Confederation of Indian Industry

From escape velocity to value: Innovation, policy and growth

September 2026

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CONTENTS

MESSAGE

Mallavarapu Apparao

Chairman

CII National Committee on Space

India's space sector has undergone a profound transformation, evolving from a mission-led program anchored in scientific exploration to an innovation-driven economy built on satellite-enabled services and applications. With a significant and growing number of private entities now engaged in space-tech, the sector is witnessing rapid advancement in satellite communication, earth observation, navigation and space-based analytics, contributing meaningfully to national development and global competitiveness.

I am pleased to introduce this report, which explores the emerging opportunities shaping India's evolving space landscape through a comprehensive value-chain framework. The report assesses both upstream capabilities - encompassing launch and manufacturing - and enabling technologies, and downstream applications that are increasingly powering India's digital and physical infrastructure.

The report underscores the centrality of policy and regulatory clarity, public-private collaboration and data-driven service models in translating technological progress into real-world impact. These imperatives are closely aligned with India's long-term vision for self-reliance, global competitiveness and technology leadership.

As we look toward Viksit Bharat 2047, CII recognizes the need to build a robust, innovation-led and service-oriented space economy through sustained investment, industry participation and coordinated ecosystem development.

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

MESSAGE

Rohan Ganapathy
Co-Chairman
CII National Committee on Space

India's space economy is entering a new phase, defined not merely by launch and mission success, but by the deeper integration of space-based capabilities into governance, development and national resilience. The liberalization of the space sector, the establishment of IN-SPACe as a single-window facilitator, and the emergence of over 300 space-tech startups building indigenous launch vehicles, satellite platforms and downstream applications have demonstrated that India's space future is no longer the preserve of government alone. This shift marks the transformation of space from a scientific frontier to a commercially driven ecosystem where entrepreneurs, industry and institutions are together advancing socio-economic progress and strategic self-reliance.

I am pleased to introduce "From escape velocity to value: Innovate, govern and grow". This thought leadership publication examines how India's space sector is evolving across the full value chain - from upstream innovation in launch systems and satellite technology to downstream applications in Earth Observation, satellite communication and navigation. It highlights how entrepreneurship, regulatory reform and institutional capacity are together shaping a new space economy that is increasingly relevant to citizens, enterprises and public systems.

The report also explores how space-based services are being deployed to address challenges in disaster response, urban planning, logistics, secure communication and environmental monitoring - and emphasizes the importance of interoperable platforms, enabling policy frameworks, and outcome-focused approaches to accelerate adoption. As India advances toward its Vision 2047 goals, embedding space applications into operational systems - backed by policy certainty and institutional readiness will be essential to building a globally competitive and inclusive space economy.

We thank EY for its partnership with CII and express our appreciation to all stakeholders who contributed to this effort.

FOREWORD

Cdr. Gautam Nanda

Partner, Business Consulting, Aerospace, Defence and Space

Ernst & Young LLP

India's space sector has entered a phase where the sector's next frontier will be shaped by India's ability to build industrial depth, commercialize technologies, strengthen supply chains and enhance space-based capabilities of national importance. The Indian Space Policy 2023, along with the institutional strengthening of IN-SPACe and NSIL, has created a strong foundation for this transition. By enabling Non-Government Entities (NGEs) to undertake end-to-end space activities, including satellite operations, launch services, ground systems, remote sensing data dissemination and mission support, the policy marks a decisive shift from a government-led model to an industry participative ecosystem.

This transition is particularly significant for the upstream segment, where satellite manufacturing, launch systems, propulsion, avionics, space-grade electronics and testing infrastructure can create new opportunities for Indian industry.

The proposed development of Space Manufacturing Clusters (SMCs) and Common Technical Facilities (CTF) across states such as Gujarat, Tamil Nadu, Andhra Pradesh and Madhya Pradesh can further deepen India's industrial base. Such interventions are essential for moving from isolated capability creation to a more distributed, scalable and globally competitive space manufacturing ecosystem.

From a defence and maritime perspective, the strategic relevance of space is equally clear. Secure communications, Earth Observation (EO), navigation, maritime domain awareness and resilient satellite-enabled networks are becoming integral to operational readiness. GSAT-7 "Rukmini" is India's dedicated naval communication satellite, built to provide multi-band communication capability over the Indian Ocean Region (IOR), which is central to safeguarding India's maritime interests.

The downstream opportunity is equally compelling. Where space-based applications are already influencing agriculture, infrastructure planning, disaster response, environmental monitoring, logistics, financial services and governance delivery. The real value of the space economy will increasingly lie in converting satellite data into decision-grade intelligence, actionable services and citizen-scale outcomes. This requires not only satellites and launch vehicles but also analytics platforms, interoperable data systems, cybersecurity, standards, skilled talent and domain-specific adoption.

This thought leadership, "From escape velocity to value: Innovate, govern and grow", examines the space sector through an integrated value chain lens, connecting upstream capability creation with downstream adoption and strategic use cases.

EY is privileged to partner with CII on this initiative and we hope this report contributes meaningfully to the ongoing partnerships between government, industry, startups, investors, academia and strategic users, while supporting India's efforts to build a resilient, innovation-led and globally competitive space economy.

Abstract

The space sector is becoming a major driver of global economic progress, with the global space economy expected to grow from INR58.75 lakh crore (US$613 billion) in 2024[1] to INR172.50 lakh crore (US$1.8 trillion) by 2035[2]. India is experiencing its own space renaissance, with its industry projected to expand from INR0.81 lakh crore (US$8.4 billion) in 2022 to INR4.22 lakh crore (US$44 billion) by 2033[3], driven by ISRO, NSIL, IN-SPACe and a growing private sector.

As India shifts from purely scientific missions to widespread use of space-based applications across agriculture, logistics, banking, defence and more, both upstream activities such as rocket launches and satellite manufacturing and downstream services enabled by satellite data are rapidly evolving. Innovations like reusable rockets and miniaturized satellites are reducing costs and lowering entry barriers, while satellite communication, navigation, and Earth Observation services are becoming essential to industries and daily life.

These shifts, combined with new business models and entrepreneurial energy, are creating major opportunities for inclusive growth. They also highlight the need for forward-looking policies and international cooperation to enable the sustainable development of the space ecosystem. This report offers a comprehensive view of these advances, covering innovations, downstream impacts, economic frameworks, and governance for industry leaders, policymakers, scientists, investors and strategic stakeholders.

Executive summary

India's space sector is entering a decisive phase of transformation. From a historically mission-led and government-driven program, the sector is evolving into a commercially enabled, innovation-led and strategically significant ecosystem. Globally, the space economy is expanding rapidly, driven by lower launch costs, satellite-enabled services, private investment, and the increasing use of space technologies across non-space sectors. India's space economy is projected to reach INR4.22 lakh crore (US$44 billion), by 2033, supported by policy reform, IN-SPACe, NSIL, private players and downstream applications.

This thought leadership examines India's space sector through an integrated value-chain lens, covering upstream innovation, downstream applications, strategic and defence use cases, economic value creation, policy reforms and international positioning. The central message is that India's next phase of growth will depend not only on building satellites and launch vehicles but also on converting space-based capabilities into commercial services, industrial depth, strategic autonomy and economy-wide impact.

The upstream segment, comprising launch vehicles, satellite manufacturing, propulsion, avionics, ground infrastructure and enabling technologies, is undergoing rapid change. Reusability, modular satellite platforms, miniaturization and advanced manufacturing are reducing costs and increasing launch cadence globally. For India, this creates opportunities for aerospace, electronics, defence, advanced materials and engineering firms to participate in satellite manufacturing, subsystem development, launch infrastructure, testing facilities and space-grade supply chains. Space Manufacturing Clusters and Common Technical Facilities (CTFs) can further support industrial scale, quality assurance and supply-chain localization.

The downstream segment is likely to be the largest driver of economic value. Satellite communication, Earth Observation (EO), navigation, Positioning, Navigation and Timing (PNT) services and geospatial analytics are increasingly relevant for agriculture, logistics, infrastructure, disaster management, urban planning, financial services, fisheries, climate resilience, telecommunications and defence. The real impact will come from translating satellite data into decision-grade intelligence, operational tools and sector-specific applications. This will require interoperable data platforms, analytics capabilities, user-friendly applications, skilled talent and stronger adoption by government and industry users.

Space is also becoming central to national security and strategic advantage. Secure satellite communication, EO, navigation, Space Domain Awareness (SDA), maritime domain awareness, and resilient satellite-enabled networks are increasingly relevant for defence preparedness, border surveillance, disaster response and critical infrastructure resilience. For India, closer coordination between civil space institutions, defence users and private industry can support dual-use technology development, secure data systems, sovereign capability and high-value commercial opportunities.

The space economy should therefore be assessed beyond direct revenues from satellites, launch services and government missions. Space-enabled applications can improve agricultural productivity, reduce logistics costs, expand connectivity, strengthen disaster preparedness, support climate monitoring and improve decision-making across critical sectors. A broader impact framework is needed to capture the full economic contribution of space technologies across upstream and downstream markets.

India's policy and governance environment has created a strong foundation for this transition. The Indian Space Policy 2023, IN-SPACe's single-window role, NSIL's commercialization mandate and growing openness to Non-Government Entities (NGEs) have enabled greater private-sector participation. The next phase will require faster execution, smoother authorization processes, timely spectrum allocation, clear liability frameworks, export facilitation and stronger financing mechanisms for deep-tech space enterprises.

