministries and public enterprises for meteorology, broadcasting, and welfare schemes via transponders.
- **Industry participation and licensing:** Under new reforms, private licensees are permitted to offer satellite broadband and VSAT services, with IN-SPACe and DoT streamlining regulatory approvals and spectrum landing rights[30].
- **Hybrid and shared infrastructure models:** PPP arrangements are emerging wherein government satellites provide core capacity and private entities build ground infrastructure or deliver last-mile services under shared or leased capacity models.

2.2.4 Challenges to scaled adoption

- **Affordability** SatCom terminal affordability remains a concern for wide-scale rural deployment where Ka-band spot-beam terminals, in particular, face pricing and ecosystem readiness gaps.
- **Ground network bottlenecks**: Delays in gateway earth station approvals, spectrum coordination, and landing rights impede timely service activation. The integration with terrestrial fibre remains uneven in remote belts.
- **Spectrum and interference risks:** Interference from adjacent 5G terrestrial services in shared bands (e.g., C-band) poses service quality and security risks for satellite operations, especially in urban peripheries.
- **Market evolution and policy maturity:** Despite policy liberalisation, investor confidence depends on long-term clarity in licensing terms, payload sharing, and coordination across DoT, IN-SPACe, and ISRO.
- **Withholding cost and challenge:** Indian enterprises face withholding tax uncertainty on satellite service payments due to royalty classification disputes, Double Taxation Avoidance Agreement conflicts, and lack of clarity in hybrid PPP models.

2.3 Satellite navigation services

2.3.1 Capability landscape

India's satellite navigation capabilities are anchored in the Navigation with Indian Constellation (NavIC)[31] system, a regionally focused Positioning, Navigation, and Timing (PNT) architecture comprising 07 operational satellites and associated ground infrastructur[32]. NavIC, also known as IRNSS, offers dual-mode services i.e. a standard positioning signal for civilian use and an encrypted restricted service for strategic applications. With geostationary and inclined geosynchronous satellites broadcasting in L5 and S bands, NavIC ensures consistent coverage across India and up to 1,500 kms beyond our borders. The system delivers sub-20 metre positional accuracy and high timing precision, comparable to other GNSS platforms[32]. The complementary efforts such as the GPS Aided GEO Augmented Navigation (GAGAN) system enhances the integrity and accuracy for civil aviation/other precision applications[33].

NavIC is currently undergoing expansion, including launches of second-generation satellites supporting the L1 frequency band to improve interoperability with global constellations[34]. These upgrades aim to mainstream NavIC across civilian and strategic domains and enable future global service extensions.

[30] Press Information Bureau, PRID=2118299, PRID=1879774, Commercial VSAT CUG, Department of Telecommunications, accessed in July 2025
[31] Navigation with Indian Constellation (NavIC), ISRO, September 2023
[32] Satellite Navigation Services, ISRO, accessed in July 2025
[33] GPS Aided GEO Augmented Navigation (GAGAN), ISRO, accessed in July 2025
[34] NVS-01 Launch with L1 Frequency Support, ISRO Press Release, May 2023

2.3.2 Use cases and demand segments

- **Strategic and defence:** NavIC's restricted service offers secure, sovereign navigation support to India's armed forces. Applications span blue-force tracking, air-sea navigational support, encrypted communication relays, and integration into strategic missile guidance systems in contested environments where GPS availability may be compromised, supporting self-reliant defence operations across domains[35].
- **Transportation and mobility:** NavIC underpins intelligent transport systems across road, rail, maritime, and aviation sectors. Its integration in vehicle tracking systems enhances fleet monitoring for commercial logistics. Indian Railways leverages NavIC for real-time tracking and automated signaling at unmanned crossings, while inland waterways and coastal fishing fleets benefit from positional accuracy and NavIC-based alert messages for maritime safety.
- **Agriculture and rural development:** Precision agriculture applications are emerging through NavIC-enabled tractors, soil mapping, and input optimisation. Rural development programmes increasingly employ NavIC-based geotagging for infrastructure tracking under schemes such as MGNREGA. NavIC's short message broadcast capability has proved vital for disseminating timely weather warnings to fishermen.
- **Telecom, power, and financial services:** PNT time synchronisation is crucial for telecom towers and power grid management. NavIC offers redundancy to GPS for secure, synchronised timing. Future applications include timestamping for financial transactions and system audits.

2.3.3 Delivery model

- **Government-led infrastructure with strategic support:** ISRO maintains satellite and ground control systems whereas user segment integration is supported via policy mandates (e.g., NavIC in smartphones and transport systems).
- **Device integration via regulatory incentives[36]:** Ministries such as DoT, MoRTH, and MoCA have issued notifications encouraging NavIC adoption in smartphones, vehicles, and avionics. Incentive schemes for local chip manufacturing are under consideration to support hardware alignment[37].
- **Public services via multi-agency coordination:** Usage in agriculture, fisheries, and disaster management is enabled through cross-sectoral integration with ministries (e.g., MoAFW, MoES, MoD).

[35] Government says, India's satellite-based navigation system, NavIC, is as good as GPS of the United States in terms of position accuracy and availability in its service region, PIB, August 2022
[36] Usage of Indian Regional Navigation Satellite System(NavIC system) has increased in sectors like transportation and personal mobility, PIB, August 2021
[37] India's NavIC will now be supported by 'Made in India' chipsets, PIB, September 2023

2.3.4 Challenges to scaled adoption

- **Limited global reach:** NavIC's regional architecture constrains international usability and plans for global expansion are underway but yet to materialise.
- **Device ecosystem and interoperability:** Full-scale adoption requires seamless integration in GNSS chipsets and firmware upgrades across commercial and strategic equipment. Also, the domestic manufacturing of compatible modules remains limited
- **Signal vulnerability and security:** GNSS signals are inherently weak, making NavIC susceptible to jamming/spoofing. Enhancements in signal hardening, anti-jamming antennas, and alternate PNT methods are critical.
- **Market awareness and brand recognition:** NavIC lacks public visibility compared to global GNSS brands and building user trust through demonstrable performance gains /branding is necessary for ecosystem maturity.

3 Enablers for scalable growth

3.1 Strengthening the supply-demand interface

Bridging capability creation and operational uptake in India's space sector depends on three enabling functions namely upstream innovation ecosystems, downstream adoption drivers, and intermediary support mechanisms.

- **Responsive upstream:** This describes a market driven R&D ecosystem in which consortia prototype modular satellites and mission ready payloads, government backed innovation schemes foster collaboration among academia, startups and end users, co-investment channels share financial risk, and IN SPACe's single window, time bound approval framework accelerates regulatory processes.[38][39][40]
- **Stimulating downstream:** This encompasses demonstration pilots that showcase the operational relevance of space-based services across priority schemes and sectors. Demand aggregation is facilitated through direct engagement with anchor government users and coordinated outreach. Uptake is further supported through incentive frameworks under Startup India, MSME schemes, and space as a service delivery models, alongside the integration of geospatial inputs into routine regulatory and administrative[41].
- **Intermediary support structures:** This comprises system integrators and specialist startups that translate raw satellite data into tailored analytics; capacity building initiatives at academic and research institutions to bridge R&D and operational expertise gaps; and structured collaboration channels with policy research organisations and industry associations that facilitate iterative refinement of best practices.

[38] Technology Development Program (TDP), ISRO, accessed in 2025
[39] Guidelines for private sector participation in space activities, IN-SPACe, 2022
[40] Indian Space Policy, December 2023, Department of Space December 2023
[41] Government e-Marketplace (GeM), Geospatial services on GeM platform, accessed in July 2025

3.2 Platform interoperability and open data standards

As India's downstream space applications evolve, seamless access, sharing and reuse of satellite derived data across sectors remains a foundational enabler for inclusive innovation. Today's silos fragmented formats, inconsistent protocols and disconnected repositories give way to a scalable, user centric digital public infrastructure through platform interoperability and open standards. This enabler underpins data driven governance, responsive commercial use cases and long-term usability across EO, SatCom and PNT.[42] [43]

Raw satellite data → Standardised format/meta data → APIs/ portals → User applications

Ecosystem collaboration

1. Multistakeholder platforms supporting reusable, interoperable satellite data applications.
2. Public–private sandboxes and open-source SDK deployments for localised experimentation and adaptation of geospatial tools.
3. Capacity building programmes for integrators and downstream users to foster expertise in interoperable tools and workflows.