Priorities for achieving a US$44 billion space economy

To achieve the projected INR4.22 lakh crore (US$44 billion) by 2033[4], space economy over the next seven to eight years, India will need a coordinated execution agenda across government, industry, startups, investors, academia and strategic users. Six priorities will be critical:

S.No	Priority	What it means
1	Scale downstream adoption across priority sectors	Move from pilots to programme-level deployment in agriculture, logistics, disaster management, urban planning, infrastructure monitoring, financial services, fisheries, climate resilience and defence.
2	Build industrial depth in upstream manufacturing and launch systems	Strengthen satellite manufacturing, launch vehicle subsystems, avionics, propulsion, sensors, space-grade electronics, composites, testing infrastructure and domestic supply-chain capabilities.
3	Strengthen the regulatory and financing environment	Enable streamlined authorisations, spectrum readiness, transparent licensing, export facilitation, early-stage risk funding, strategic corporate investment, innovation grants, public procurement and viability gap support.
4	Use government demand to de-risk commercial adoption	Embed space-enabled services into the operating systems of ministries, state governments, municipalities, infrastructure agencies, defence users and disaster management authorities.
5	Deepen strategic and defence space capabilities	Advance secure SATCOM, Earth Observation, Space Domain Awareness, resilient navigation, cyber-secure ground infrastructure and protection of critical space assets.
6	Position India as a global space partner and export hub	Leverage cost competitiveness, engineering talent, launch heritage and private-sector capability to serve demand in Asia, Africa, the Global South and other emerging markets.

The opportunity for India is not limited to becoming a larger launch or satellite manufacturing market. It lies in building a full-spectrum space economy where upstream capability, downstream applications, policy reform, private enterprise, strategic use cases and international partnerships reinforce each other. With focused execution, India can move from being a proven spacefaring nation to a globally competitive space economy that supports growth, resilience, security and broad-based development

CHAPTER 01

Introduction

The global space sector is undergoing a transformative expansion, emerging as a cornerstone of 21st-century economic growth. Valued at approximately INR58.75 lakh crore (US$613 billion) in 2024[5], the space economy is projected to reach nearly to INR172.50 lakh crore (US$1.8 trillion) by 2035[6], driven by rapid technological innovation, increasing commercialization, and broader adoption of space-enabled services. This growth is not confined to traditional spacefaring nations; instead, it reflects a globally distributed ecosystem involving governments, private enterprises, startups and international partnerships. Historically dominated by government-led missions, the sector has expanded into a multi-layered value chain comprising upstream manufacturing and launch services, midstream data relay systems and downstream applications that translate space-derived data into real-world solutions. Private sector participation has accelerated this shift, with companies investing heavily in satellite constellations, reusable launch technologies and data-driven services.

A notable trend is the increasing dominance of downstream applications, which account for the largest share of the space economy. Services such as satellite communication, navigation, Earth Observation (EO) and geospatial analytics are now integral to industries including agriculture, climate monitoring, urban planning, logistics, finance and defence[7]. Simultaneously, innovations such as miniaturized satellites and reusable launch vehicles have significantly lowered costs, enabling broader accessibility and fostering a competitive global marketplace.

India is experiencing a dynamic phase of growth in its space sector, often described as a "space renaissance." The industry, currently valued at around **INR0.81 lakh crore (US$8.4 billion)[8]**, is projected to expand to approximately **INR4.22 lakh crore (US$44 billion) by 2033[9]**, reflecting strong policy support, increasing private sector participation, and rising global demand for cost effective space solutions. India's evolution is marked by a transition from a government-centric model led by ISRO to a more collaborative ecosystem involving startups, private enterprises and regulatory institutions. This shift is enabling both upstream innovation and downstream value creation.

The highlights of India's space sector are as follows[10]:

1 Strong institutional backbone

- ISRO continues to play a pivotal role in launch services, satellite development, and deep-space missions.
- Establishment of bodies like IN-SPACe and NSIL to promote private sector participation.

2 Upstream capabilities

- Proven expertise in cost effective launch services.
- Emerging private launch providers and satellite manufacturers.

3 Downstream expansion

Increasing use of satellite based services in:

- Agriculture (precision farming, crop monitoring).
- Logistics (fleet tracking, supply chain optimisation).
- Banking and finance (secure communication, geospatial insights).

4 Policy and regulatory reforms

New space policy frameworks and Space Policy 2023 encourage FDI, private investment, and international collaboration which focuses on building a globally competitive and self-reliant space ecosystem.

5 Global positioning[11]

India is recognized as a reliable and cost-effective launch partner with increasing participation in international missions and commercial satellite launches.

As the space sector evolves in both global and Indian contexts, it becomes essential to move beyond traditional mission-based perspectives and adopt a value chain lens. This approach enables a more holistic understanding of how different segments of the ecosystem interact, generate value and drive economic impact.

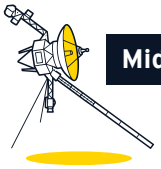
Space sector value chain

Upstream, midstream and downstream analysis

From innovation to impact: Powering the space economy

Figure 1: Space sector value chain

Upstream



Midstream

Downstream

	Upstream	Midstream	Downstream
Definition	**Design, R&D and manufacturing of space systems** Satellite platforms, payloads, propulsion systems, launch vehicle subsystems and space-grade components are designed, integrated and tested before deployment	**Launch and orbital deployment, operations and support** Launch services, mission control, telemetry, tracking and command, ground segment operations and orbital support connect space assets with terrestrial infrastructure	**Data services, applications and end-user solutions** Satellite communication, Earth Observation, navigation, geospatial analytics and sector-specific applications convert space-derived data into user outcomes
Key equipment	▪ Engines, avionics and payloads ▪ Clean rooms and AIT facilities ▪ Thermal, vibration, EMI/EMC and calibration labs	▪ Launch vehicles and launch pads ▪ Ground stations and antennas ▪ Tracking, telemetry and command systems	▪ Ground stations, GNSS and user terminals ▪ Data processing systems ▪ Cloud, analytics and application platforms
Key stakeholders	▪ ISRO, NASA and ESA ▪ SpaceX, Boeing and Airbus ▪ Skyroot, Agnikul and Pixxel	▪ SpaceX, ISRO and Arianespace ▪ ULA and Rocket Lab ▪ Spaceports and defence users	▪ Starlink, OneWeb and Viasat ▪ Airtel and Jio ▪ Planet Labs, Maxar and end users
Regulators	▪ IN-SPACe and DoS/ISRO ▪ NASA and ESA ▪ ITAR and MTCR	▪ FAA-AST and IN-SPACe ▪ ISRO and CNES ▪ ICAO and spaceport authorities	▪ TRAI and DoT (India) ▪ ITU and FCC ▪ NOAA and MeitY

Impact

Enabling a connected, sustainable and innovative space economy

- Global connectivity
- Economic growth and jobs
- Sustainability and climate action
- National security and strategic autonomy
- Innovation and future echnologies

Source: Consultant analysis; Note: The equipment and stakeholders listed are not exhaustive.

CHAPTER 02

Reaching new heights

The upstream segment of the space sector, comprising launch vehicles, satellite manufacturing, ground infrastructure and associated technologies, is undergoing a rapid and structural transformation globally and in India. Traditionally characterized by high capital intensity, long development cycles and government dominance, the upstream ecosystem is now being reshaped by technological innovation, private sector participation and evolving business models[12].

At a global level, the entry of private players such as reusable launch providers and satellite manufacturers has fundamentally altered cost structures and access to space. The cost of launching payloads has declined significantly over the past decade, driven largely by innovations in reusability, modular design and advancements in propulsion systems. For instance, recent industry estimates indicate that partially reusable rockets can reduce launch costs by around 40% or more compared with the lower end of traditional expendable launch systems, with partially reusable launch costs estimated at around US$67 million per launch against US$110 million to US$180 million for expendable rockets. This has enabled a higher launch cadence, improved asset utilization and more economically viable missions[13].[14]

The upstream segment of India's space sector is emerging as a significant industrial opportunity, supported by growing private participation across satellite manufacturing, launch services, subsystem development and enabling space infrastructure. India's space economy is projected to grow from INR0.81 lakh crore (US$8.4 billion) in 2022 to INR4.22 lakh crore (US$44 billion) by 2033, with satellite manufacturing and launch services together expected to contribute around INR0.78 lakh crore (US$8.1 billion) by 2033[15]. This marks a shift from a historically government-dominated scientific domain to a more industry-led ecosystem, enabled by space-sector reforms, IN-SPACe's single-window facilitation role, technology transfer, access to facilities, startup funding and private-sector participation across the space value chain.

The opening of the space sector to private players in 2020, along with the operationalization of IN-SPACe, has enabled startups and private enterprises to actively participate in upstream activities. India today has over 300 space startups working across launch services, satellite manufacturing, propulsion systems and space-based infrastructure[16].

Simultaneously, the role of ISRO has evolved from being a sole operator to an enabler of the ecosystem, focusing on advanced R&D, deep space missions, and technology transfer. The establishment of NewSpace India Limited further supports the commercialization of launch services and satellite manufacturing, bridging the gap between public capabilities and private sector execution.

2.1 Launch revolution

The launch segment is at the forefront of upstream innovation, with reusability, satellite miniaturization and private-sector participation reshaping the economics and accessibility of space. In 2024, a record 259 launches deployed 2,695 satellites into Earth orbit, while worldwide commercial launch revenues increased to US$9.3 billion, reflecting a 30% increase over 2023. This momentum continued in 2025, with 296 launches deploying a record 4,434 satellites, a 65% increase over 2024, underscoring the growing demand for high-cadence and commercially procured launch services. Historically, launch services were expensive and infrequent, limiting access to space largely to government agencies and large institutional programs[1718].

This evolution opens avenues in precision engineering, propulsion systems, avionics, advanced materials and structural components. Industries traditionally associated with automotive, heavy engineering and aerospace manufacturing are well positioned to integrate into these emerging supply chains. Moreover, the increasing competitiveness of India's launch capabilities, offering cost advantages in select segments compared to global benchmarks, strengthens the country's positioning as a global hub for cost-efficient launch services and related manufacturing exports. The establishment of private launch facilities, along with the progressive transfer of launch vehicle production to industry, including end-to-end realization of PSLV by the HAL-L&T consortium and technology transfer of SSLV to HAL, reflects a clear policy push towards industry-led growth[1920]. This creates opportunities for private players, infrastructure developers and industrial service providers to participate in building and operating space-related facilities under public-private partnership models.

In parallel, the rise of small satellite launches has created demand for dedicated small launch vehicles. Indian startups such as Skyroot Aerospace and Agnikul Cosmos are pioneering this segment. Skyroot's Vikram series and Agnikul's Agnibaan rockets are designed to offer flexible, on-demand launch capabilities for small payloads. Notably, Agnikul successfully tested its semi cryogenic 3D printed engine (Agnilet), marking a significant milestone in indigenous propulsion innovation. These developments are complemented by the increasing role of public-private partnerships. Furthermore, infrastructure support such as private launch pads and integration facilities is being expanded, including India's first private launchpad established by Agnikul at Sriharikota.

Figure 2: Key developments in India's satellite launch segment

Transforming the launch segment

Company	Overview	Key developments and offerings
Skyroot Aerospace	Indian private space launch startup focused on building small-lift launch vehicles to provide affordable and frequent access to space, especially for small satellites	▪ Developing the Vikram series of launch vehicles ▪ Test fires of Kalam engines ▪ Mission simulations and qualifications ▪ On-demand dedicated launch services
Agnikul Cosmos	Indian private space company developing end-to-end launch vehicles with a focus on high-performance, cost-effective and rapidly deployable solutions	▪ Agnibaan launch vehicle up to 300 kg to LEO ▪ Agnilet semi-cryogenic engine ▪ First private launchpad at Sriharikota ▪ Flexible mission solutions

Source: ISRO Annual Report 2023-24, IN-SPACe, company websites, EY-CII report.

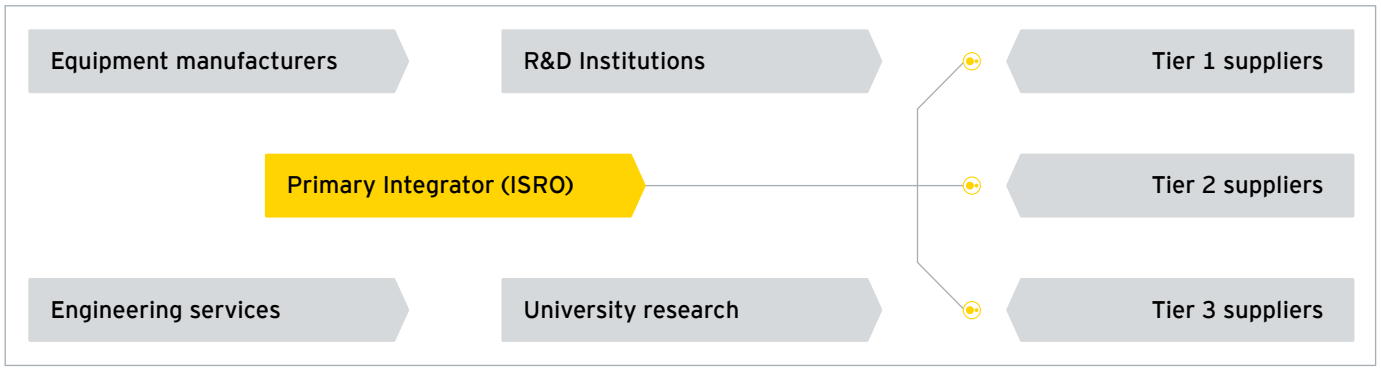
2.2 Next generation manufacturing and design

Satellite manufacturing is being transformed by miniaturization, modularization and advanced manufacturing technologies. The ecosystem is moving production models towards scalable, industrialized manufacturing processes, driven by the rapid adoption of small satellites and constellation-based architectures. In 2024, small satellites accounted for 97% of spacecraft launched globally, highlighting the shift towards modular and faster-to-deploy satellite platforms[21]. This trend is also visible in India, where companies such as Pixxel are developing EO and satellite constellations to support applications across agriculture, climate monitoring, disaster management, environmental compliance and urban planning[22]. The overall direction of the market is towards faster, cost-efficient and scalable satellite deployment.

Advanced manufacturing techniques, such as additive manufacturing, digital twin modeling and automated assembly lines, are also gaining traction. These approaches significantly reduce production timelines and costs while improving design flexibility and performance. For instance, 3D printing of rocket engines and satellite components allows for rapid prototyping and reduced material wastage, as demonstrated by companies like Agnikul Cosmos[23].

For the Indian industry, this transition represents a significant opportunity to participate in large-scale manufacturing. Electronics manufacturers and aerospace suppliers can play a key role in producing satellite subsystems, including sensors, communication modules, power units and structural components[24]. Another important trend is the increasing focus on supply chain localization, driven by the broader vision of Atmanirbhar Bharat. Efforts to reduce dependence on imports for critical components and materials are creating opportunities for MSMEs and Tier-II and Tier-III suppliers to integrate into both domestic and global space supply chains. High throughput communication satellites, advanced EO payloads and IoT-enabled satellite systems are expanding the scope of space-based services.

Figure 3: Key stakeholders in India's space infrastructure value chain



CHAPTER 03

Bringing space to Earth

The downstream space sector refers to applications and services derived from satellite data that impact daily life, economy, governance and sustainability.[25]The downstream space and geo-information sector, which relies on Global Navigation Satellite System (GNSS) data, is of strategic importance with great potential to support national and sub-national policy priorities[26]. This sector encompasses numerous services across multiple market segments that use satellite-based positioning and/or EO data generated by satellites. The pillars of the downstream space segment are:

1. **Connectivity and communication**
2. **Navigation**
3. **Earth Observation (EO)**

EO and GNSS are characterized by their cross-industry nature and capacity to provide economic benefits in terms of cost-effectiveness in many industrial ecosystems and become increasingly useful in decision-making processes[27]. The data is used around the world for diverse applications, benefiting citizens and society and providing information for different market segments.

Figure 4: Bringing space to Earth

Bringing space to Earth

EO and GNSS-enabled services are supporting decisions across infrastructure, mobility, environment, economy and security

Built on three pillars

- **Connectivity and communication**
  Enabling broadband access, resilient networks and secure communications
- **Navigation**
  Enabling precise positioning, timing and navigation for people, vehicles and assets
- **Earth Observation (EO)**
  Delivering geospatial data and insights for informed decision-making and sustainable outcomes

Downstream applications across key sectors

1 Agriculture and natural resources
- Precision agriculture
- Fisheries and aquaculture
- Forestry
- Energy and raw materials

2 Climate, environment and resilience
- Climate service
- Environmental monitoring
- Biodiversity and ecosystems assessment
- Disaster management

3 Infrastructure and urban systems
- Critical infrastructure planning and monitoring
- Urban development
- Cultural heritage
- Utilities and asset monitoring

4 Mobility and transport
- Aviation and drones
- Maritime and inland waterways
- Rail
- Road and automotive

5 Economic and citizen services
- Insurance and finance
- Consumer solutions
- Tourism and health
- Emergency management and humanitarian aid

6 Security and strategic applications
- Space situational awareness
- Security and defence
- Border and maritime surveillance
- Secure navigation and communication support

3.1 Connectivity and communication

Satellite communication remains one of the most mature and commercially significant segments within the downstream space economy, enabling data, voice, and video connectivity across terrestrial, maritime and aviation use cases. While the broader commercial satellite industry accounted for approximately 71% of the global space economy in 2024, satellite communication continues to be a major contributor to downstream value creation, supported by demand for broadband connectivity, broadcasting, enterprise networks, mobility services and secure communications[28][29]. Advances in satellite technology, particularly the deployment of LEO constellations and high-throughput satellites, are improving global connectivity by enabling high-speed, lower-latency broadband services and expanding coverage in remote areas.

A key driver of demand is the persistent global digital divide. Despite the expansion of terrestrial networks, approximately 220 crore people worldwide still lack reliable internet access, according to global telecom assessments[19]. Satellite communication is uniquely positioned to address this gap by providing universal coverage, particularly in rural, remote, maritime and aviation environments. Unlike terrestrial infrastructure, satellite networks can deliver connectivity across vast geographies without requiring extensive ground infrastructure, making them cost-effective for underserved regions.[30]

Figure 5: Satellite communication

Satellite communication

Satellite communication (SATCOM) enables data, voice and video transmission through satellites (GEO, MEO, LEO).

Types of services

- Broadband internet (Starlink, OneWeb)
- TV broadcasting (rural areas)
- Emergency communications
- IoT and 5G satellite integration

Applications

- Rural internet access →bridging the digital divide
- Telemedicine and e-learning
- Maritime and aviation communications

Key features

- Global coverage (including oceans, deserts)
- Telemedicine and e-learning
- Maritime and aviation communications
- Disaster relief communication

Example:

Satellites provide instant broadband and communication even where ground networks fail, especially during disasters.