National governance framework

1. A unified framework for data stewardship, access control, licensing models and platform standards.
2. Assigned stewardship roles across ministries and institutions to ensure compliance, oversight and operational continuity.
3. Continuous policy industry feedback loops to align technical protocols with evolving downstream use cases.

Data architecture and standards

1. Open APIs, FAIR metadata schemas and common ontologies for discoverability, reuse and sectoral convergence.
2. Machine readable repositories and a national catalogue integrating EO, SatCom and PNT datasets for streamlined discovery and analysis.
3. Alignment with global data standards, reinforcing India's leadership in geospatial and positioning data exchange.

[42] Bhuvan Geoportal and Open Data Initiatives, ISRO report, 2023
[43] Strategy for National Geospatial Policy, NITI Aayog report, 2020

3.3 Demand aggregation and catalysing anchor use cases

As India shifts from a supply-led model to an adoption-driven space economy, the ability to consolidate demand across sectors and cultivate high-impact, replicable anchor use cases become vital. Demand aggregation creates predictable markets, lowers barriers for private entrants, and enables economies of scale in delivery. The use cases serve as demonstration projects that validate the value of space-enabled solutions and catalyse downstream innovation.

Aggregating demand for market scale

- The traditional fragmentation of procurement across ministries, departments, and states has constrained the efficient uptake of space-based services like satellite data, geospatial analytics, and communications.
- Institutional aggregators, notably IN-SPACe, now anchor demand consolidation under the Indian Space Policy 2023, harmonising government and public agency requirements while coordinating capacity acquisition from ISRO and private players[44].
- This consolidated demand facilitates optimal utilisation of critical space assets such as transponders and EO platforms while offering volume-based pricing advantages that lower access costs for users.
- Globally proven models, including Europe's Copernicus and the US NOAA satellite services, validate potential of demand aggregation in sustaining robust upstream-downstream value chains[45].

Catalysing use cases as market catalysts

This anchor use case, primarily driven by government or large public entities, provides the necessary scale and early validation critical to unlocking downstream market confidence and private co-development. Noteworthy examples include:

- Geo-tagging of INR3.16 crores rural assets for MGNREGA asset tracking[46].
- Satellite-enabled crop insurance indexation aligned with PMFBY in states like Haryana and Madhya Pradesh.
- Satellite-based flood early warning systems operational in Assam and Odisha.
- PM Gati Shakti leverages satellite imagery and geospatial overlays for coordinated logistics and asset planning across ministries.

As India shifts from a supply-led model to an adoption-driven space economy, the ability to consolidate demand across sectors and cultivate high-impact, replicable anchor use cases become vital. Demand aggregation creates predictable markets, lowers barriers for private entrants, and enables economies of scale in delivery. The use cases serve as demonstration projects that validate the value of space-enabled solutions and catalyse downstream innovation.

[44] Norms, Guidelines and Operational Procedures for Space Policy Implementation, IN-SPACe, December 2024
[45] Group on Earth Observations., A Global Perspective, December 2022
[46] Assets created under MNREGA, Ministry of Rural Development, PIB, July 2019

3.4 Public procurement, financing models, and risk mitigation

A thriving and commercially viable space ecosystem depend significantly on strengthening enablers that address market access, financial viability, and investor confidence. Key areas such as procurement frameworks, fit-for-purpose financing instruments, and forward-looking risk mitigation mechanisms remain at various stages of development. Without calibrated progress on these fronts, even technically sound space solutions risk under-deployment due to uncertainties in capital security, policy clarity, or contractual predictability.