From the Indian stakeholder's perspective, this transformation creates substantial opportunities across telecom infrastructure, electronics manufacturing and digital services. Indian enterprises can participate in building satellite communication, ground infrastructure, manufacturing user terminals and devices, and developing enterprise solutions for sectors such as aviation, shipping and remote industrial operations[31]. This translates into opportunities across telecom infrastructure, device manufacturing, network integration and digital service delivery, particularly in the context of India's Digital India and BharatNet initiatives.

3.2 Navigation and beyond

Satellite-based navigation systems have become critical infrastructure for modern economies, enabling precise Positioning, Navigation and Timing (PNT) services that underpin a wide range of economic activities. Global Navigation Satellite Systems (GNSS), including GPS, Galileo and India's NavIC, support applications across transportation, logistics, aviation, maritime operations, financial transactions and everyday consumer services[32].

Navigation technologies play a vital role in enhancing efficiency, safety and reliability across modern economies. Satellite navigation systems support real-time fleet management[33], route optimization and asset tracking, enabling logistics and transportation networks to reduce fuel consumption, improve delivery performance and strengthen supply chain resilience. In the aviation and maritime sectors, precise positioning and navigation capabilities enhance operational safety and route management . Beyond transportation, GNSS timing services are essential for synchronizing financial transactions, power grids and telecommunications networks, enabling the integrity and seamless functioning of critical infrastructure while reducing operational costs and improving overall system performance.

In India, the development of NavIC represents a strategic capability that supports technological sovereignty and reduces dependence on foreign systems. The increasing adoption of NavIC-enabled devices in sectors such as transportation, fisheries, disaster management and mobile applications is expected to drive domestic innovation[34]. This creates opportunities in semiconductor design, device manufacturing, IoT integration and the development of location-based services, particularly in areas such as mobility, smart infrastructure and logistics optimization.

3.3 Eyes on the planet

EO services represent one of the fastest-growing segments of the downstream space economy, driven by increasing demand for data driven decision making across environmental, agricultural and urban applications[35]. Satellite-based remote sensing provides high-resolution, real-time data that is critical for monitoring climate change, managing natural resources and responding to disasters. EO applications are extensively used in agriculture for crop monitoring, yield prediction and precision farming, enabling improved productivity and food security. In urban planning, satellite imagery supports infrastructure development, land-use mapping and smart city planning[36].

Table 1: EO applications and services

S.No	Priority	What it means
Concept	EO uses satellite imagery and sensors to monitor Earth systems	Land, oceans, atmosphere, weather, climate and disasters
Key technologies	a) Optical imaging b) Radar c) Thermal sensors	Enables all-weather monitoring and multi-dimensional data collection
Agriculture	Crop mapping and yield prediction; irrigation monitoring; precision farming	Help farmers make data-driven decisions on crop health and productivity
Disaster management	Flood and cyclone monitoring, early warning systems and damage assessment	Enables real-time hazard tracking and improves disaster preparedness
Urban and environmental uses	Crop mapping and yield prediction; irrigation monitoring; precision farming	Supports sustainable development and governance
Case studies	a) COMPASS system (crop monitoring using EO) b) Copernicus Programme (European Union EO system) c) EO + GNSS-based flood prediction	Weekly crop monitoring and enhanced agricultural productivity[HA1.1][VM1.2] through EO systems

As access to satellite data becomes more democratized, Indian enterprises, including startups and MSMEs can play a key role in developing innovative applications and services within this rapidly growing ecosystem.

For Indian stakeholders, EO presents opportunities across agritech, climate tech, infrastructure planning, and ESG compliance. The ability to leverage satellite data for predictive analytics and operational intelligence can improve efficiency, reduce risks, and support sustainable business practices[37].

The integration of EO data with artificial intelligence and big data analytics is further enhancing its commercial value. Industries such as insurance, energy, mining and infrastructure are increasingly using satellite-derived insights for risk assessment, asset monitoring and operational optimization. This shift towards analytics-driven applications is significantly expanding the addressable market for EO services.

Disaster management agencies rely on EO data for early warning systems, damage assessment and emergency response, while environmental monitoring uses satellite data to track deforestation, glacier melt, ocean health and pollution levels. The integration of EO data with advanced analytics and AI is further enhancing its value, enabling predictive insights and automated decision making[38]. These capabilities are particularly relevant in addressing global challenges such as climate change and sustainability, aligning with international frameworks and ESG priorities.

The ability to leverage satellite data for operational intelligence can drive efficiency, reduce risks and support sustainable business practices. Moreover, the growing availability of satellite data and analytics platforms lowers entry barriers, enabling startups and enterprises alike to participate in this expanding ecosystem.

CHAPTER 04

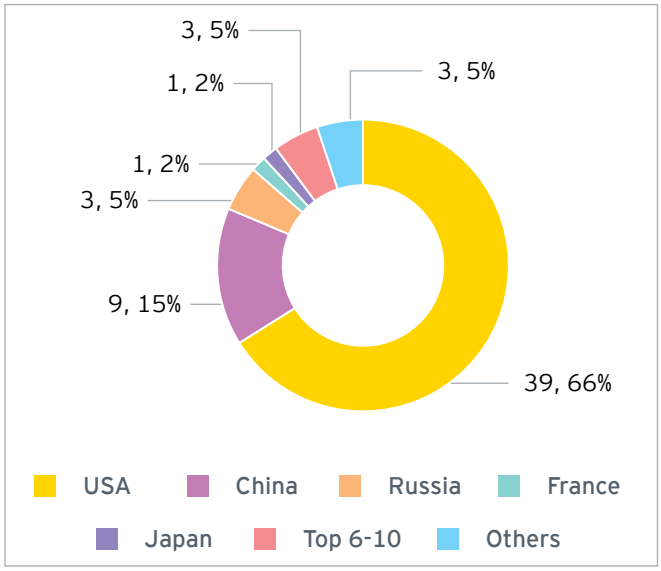
Space for national security and strategic advantage

Space has fundamentally transitioned from exploration into a highly contested arena where orbital assets form the backbone of modern military power. Satellites dictate strategic advantage through real-time surveillance, precision navigation, secure communications and early warning systems, making space an irreplaceable element of national security planning[39].

Global government expenditure on defence related space programs has continued to expand rapidly, reaching approximately INR7.04 lakh crore (US$73.5 billion) in 2025, and accounting for nearly 54% of total government space budgets. This represents a sustained increase from INR5.60 lakh crore (US$58.4 billion) in 2023 and INR3.09 lakh crore (US$32.2 billion) in 2018, with a CAGR of 12.5% over 2018-2025. The trend underscores the growing recognition of space as a critical domain for national security, resilience and strategic autonomy[4041].

Global government space expenditure remains highly concentrated among major space powers, with the United States accounting for 58% of global government space budgets in 2025, followed by China at 15% and Europe at 11%. These leading space powers are scaling investments across priority defence and security applications, including early warning, secure communications, EO and surveillance[4243].

Figure 6: Space defence and security expenditure, 2023, by country (US$ billion, percentage share)



Source: Novaspace

The growing dependence on space assets for military operations has made these systems targets for adversaries. To mitigate the risks associated with potential attacks, there is a shift towards developing resilient and proliferated architectures. The US Space Force is investing heavily in proliferated LEO constellations, which offer redundancy and reduce the risk of a single point of failure[44].

Countries are also focusing on improving their Space Domain Awareness (SDA) capabilities to better monitor and protect their space assets. This includes tracking an increasing number of Resident Space Objects (RSOs), including both active satellites and space debris. SDA capabilities are essential for identifying potential threats and enabling the safety and operational effectiveness of space-based systems[45].

Figure 7: Strategic intent and key enablers for the space defence sector

Space for defence

- Includes various uses of space capabilities for military operations and missile defence (early warning)
- Accounts for the main functions of interest for military intelligence, Intelligence, Surveillance and Reconnaissance (ISR), satellite communications, positioning, navigation and timing, space surveillance

Defence of space

- Accounts for the prevention of potential threats to space assets (kinetic, directed energy, jamming, spoofing, cyber) and existing countermeasures
- Includes defence of space-based, ground-based, down- and uplink segments when an asset is in operation

Strategic intent	**Enhance military operations**	**Develop capabilities for space warfare**
Enabling requirements	Integrate space across defence domains Build resilience in space systems and services Enhance non-kinetic capabilities of space systems	Develop own small satellite capability Develop advanced terrestrial sensors for satellites Develop defensive capabilities against ASAT and RPOs

4.1 Military applications and defence space programs

The table below provides the key functions, capabilities and impact of the main categories of military applications of space.

Table 2: Key military applications of space

Category	Function	Key capabilities	Strategic impact
Communication (SATCOM)	Enables secure military communication	▪ Secure global communication between units ▪ Real-time coordination of operations ▪ Resistant to jamming and disruption	Enables network-centric warfare
Intelligence Surveillance and Reconnaissance (ISR)	Provides intelligence and monitoring	▪ Monitoring enemy movement and infrastructure ▪ High-resolution satellite imagery ▪ Signals intelligence (SIGINT) collection Provides real-time battlefield awareness	Provides real-time battlefield awareness
Targeting and precision strike	Supports accurate military operations	▪ Accurate geolocation of targets ▪ Integration with missiles and drones ▪ Precision-guided weapons	Improves accuracy and reduces collateral damage
Missile warning and defence	Detects and tracks threats	▪ Early detection of missile launches ▪ Tracking ballistic missiles ▪ Supports anti-missile defence systems	Enables early warning and deterrence

Table 3: Major defence space programs in India

Program/system	Description	Strategic role
NavIC (IRNSS)	Indigenous satellite navigation system	Enables strategic autonomy in navigation
GSAT series	Dedicated naval communication satellites, including GSAT-7 "**Rukmini**" and GSAT-7R / CMS-03[46]	Provides secure, high-capacity communication between ships, submarines, aircraft and maritime operations centers
RISAT satellites	Radar imaging satellites	Enables all-weather surveillance and reconnaissance
Mission Shakti	Anti Satellite (ASAT) capability test	Demonstrates space defence and deterrence capability

Source: Center for Security and Emerging Technology, The Enduring Dangers of Anti-Satellite Weapons and Space Debris, 2025

4.2 Security challenges and space safety

The space domain is becoming increasingly complex, driven by rapid growth in satellite deployments, intensifying geopolitical competition and rising dependence on space-based systems for communications, navigation, EO, climate monitoring, disaster response and national security. By the end of 2024, around 11,539 operational satellites were in Earth orbit, compared with 3,371 in 2020, reflecting more than three times increase in just four years[47]. This growth continued in 2025, with a record 4,434 satellites deployed during the year and approximately 14,266 operational satellites in orbit by year-end[48]. The increasing density of satellites, particularly in LEO, is also raising concerns around orbital congestion, collision risk and space sustainability, making resilient architectures, space situational awareness and responsible behavior critical priorities for governments and industry.

This growing dependence on space infrastructure has amplified the consequences of disruption, whether arising from congestion, hostile action or system vulnerabilities. Any degradation of satellite services can have cascading effects across communications, navigation, weather monitoring, financial systems, power grids and national security operations. The increasing militarization of space is further altering the risk landscape, with several nations developing or demonstrating counterspace capabilities such as anti-satellite weapons, jamming, spoofing and cyberattacks. The dual-use nature of space technologies adds to this complexity, as many systems simultaneously support civilian services and strategic military functions[49].

To address these challenges, the international community is working towards establishing norms and frameworks for responsible behavior in space. The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) has developed guidelines for the long-term sustainability of space activities, focusing on safe operations, debris mitigation and international cooperation[50]. Additionally, efforts such as proposed bans on destructive ASAT testing and the promotion of transparency and confidence building measures aim to reduce risks and prevent escalation of conflicts in space. However, many of these measures are voluntary and lack enforcement mechanisms, highlighting the need for stronger global governance.

Outer space is widely regarded as a global common, meaning it should be accessible to all nations for peaceful purposes; however, growing congestion and competition threaten this principle. Enabling space to remain a "safe common" requires collective responsibility, sustainable practices and international cooperation. This includes responsible satellite operations, debris mitigation efforts and adherence to agreed norms of behavior. As reliance on space-based technologies continues to grow, preserving the safety and sustainability of the space environment is critical for future generations and the continued advancement of the global space economy.

CHAPTER 05

Space economy: Growth, entrepreneurship and value creation

The space economy has evolved from a government-led scientific endeavor into a significant economic sector that generates value across industries. Traditionally, assessments of the space sector focused on direct revenues generated by satellite manufacturing, launch services, and satellite operations. Space-enabled technologies such as satellite communications, navigation and EO create substantial spillover benefits across transportation, agriculture, financial services, defence, climate monitoring, logistics and digital infrastructure.

As a result, policymakers and industry stakeholders are increasingly adopting a holistic view of the space economy that measures not only direct industrial output but also the indirect and induced economic benefits generated by space technologies throughout the economy. OECD defines the space economy as the full range of activities and use of resources that create value and benefits through exploring, researching, understanding, managing and utilizing space . This includes both upstream and downstream activities, as well as societal, environmental and economic impacts.

Space technologies have become deeply embedded in everyday economic activities.

OECD estimates suggest that space systems support more than half of the most frequently designated critical infrastructure services across developed economies.

The downstream segment generates the largest share of global space economy revenues and creates widespread value across non-space industries. Importantly, much of the future value creation is expected to originate outside the traditional space sector through space-enabled applications used by industries such as transportation, agriculture, insurance and retail.

Table 4: Indian space economy opportunities

Theme	Key elements	Strategic impact
Growth drivers	■ Space Policy 2023 ■ IN-SPACe reforms ■ Growing SpaceTech startup ecosystem ■ Increasing NavIC adoption ■ Expansion of satellite communication services ■ EO driven applications ■ Digital India initiatives	Creates an enabling ecosystem for private participation, innovation, and commercialization of space technologies
Agriculture	■ Precision farming ■ Crop monitoring ■ Yield prediction ■ Irrigation management	Improved productivity, resource optimization and food security
Disaster management	■ Early warning systems ■ Flood and cyclone monitoring ■ Emergency response planning	Reduced disaster risk and faster response capabilities

Theme	Key elements	Strategic impact
Urban planning	■ Smart city planning ■ Land-use mapping ■ Infrastructure development	Better governance and sustainable urban development
Logistics and transportation	■ Fleet tracking ■ Route optimization ■ Asset monitoring	Lower operational costs and improved supply-chain efficiency
FinTech and digital services	■ Location-based services ■ Digital payments support ■ Timing and navigation services	Strengthens the digital economy and financial inclusion
Mobility solutions	■ Navigation services ■ Connected mobility ■ Intelligent transportation systems	Enhanced transport efficiency and user experience
Telecommunications	■ Rural broadband ■ Satellite internet ■ Direct-to-device services	Bridging the digital divide and expanding connectivity
Opportunity base	200+ space-enabled use cases identified across: ■ EO ■ Satellite Communication (SatCom) ■ PNT	Significant market opportunities across commercial and public-sector applications
Value creation outcomes	■ Economic growth ■ Employment generation ■ Innovation and entrepreneurship ■ Technology self-reliance ■ Digital inclusion ■ National competitiveness	Positions India as a leading global SpaceTech

Source: Propelling India into a New Era of Space and Innovation, Confederation of Indian Industry (CII), 2025

5.1 Growing space ecosystem and industry growth

The global space sector is undergoing a profound transformation driven by the rapid rise of private enterprises, venture capital investment, technological innovation and supportive government policies. Traditionally dominated by national space agencies, the sector is increasingly characterized by entrepreneurial ventures, commercial partnerships, and new business models that are expanding access to space and accelerating innovation. This transition, often referred to as the new space economy, is reshaping the entire space value chain from launch services and satellite manufacturing to downstream applications and data-driven services[52].

The rise of private enterprise in space

Private companies have become key drivers of growth within the space sector, introducing innovative technologies, improving operational efficiencies and reducing the cost of accessing space. Globally, companies such as SpaceX, Blue Origin, Rocket Lab, Planet Labs, ICEYE and OneWeb have demonstrated that commercial enterprises can successfully participate in areas previously dominated by governments[53]. These firms are developing reusable launch vehicles, satellite constellations, EO platforms and satellite communication networks that are driving significant market expansion.

The increasing commercialization of space has enabled broader participation from startups, technology firms, investors and non-space industries. As launch costs decline and satellite technologies become more affordable, the barriers to entry for new companies continue to fall.

Venture capital and private investment

Private investment has become an important growth enabler for the space economy. Venture capital firms, institutional investors, sovereign funds and strategic corporate investors are increasingly funding emerging space technology companies. Global private investment in the space sector reached approximately INR75,618 crore (US$7.9 billion/ €6.9 billion) in 2024[54], reflecting renewed investor confidence.

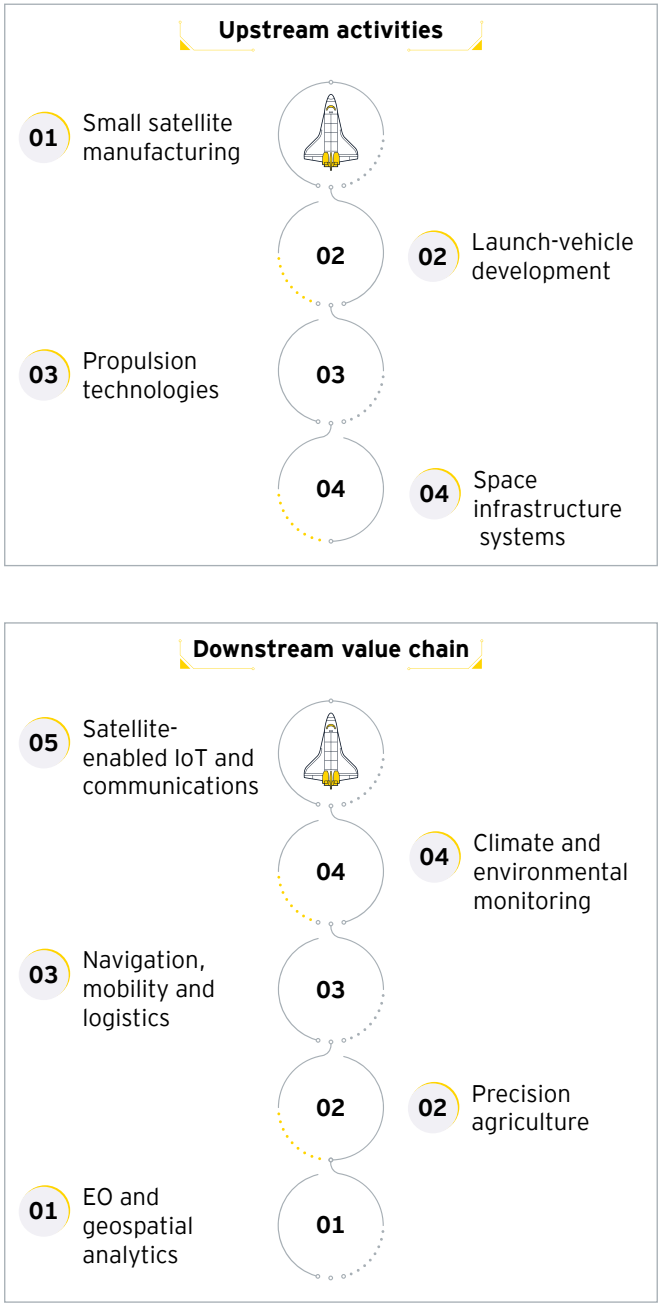
Venture capital remains the dominant source of private funding in the space sector, accounting for 92% of start-up space investment in 2024 and 81% of cumulative start-up space investment during 2015-2024. Investment activity is increasingly concentrated in high-growth segments such as:

1. Satellite communications
2. EO analytics
3. Space-based connectivity
4. Defence and security applications
5. Space data services
6. Satellite manufacturing and launch technologies

Startup ecosystem and entrepreneurship

Entrepreneurship has emerged as a defining feature of the modern space economy. Startups are introducing innovative solutions across the entire space value chain, including[56]:

Figure 8: Upstream and downstream activities



Startups are often more agile and innovation-focused than traditional aerospace organizations, enabling faster development cycles and the commercialization of emerging technologies. Their role has become increasingly important in addressing market gaps and creating new commercial opportunities.