Strategic procurement as a market access lever	Financing the space ecosystem	De-risking investments and ensuring mission reliability
India's procurement structure, while traditionally anchored in ISRO and DoS, is undergoing transformation through NSIL's project-partner model and IN-SPACe's facilitation of private missions. These institutional mechanisms are designed to enable predictable and sustained engagement across mission verticals. Demand-side initiatives include pre-bid orientation, improved scoring systems, and ministry-level onboarding for space services measures that help level the playing field for startups and MSMEs.	IN-SPACe has laid out support mechanisms for venture and alternative investment flows, including early-stage funding models that catalyse innovation-led entrants. For mature players, blended finance opportunities through public-private partnerships are emerging. Emerging financing avenues include viability gap instruments, sovereign-backed export credit lines, and sector-specific offsets. These mechanisms are progressively shaping the capital flows into commercial EO, SatCom, and PNT services.	Risk reduction efforts span multiple fronts: from satellite collision avoidance and Space Situation Awareness (SSA) participation to standardised liability norms. These frameworks aim to enhance investor assurance and broaden insurance uptake across operational phases. Standardised insurance offerings (covering launch/ post-launch risks and third-party liabilities) and improved cyber-security are vital for mission reliability and market bankability.

3.5 Building awareness and institutional capacity

As India's space sector expands into civil, commercial, and social domains, sustained awareness and institutional readiness emerge as critical enablers to ensure inclusive and effective adoption of space-enabled solutions. Despite growing investments in upstream capabilities and downstream applications, accelerating utilisation depends on bridging significant gaps in user understanding and organisational capacity across entities.

Addressing the awareness gap

- The proliferation of EO, SATCOM, and PNT services has not yet led to widespread uptake and many agencies remain unaware about data availability, relevance, or accessibility[47].
- Even when conceptual awareness exists, field-level deployment especially in domains like agriculture and disaster management is often hindered by limited digital literacy, insufficient data interpretation capabilities, and weak financial linkages.

Strengthening institutional capacity across stakeholders

Building a resilient space ecosystem calls for multi-layered capacity development:

- ISRO's Capacity Building Program Office (CBPO), SRSACs, and sector-specific training modules serve as core platforms enabling ministries, state bodies and local agencies to adopt and operationalise space solutions at all levels.
- Orientation programmes and engagement channels led by IN-SPACe, innovation councils, and Startup India actively integrate startups and private developers into geospatial workflows, regulatory environments, and funding pipelines.
- Institutions and universities function as foundational enablers, aligning curricula and delivering joint capacity-building programmes to grow India's skilled space workforce.

These enablers are crucial to mitigating underutilisation risks, bridging the implementation gap, and building a digitally literate ecosystem that is prepared to leverage space-derived insights for socio-economic growth and innovation.

[47] Guidelines for Private Sector Participation and Ecosystem Outreach, INSPACe, May 2024

4 Building an adoption-centric ecosystem

Building on the foundational enablers that range from platform interoperability and procurement reform to institutional capacity awareness mechanisms, this chapter transitions towards implementation. It outlines the ecosystem shifts, infrastructure priorities and segment specific strategies required to scale downstream adoption of a shift from fragmented deployments to systemic institutionalisation.

4.1 Policy priorities and implementation pathways

The implementation pathways hinge on coherent policy anchoring supported by structured pathways to integrate Earth Observation (EO), Satellite Communication (SatCom), and Positioning, Navigation, and Timing (PNT) services into core governance and development workflows such as:

- **Programmatic integration across schemes:** EO, SatCom, and PNT-based inputs are well-positioned to enhance national programmes such as PM Gati Shakti (logistics planning), Jal Shakti Abhiyan (water tracking), and PMGSY (rural road monitoring)[48]. These services can be progressively embedded within the operational frameworks of these schemes to improve efficiency and traceability[49].
- **Standardised procurement and budgeting mechanisms:** India is already witnessing a gradual shift toward service-oriented procurement for space-based data, including subscription models and pay-per-use frameworks. To support broader adoption, these models can be progressively standardised through clear procurement templates and budgeting norms, enabling entities to plan recurring service access more effectively[50].
- **Phased maturity-linked adoption model:** Adoption pathways can be tailored across ministries and states based on their digital readiness:
  - **Phase 1:** Enablement and awareness-building, supported by basic toolkits and orientation.
  - **Phase 2:** Regular integration into dashboards, MIS platforms, and decision systems.
  - **Phase 3:** Transition toward predictive analytics and decision automation.

IN-SPACe can progressively extend its role to include monitoring of adoption progress[51].