India's emerging space ecosystem[57]

India is rapidly emerging as one of the world's most dynamic space economies, wherein reforms such as the creation of **IN-SPACe** and the introduction of the **Indian Space Policy 2023** have transformed the country's space ecosystem. These initiatives are enabling startups, private enterprises, research institutions and investors to actively participate in the sector. The Indian startup ecosystem is increasingly attracting domestic and international investment, supported by[58]:

1. Government reforms
2. Growing demand for space-enabled services
3. Success of missions, such as Chandrayaan 3
4. Rising investor confidence
5. Expanding commercial opportunities

5.2 Measuring space's economic impact

One of the biggest challenges in evaluating the space sector is that its economic contribution extends far beyond traditional measures such as satellite manufacturing revenues, launch contracts, or government spending. Space technologies generate significant benefits across multiple sectors; as a result, conventional methods often underestimate the true value created by space activities. A more comprehensive framework is therefore required to capture both the direct contributions of the space industry and the wider economic benefits generated throughout the economy .

Most existing assessments focus on the direct size of the space sector, such as satellite manufacturing revenues, launch services, ground infrastructure, space agency expenditure, satellite operations, among others. While these indicators are important, they fail to account for how space technologies enhance productivity and create economic value in non-space sectors. For example, GPS-enabled logistics platforms, EO-enabled precision agriculture, satellite broadband services, and digital payment systems all generate significant economic benefits that are not captured within traditional space industry statistics.

Proposed economic impact framework

The proposed framework measures the economic contribution of space across four dimensions[60]:

1 Direct impact:

Economic output generated directly by space sector activities, including satellite manufacturing, launch services, ground stations, space operations, satellite communication providers, among others.

2 Indirect impact:

Economic activity generated through supply chains supporting the space sector, including electronics manufacturing, advanced materials, software development, engineering services, data infrastructure, among others.

3 Induced impact:

Economic benefits arising from employment and spending generated by the space ecosystem, including high-skilled job creation, household consumption, ancillary business activity, among others.

4 Spillover impact:

The broader value created when space-enabled technologies improve productivity and decision-making in other sectors, including agriculture productivity gains, reduced transportation costs, disaster loss mitigation, climate resilience, improved connectivity, enhanced operational efficiency, among others. Spillover impact is increasingly recognized as the largest source of long-term value creation from space investments.

The proposed framework incorporates three additional factors that are often overlooked in traditional economic models[61]:

1 Technology readiness:

The value generated by space technology depends on its maturity and commercial adoption. Assessment parameters include technology readiness level, commercial viability, scalability and market adoption, where readiness levels generally translate into greater economic impact and market realization.

2 Government policies:

Government policies can either accelerate or constrain growth. Wherein lower policy friction enables faster commercialization and higher private sector participation.

3 Institutional support:

Strong institutions improve innovation and ecosystem development. Assessment parameters include national space policies, research institutions, public funding, startup incentives and industry-academia partnerships. Countries with strong institutional ecosystems generally achieve greater returns from space investments.

Upstream versus downstream: Value creation across the space economy

	Dimension	Upstream segment	Upstream segment
01	Business model	Capital-intensive hardware and infrastructure development	Service-oriented and application-driven business models
02	Nature of investment	High upfront investment, long development cycles	Lower capital requirements with scalable service deployment
03	Value creation mechanism	Technology development and asset creation	Productivity enhancement and cross-sector integration
04	Revenue sources	Manufacturing contracts, launch agreements, government missions, satellite procurement	Subscription services, data analytics, connectivity services, location-based services
05	Employment impact	Generates highly skilled jobs in engineering, manufacturing and R&D	Generates jobs across IT, analytics, telecom, logistics, agriculture and digital services
06	Innovation impact	Advanced materials, propulsion systems, spacecraft engineering	AI, IoT, geospatial intelligence, digital platforms, predictive analytics
07	Market reach	Primarily space-sector focused	Extends across multiple industries and end-user markets
08	Economic contribution	Direct contribution to industry-output and technological capability	Indirect and induced economic impact across the broader economy
09	Key beneficiaries	Aerospace firms, launch providers, satellite manufacturers, defence contractors	Agriculture, logistics, transportation, telecom, banking, insurance, urban planning, climate-tech industries
10	Scalability	Limited by manufacturing capacity and launch infrastructure	Highly scalable through digital platforms and data services
11	GDP impact	Generates direct revenue and industrial output	Generates larger multiplier effects through economy-wide adoption
12	Strategic value	Builds sovereign capabilities and technological self-reliance	Enhances national productivity, economic competitiveness and societal outcomes

Table 5: Value creation across the upstream and downstream segments

CHAPTER 06

Policy and governance

The growth and competitiveness of the space sector are shaped not only by technological innovation and investment but also by the policy, regulatory and governance frameworks that govern space activities. Effective policies create certainty for investors, encourage innovation, facilitate international cooperation and enable the sustainable and secure use of outer space.

As the ecosystem evolves, continued efforts to enhance regulatory clarity, streamline processes and strengthen institutional coordination can further support private-sector participation and industry growth.

As the global space economy expands and commercial actors become increasingly prominent, governments are transitioning from being sole operators of space programs to becoming regulators, facilitators and ecosystem enablers. This shift requires balanced governance frameworks that simultaneously promote innovation, safeguard national interests and uphold international norms governing outer space activities.

Table 6: Policy enablers versus policy constraints

Policy enablers	Policy constraints
Clear regulations	Enhancing regulatory clarity
Single-window approvals	Streamlining licensing procedures
Private-sector participation	Optimizing compliance processes
Startup incentives	Expanding access to financing
International partnerships	Enabling technology collaboration
Open data policies	Strengthening data-sharing frameworks
Spectrum coordination	Facilitating timely spectrum allocation

6.1 India's space policy reforms

India's space sector has undergone a significant transformation over the past few years, moving from a predominantly government-led model to a more collaborative and commercially driven ecosystem. The reforms initiated in 2020 and formalized through the Indian Space Policy 2023 have opened the sector to private participation, encouraged investment, and established new institutional mechanisms to accelerate growth and innovation. These developments mark a shift from ISRO being the primary operator of space activities to a broader ecosystem where government agencies, startups, private firms, academia and investors collectively contribute to India's space ambitions.

Evolution of India's space governance framework[62]

Phase 1- Government-led space development:
For several decades, India's space program was primarily driven by ISRO, which was responsible for satellite development, launch vehicle programs, scientific missions, space applications, ground infrastructure, among others. This model helped India establish itself as a leading spacefaring nation through programs such as INSAT, IRS, Chandrayaan, Mangalyaan and Gaganyaan.

Phase 2- Space sector reforms (2020 onwards):
Recognizing the growing global commercialization of space, the Government of India announced major reforms in 2020 to unlock private-sector participation across the entire space value chain. The key objectives included:

1. Increasing commercial participation
2. Attracting private capital
3. Encouraging technology transfer
4. Developing a competitive domestic industry
5. Expanding international collaboration

These reforms culminated in the release of the **Indian Space Policy 2023**, which provides regulatory certainty and a framework for increased participation by Non-Government Entities (NGEs).

Figure 9: India's space governance ecosystem

India's space governance ecosystem

Regulator and collaborator: dual role of institutions

India's institutional framework is unique because several agencies act both as facilitators and regulators.

The Indian space governance ecosystem is summarised below

Space reforms journey

Pre-2020
Government-led ecosystem

2020 space reforms
Space sector liberalization private sector entry enabled

Private participation
Innovation and strategic missions

Key institutions

Investment growth

200+ startups

Technology transfer

ISRO
Innovation and strategic missions
- Innovator enabler

In-SPACe
Technology transfer
- Industry transfer
- Industry partnerships
- Single-window facilitation

NSIL
Commercialisation

DSA
Defence capability
- Strategic capabilities
- Defence coordination

Ecosystem impact

Investment growth | 200+ startups | Technology transfer | PPP models | Global competitiveness

6.2 Regulatory enablers and challenges

A robust regulatory framework can accelerate innovation and industry growth, while excessive bureaucracy, policy uncertainty and fragmented governance can slow the development of the space ecosystem. As space activities become increasingly commercialized and internationalized, governments are required to balance competing objectives, namely promoting innovation, safeguarding national interests, and ensuring the long-term sustainability of the space environment. An effective regulatory regime therefore acts as both an enabler of growth and a mechanism for responsible governance.

Regulatory enablers

1. **Spectrum allocation and satellite communications**

   Satellite operators depend on access to radio frequency spectrum and orbital slots to provide communication services. Efficient spectrum management is essential for satellite broadband services, mobile satellite communications, direct to device connectivity, broadcasting services, among others. As demand for space-based connectivity grows, timely allocation of spectrum resources becomes increasingly important for enabling industry expansion and competition.

2. **Licensing for launches and satellite operations**

   Satellite operators depend on access to radio frequency spectrum and orbital slots to provide communication services. Efficient spectrum management is essential for satellite broadband services, mobile satellite communications, direct to device connectivity, broadcasting services, among others. As demand for space-based connectivity grows, timely allocation of spectrum resources becomes increasingly important for enabling industry expansion and competition.

3. **Export controls and technology transfer**

   Space technologies often have dual-use applications, meaning they can be used for both civilian and defence purposes. Regulations governing technology exports, international collaboration, foreign participation, and strategic technology transfers have a direct impact on global partnerships and industry competitiveness.[63] While export controls protect national security interests, excessive restrictions can limit innovation and collaboration. Policymakers are therefore increasingly exploring balanced approaches that encourage technology diffusion while maintaining strategic safeguards.

4. **Financial incentives and government support**

   Governments can stimulate industry development through tax incentives, startup grants, research funding, innovation accelerators, space incubators and public procurement programs. Such support mechanisms reduce the risks associated with developing capital-intensive space technologies and help nurture emerging startups and SMEs.

6.3 International cooperation

International cooperation has been a cornerstone of space activities since the beginning of the space age. As space becomes increasingly global, commercialized and interconnected, international partnerships, treaties and governance frameworks play a critical role in enabling innovation, promoting responsible behavior, and enabling long-term sustainability of outer space. Space activities today rely on collaboration among governments, international organizations, private companies and research institutions to address shared challenges and unlock collective benefits[64]. Space is inherently a global domain because:

1. Satellites operate across national boundaries
2. Orbital resources are shared globally
3. Radio frequencies require international coordination
4. Space debris impacts all space actors
5. Climate monitoring and disaster management require global data sharing

The growing complexity of the space ecosystem has increased the importance of common rules, standards and confidence-building measures. International cooperation helps countries share costs, reduce duplication of efforts, enhance technological capabilities, and promote peaceful uses of space while enabling outer space to remain accessible to all nations.

Thus, international cooperation enables nations to maximize the benefits of space technologies while minimizing risks associated with congestion, conflicts and environmental degradation.

Table 7: Key international space organizations and their role in space cooperation

Organization	Role in space cooperation
UNOOSA	Space governance, legal frameworks, capacity building
COPUOS	International policy dialogue and sustainability
ITU	Spectrum and orbital slot coordination
ESA	Multinational research and development
COSPAR	Scientific collaboration and planetary protection

International cooperation and India's space ambitions[66]

India has increasingly embraced international collaboration through joint satellite missions, bilateral agreements, participation in multilateral forums, engagement with UNOOSA and COPUOS, EO partnerships, capacity-building initiatives, etc. These partnerships support India's goals of enhancing technological capabilities, expanding global influence and strengthening its position as a leading spacefaring nation.

CHAPTER 07

Current landscape of spacefaring countries

Presents a comprehensive comparative analysis of major spacefaring countries across various metrics:

#	Metric	China	USA	Europe	Russia	Japan	India
1	Percentage of total budget allocation	Part of 328 global attempts[67]	Global about 259 in 2024. US about 145 in 2024[68]	6–10 launches/ year (recent avg; Ariane 6 + Vega-C cadence) [69]	Part of 328 global attempts[70]	Part of 328 global attempts[71]	Five orbital launches (ISRO); 328 global attempts; 315 successful globally[72]
2	Lunar program maturity	Chang'e missions (active)[73]	Artemis program (active)[74]	3.5/5 (participates in Artemis, robotic strong, no independent human lunar capability)75	Luna-25 failed (2023)[76]	SLIM successful (2024)[77]	Chandrayaan-3 successful (2023)[78]; Chandrayaan-4 (2027-28), Chandrayaan-5, 6, 7, 8 planned; crewed lunar mission by 2040[79]
3	National space law enacted	No comprehensive national space law; regulated by administrative regulations; a national law is still in draft[80]	Yes[81]	Yes (multiple countries e.g., France 2008, EU frameworks)[82]	Yes[83]	Yes[84]	Pending (Draft Space Activities Bill under consideration)[85]
4	Single-window regulator (SLA)	SASTIND[86] (State Administration for Science, Technology and Industry for National Defence)	FAA for commercial launches (multiple agencies)[87]	No single unified regulator; fragmented (ESA + EU Commission + national agencies like CNES, DLR)[88]	Roscosmos[89]	Cabinet Office/MEXT (multiple agencies)[90]	IN-SPACe (established 2020, autonomous agency under DOS)[91]

#	Metric	China	USA	Europe	Russia	Japan	India
5	Core UN treaties ratified (0–5)	All five (China joined the Outer Space Treaty 1983[92]; others subsequently)[93]	All five ratified[94]	All five ratified (most European states ratified all major treaties)[95]	All five ratified[96]	All five ratified[97]	Outer Space Treaty, Rescue and Return, Liability Convention, Registration Convention[98] (Moon Agreement not ratified)
6	Artemis Accords signatory	No[99]	Yes (founding signatory, 2020)[100]	Yes (the majority of European countries signed; 30+)[101]	No[102]	Yes (signed 2020)[103]	Yes (signed June 21, 2023)[104]
7	Total space economy	Data not separately available[105]	US$613 billion global space economy (2024); US has the largest share[107]	US$100 billion –US$150 billion (Europe's share of global space economy)[108]	Data not separately available[108]	US$24.7 billion (¥4 trillion) by 2020 target; US$49.4 billion (¥8 trillion) by early 2030s target[109]	INR0.81 lakh crore (US$8.4 billion) (2024); 2% global share[110]

#	Metric	China	USA	Europe	Russia	Japan	India
8	Percentage of total budget allocation	US$72 billion (estimated) of US$246 billion defence budget[111]	US$28.7 billion Space Force + NASA ~US$25 billion[112]	10% of global public space spending (€22.1 billion is ESA's budget for 2026 to 2028)[113]	US$6.3 billion total (US$22.5 billion over 10 years)[114]	US$0.5 billion (¥79 billion) MEXT space and aeronautics + US$1.2 billion (¥200 billion) Space Strategy Fund[115]	INR13,000 crore (US$1.56 billion) for Dept of Space (2025)[116]
9	Defence space command/ agency	PLA Aerospace Force (space component)[117]	US Space Force (established 2019)[118]	Yes (emerging; EU Space Programme + ESA defence role expanding)[119]	Space Forces of the Russian Aerospace Forces[120]	Space Operations Group, established in 2022, building on the Space Operations Squadron, established in 2020[121]	Defence Space Agency (DSA) coordinates tri-service space efforts[122]
10	Defence space budget	China's total government space budget was over US$19 billion in 2024[123]	US$28.7 billion Space Force/US$895 billion total defence ≈ 3.2% (~US$33.7 billion DOD space capabilities approx. 3.8%)[124]	1%-2% (fragmented national spending; growing)[125]	US$6.3 billion total space est / Russia defence budget[126] ~US$86 billion (2024) ≈ 7.3%	Part of US$53.7 billion (¥8.7 trillion) defence budget[127]	1%-2% (estimated)[128]

#	Metric	China	USA	Europe	Russia	Japan	India
11	ASAT capability	Yes[129]	Yes	No (no publicly tested[130] destructive ASAT capability)	Yes[131]	No (developing non-destructive capabil-ities)[132]	Yes[133]
12	Active launch sites	5–6 (Jiuquan, Xichang, Taiyuan, Wenchang + sea platforms)[134]	7–10 (Cape Canaveral, Kennedy, Vandenberg, Wallops, Kodiak, Starbase, etc.)[135]	One major orbital site (Kourou) + emerging micro-launch sites[136]	5–6 (Baikonur, Plesetsk, Vostochny + others)[137]	2–3 (Tanegashima, Uchinoura, emerging sites)[138]	2 (Sriharikota, Kulasekar-apattinam upcoming/ limited ops)[139]
13	Human space flight capabilities	Yes[140]	Yes[141]	No (no independent crew launch capability)[142]	Yes[143]	No[144]	No (planned – Gaganyaan)[145]
14	Space sector companies	300–400+ (rapidly growing commercial ecosystem)[146]	10,000+ (broad aerospace and space economy firms)[147]	1,000–2,000 companies (large industrial + SME+ startup base)[148]	100–200 (state dominated + limited private sector)[149]	200–300[150]	300+ (including 200+ startups)[151]

CHAPTER 08

Way forward: Building Indian space economy

India's space sector has the potential to move from a largely mission-led and institution-driven ecosystem to a scaled commercial economy anchored in industry participation, downstream adoption and strategic capability creation. Achieving the projected INR4.22 lakh crore (US$44 billion) space economy over the next seven to eight years will require a coordinated effort across government, industry, startups, investors, academia and strategic users. The next phase may focus not only on building satellites and launch vehicles but also on converting space-based capabilities into commercial services, and build industrial depth and strategic autonomy.

1 Scale downstream adoption aacross priority sectors

The largest economic opportunity comes from downstream applications that convert satellite communication, EO, navigation and geospatial data into usable services. India should prioritize sectors where space solutions can deliver measurable outcomes, including agriculture, logistics, disaster management, urban planning, infrastructure monitoring, financial services, fisheries, climate resilience and defence.

Government and industry users may move from pilot to program-level deployment. This will require sector-specific use cases, interoperable data platforms, standard procurement models and clear outcome metrics.