48 Quick reference guide: Geographic Information System, NRSC, accessed in July 2025
49 50 Years of Journey, NRSC, accessed in July 2025
50 IN-SPACe Procurement Guidelines, July 2024
51 The Indian Space Policy 2023

4.2 Infrastructure readiness and digital public infrastructure (DPI) integration

Mainstreaming downstream space applications relies heavily on the maturity of digital infrastructure. India has developed a robust stack that includes India's foundational digital infrastructure laying the groundwork for scaled adoption of downstream space services. Key platforms such as Bhuvan NextGen (launched in 2024)[52], India Urban Observatory (under the Ministry of Housing and Urban Affairs), and the National Geospatial Data Registry (NGDR) serve as essential enablers for EO data visualisation, urban monitoring, and spatial metadata management, respectively. On the connectivity front, initiatives like PM-WANI and BharatNet have expanded broadband access across rural regions, offering potential SatCom backhaul in low-connectivity zones[53].

To build on these foundations, the next phase of integration should focus on interoperability, resilience, and service continuity across departments. The following areas merit priority:

- **Interoperability of EO and PNT data:** APIs adhering to recognised standards such as OGC (GeoTIFF, COG, GeoJSON) can facilitate seamless data exchange, version control, and scalable analytics across ministries and agencies.
- **Federated architecture for NavIC services:** As NavIC undergoes satellite upgrades and dual-band expansion, there is an opportunity to develop federated APIs tailored to use cases in logistics, mining, and transport monitoring enabling secure timestamping and enhanced traceability.
- **Resilience in DPI networks via SatCom integration:** While BharatNet has achieved wide-scale rural reach, downstream resilience can be strengthened by incorporating SatCom-based redundancy layers in disaster-prone or remote regions. This would ensure uninterrupted service delivery during natural calamities or network disruptions.

The above elements should be treated as parallel efforts and should be integrated into a cohesive infrastructure strategy. Such alignment could ensure that existing digital assets not only support but actively scale the adoption of integrated downstream applications in a structured, interoperable, and mission-aligned manner.

[52] Bhuvan NextGen: Enabling Geospatial Economy, NRSC (official website), accessed in July 2025
[53] PM-WANI, BharatNet, MeitY (official website), accessed in July 2025

4.3 Programmatic alignment with sectoral missions

The integration of downstream space services into India's flagship missions presents one of the most effective pathways to scaled adoption. These missions operate at national scale and offer institutional continuity, making them ideal vehicles to embed EO, SatCom, and PNT services[54].

Priority areas for integration

- **Urban programmes (Smart Cities & AMRUT 2.0):** EO data can support heat island detection, unauthorised construction alerts, and environmental trend monitoring[55].
- **Water and agriculture (PMKSY, Jal Shakti Abhiyan):** EO and PNT inputs can improve planning for groundwater recharge, watershed mapping, and seasonal irrigation scheduling[56].
- **Land governance (DILRMP):** Multi-temporal EO datasets can enable early warning of encroachment, unauthorised use, and land-use changes.
- **Health systems (Ayushman Bharat Digital Mission):** SatCom can bridge digital gaps in remote zones, supporting diagnostics and health information transfer[57].

Way forward: Embedding adoption into mission architecture:- To enable sustainable and measurable adoption within these missions there is need to create the following:

- **Co-budgeting at scheme inception:** Space services must be treated as core enablers during programme planning and budget approvals, not as post-hoc enhancements.
- **Dedicated space adoption units (SAUs):** These in-mission units should facilitate coordination with ISRO and IN-SPACe, standardise data flows, and support contextual integration into mission dashboards.
- **Unified monitoring indicators:** Adoption must be tracked not only by number of use cases but also through institutional metrics such as percentage of routine planning processes using EO data or coverage of SatCom-enabled service zones.

[54] ISRO Annual Report 2024-25
[55] ISRO: Diverse space applications for national development, 2022; Urban Heat Island Effect on Top Cities, PIB, December 2024
[56] MoHUA (official website), accessed in July 2025
[57] MOHFW (official website), accessed in July 2025

4.4 Addressing Strategic Segments: Defence, Disaster, and Governance

Strategic domains such as defence, disaster resilience, and public governance demand downstream space capabilities that are secure, interoperable, and operationally dependable. Strengthening these sectors requires a calibrated approach that not only builds on existing institutional usage but also anticipates the evolving operational scenarios, risk environments, and data fusion needs[58].

Defence and ISR applications

- Future ISR systems must be built on layered sensing architectures, combining SAR, optical, and thermal datasets to support surveillance across varying terrains and conflict intensities.
- NavIC's secure signal services can be integrated into indigenous timestamping protocols for secure telemetry, missile tracking, and geofencing in border zones. As ISRO continues phased upgrades to NavIC, federated APIs could be developed for mission-specific data streams.
- Low-latency EO delivery, combined with automated analytics pipelines and encryption standards shall be central to operationalising downstream services in tri-service and theatre commands.
- Continuous alignment with defence-specific data standards and simulation environments should be key to enabling adaptive mission planning.

Disaster preparedness and response

- EO-derived risk models tracking seasonal changes in floodplains, coastal zones, and landslide-prone areas can be integrated into state-level disaster dashboards for anticipatory governance.
- SatCom overlays can offer resilient communication pathways during terrestrial network outages. Integration with district-level disaster nodes could support decentralised response coordination.
- The development of readiness indices (e.g., asset exposure heatmaps, service restoration timeframes) aligned with India's disaster risk reduction plans can enable performance-linked resource mobilisation.

Enhancing governance through spatial intelligence[59]

- At the state level, GIS-EOS fusion tools can be scaled to support land management, encroachment detection, and project implementation audits.
- Standardised EO ingestion modules and plug-and-play data viewers, supported by DPI-compliant APIs, can help embed space-derived insights into core governance platforms (e.g., DM dashboards, revenue records, PWD asset tracking).
- Priority should be placed on scalable, low-friction deployment models that allow for inter-departmental data sharing while maintaining data custodianship integrity.

Forward consideration: Operational continuity and orbital risk[60]

- As reliance on EO, SatCom, and PNT systems grows, resilience planning must account for orbital congestion, satellite decommissioning, and temporary data inaccessibility.
- Promoting continuity-aware practices such as secondary sensing routes and blackout simulation drills particularly in critical domains like defence and disaster management, can assist build institutional agility.

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[58] Focus on strengthening telecom infrastructure resilience, enhancing coordination among stakeholders and refining disaster management policies within telecom sector, PIB, August 2024

[59] National Geospatial Policy meets Government commitment to inclusion & progress through access to locational data & related services, PIB, February 2024

[60] India's Intent on Debris-Free Space Missions, ISRO (official website), accessed in July 2025

4.5 International collaboration and standards harmonisation

India's downstream space trajectory is increasingly shaped by its ability to align with and influence international standards across EO, PNT, and SatCom domains. As adoption expands, interoperability, regional cooperation could play a critical role in realising broader developmental and strategic outcomes.

EO

- Continued engagement with global platforms such as the Committee on Earth Observation Satellites (CEOS) offers India a pathway to contribute region-specific schema enhancements such as terrain-adapted metadata structures or seasonality-tuned temporal sampling relevant to South Asia.
- Active participation in the development of Analysis Ready Data (ARD) standards further improves cross-border data usability and reduce downstream processing overhead.

PNT

- NavIC integration with ICAO and IMO frameworks enhances civil aviation and maritime adoption.
- Planned dual-band expansion and timing precision upgrades align with international interoperability goals.

SatCom

- The creation of regional SatCom corridors for applications such as humanitarian aid, disaster communication, and emergency response can be anchored on shared access protocols, transparent governance, and cost-effective bandwidth allocation.
- India's approach to these corridors can reflect principles of equitable access, technical standardisation, and cooperative use aligned with international priorities.

Conclusion

India's downstream space ecosystem is shifting from an innovation-led frontier to a foundational pillar of governance, development, and resilience. Systemic adoption hinges on integrating space-based services into core operations. A future-ready ecosystem will be defined by interconnected use cases across sectors, procurement and budgeting aligned to service-centric models, and DPI frameworks that embed EO, SatCom, and PNT as defaults. Strategic segments such as defence, disaster response, and governance will set the benchmark for mission-grade applications, while international collaboration positions India as both a contributor and regional enabler. This trajectory reflects a scalable model rooted in institutional maturity, programmatic alignment, and inclusive implementation.

About CII

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

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