2 Build industrial depth in upstream manufacturing and launch systems

India may look at scaling its upstream ecosystem across satellite manufacturing, launch vehicle subsystems, avionics, propulsion, sensors, space-grade electronics, composite materials and testing infrastructure. This is essential to reduce import dependence, strengthen domestic supply chains and improve global competitiveness. Industry participation can be accelerated through long-term procurement visibility, technology transfer, CTFs and certification frameworks. Anchor developers such as large-scale aerospace, electronics, defence and engineering firms can anchor supply chains, while MSMEs and startups can support specialized components, subsystems and software-defined capabilities.

3 Further strengthen the regulatory and financing environment

Policy reform has created a strong foundation, but the next phase requires faster execution. Streamlined authorizations, timely spectrum allocation, transparent licensing, clear liability norms, remote sensing data regulations, and export facilitation will be critical to attract private capital and global partnerships. India will also need capital for deep-tech space enterprises, which includes venture funding, strategic corporate investment, innovation grants, public procurement and viability gap support.

The government may create early market demand through targeted procurement, while investors and industry can help startups scale proven prototypes into commercially viable products and services.

4 Use government demand to de-risk commercial adoption

For many space applications, early demand will need to be led by public-sector users. Central and state governments, municipalities, infrastructure agencies, defence users and disaster management authorities should embed space-enabled services into operating systems. Priority use cases may include infrastructure monitoring, crop intelligence, climate risk mapping, logistics optimization, fisheries advisory, maritime domain awareness, border surveillance and emergency response.

A structured "government as first customer" approach may de-risk innovation, provide reference use cases and help Indian companies build credibility for domestic and export markets.

5 Deepen strategic and defence space capabilities

Space is becoming central to national security, secure communication, navigation, surveillance, maritime awareness and operational resilience. India should strengthen capabilities in secure SATCOM, EO, Space Domain Awareness (SDA), resilient navigation, cyber-secure ground infrastructure and protection of critical space assets.

The defence space agenda should be closely linked with the commercial ecosystem. Private industry can support satellite manufacturing, payloads, ground systems, analytics, secure data platforms and dual-use technologies. Better coordination between defence users, civil space institutions and industry can build sovereign capability while creating high-value commercial opportunities.

6 Position India as a global space partner and export hub

India's cost competitiveness, engineering talent, launch heritage and growing private ecosystem provide a strong base for global partnerships. The next phase should position India as a trusted partner for satellite manufacturing, launch services, downstream applications, analytics, ground infrastructure and capacity-building solutions.

This will require export facilitation, standards alignment, targeted international cooperation and participation in multilateral space governance forums. Indian companies should be supported in accessing global markets, particularly in Asia, Africa and the Global South, where demand for affordable space-enabled solutions in agriculture, connectivity, disaster management and governance is expected to grow.

Glossary

Abbreviation	Description
AI	Artificial Intelligence
ASA	Australian Space Agency
ASAT	Anti-Satellite
CAGR	Compound annual growth rate
CPSE	Central Public Sector Enterprise
CSA	Canadian Space Agency
CTF	Common Technical Facility
DoS	Department of Space
DoT	Department of Telecommunications
DPSU	Defence public sector undertaking
EO	Earth Observation
ESA	European Space Agency
ESA	European Space Agency
EUSPA	European Union Agency for the Space Programme
FDI	Foreign Direct Investment
GAGAN	GPS Aided Geo Augmented Navigation
GDP	Gross Domestic Product
GEO	Geostationary Earth Orbit
GNSS	Global Navigation Satellite System
GoI	Government of India
GPS	Global positioning service
GSAT	Geostationary Satellite
GSLV	Geo-stationary Satellite Launch Vehicle
INCOSPAR	Indian National Committee for Space Research
IN-SPACe	Indian National Space Promotion and Authorisation Centre
IOR	Indian Ocean Region
IoT	Internet of Things
ISRO	Indian Space Research Organisation
ITU	International Telecommunication Union
JAXA	Japan Aerospace Exploration Agency
LEO	Low Earth Orbit
NASA	National Aeronautics and Space Administration
NavIC	Navigation with Indian Constellation
NDT	Non-Destructive Testing
NE	Northeast
NGE	Non-Government Entity
NGLV	Next generation launch vehicle
NSIL	Newspace India Limited
OECD	Organisation for Economic Co-operation and Development
PIB	Press Information Bureau
PNT	Positioning, Navigation and Timing
PPP	Public Private Partnership
PSLV	Polar satellite launch vehicle
R&D	Research and Development
RISAT	Radar Imaging Satellite
SAR	Synthetic aperture radar
SATCOM	Satellite communication
SDSC	Satish Dhawan Space Centre
SMC	Space Manufacturing Cluster
SME	Small and Medium Enterprise
SSLV	Small Satellite Launch Vehicle
UNOOSA	United Nations Office for Outer Space Affairs
WEF	World Economic Forum

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Notes

Notes

Notes

We acknowledge contributions from the team

EY team

Dhruv Mangal
Director
Business Consulting, Aerospace, Defence and Space, EY LLP

Sanura Fernandez
Senior manager
Business Consulting, Aerospace, Defence and Space, EY LLP

Atul Shukla
Manager
Business Consulting, Aerospace, Defence and Space, EY LLP

Vinayak Mishra
Senior consultant
Business Consulting, Aerospace, Defence and Space, EY LLP

Arjun Anand
Senior consultant Business Consulting, Aerospace, Defence and Space, EY LLP

Manoj Gundeti
Senior analyst
Business Consulting, Aerospace, Defence and Space, EY LLP

EY contact:
Cdr. Gautam Nanda
Partner
Gautam.Nanda1@in.ey.com

Dhruv Mangal
Director
Dhruv.mangal@in.ey.com.

CII team

Ms. Sangeeta Karki
Director & Head (Space)
Confederation of Indian Industry

Mr. Vishal Kant Rai
Deputy Director (Space)
Confederation of Indian Industry

CII contact:
chairman.space@cii.in ; cii.space@cii.in

Our offices

Ahmedabad
22nd Floor, B Wing, Privilon
Ambli BRT Road, Behind Iskcon Temple
Off SG Highway, Ahmedabad - 380 059
Tel: + 91 79 6608 3800

Gandhinagar
8th Floor, Building No. 14A
Block 14, Zone 1
Brigade International Financial Centre
GIFT City SEZ
Gandhinagar – 382 355
Tel: + 91 79 6608 3800

Bengaluru
12th & 13th Floor
"UB City", Canberra Block
No.24 Vittal Mallya Road
Bengaluru - 560 001
Tel: + 91 80 6727 5000

Ground & 1st Floor
11, 'A' wing
Divyasree Chambers
Langford Town
Bengaluru - 560 025
Tel: + 91 80 6727 5000

3rd & 4th Floor
MARKSQUARE
#61, St. Mark's Road
Shantala Nagar
Bengaluru - 560 001
Tel: + 91 80 6727 5000

1st & 8th Floor, Tower A
Prestige Shantiniketan
Mahadevapura Post
Whitefield, Bengaluru - 560 048
Tel: + 91 80 6727 5000

Ecospace
1st Floor, Campus 1C
Ecospace Business Park
Outer Ring Road, Bellandur - Sarjapura Area,
Varthur Hobli,
Bengaluru Urban – 560103

Bhubaneswar
8th Floor, O-Hub, Tower A
Chandaka SEZ
Bhubaneswar – 751024
Tel: + 91 674 274 4490

Chandigarh
Elante offices, Unit No. B-613 & 614
6th Floor, Plot No- 178-178A
Industrial & Business Park, Phase-I
Chandigarh - 160 002
Tel: + 91 172 6717800

Chennai
6th & 7th Floor, A Block,
Tidel Park, No.4, Rajiv Gandhi Salai
Taramani, Chennai - 600 113
Tel: + 91 44 6654 8100

Delhi NCR
Aikyam
Ground Floor
67, Institutional Area
Sector 44, Gurugram - 122 003
Tel: + 91 124 443 4000

3rd & 6th Floor, Worldmark-1
IGI Airport Hospitality District
Aerocity, New Delhi - 110 037
Tel: + 91 11 4731 8000

4th & 5th Floor, Plot No 2B
Tower 2, Sector 126
Gautam Budh Nagar
Noida - 201 304
Tel: + 91 120 671 7000

Hyderabad
THE SKYVIEW 10
18th Floor, "SOUTH LOBBY"
Survey No 83/1, Raidurgam
Hyderabad - 500 032
Tel: + 91 40 6736 2000

THE SKYVIEW 20
2nd Floor, 201 & 202
Right Wing, Survey No 83/1
Raidurgam, Hyderabad - 500 032
Tel: + 91 40 6736 2000

Jaipur
9th Floor, Jewel of India
Horizon Tower, JLN Marg
Opp Jaipur Stock Exchange
Jaipur - 302018
Tel: + 91 141 4618415

Kochi
7th Floor, ABAD Nucleus
NH-49, Maradu PO
Kochi - 682 304
Tel: + 91 484 433 4000

Kolkata
22 Camac Street
3rd Floor, Block 'C'
Kolkata - 700 016
Tel: + 91 33 6615 3400

6th floor, Sector V, Building Omega
Bengal Intelligent Park, Salt Lake
Electronics Complex, Bidhan Nagar
Kolkata - 700 091
Tel: + 91 33 6615 3400

Mumbai
14th Floor, The Ruby
29 Senapati Bapat Marg
Dadar (W), Mumbai - 400 028
Tel: + 91 22 6192 0000

5th Floor, Block B-2
Nirlon Knowledge Park
Off. Western Express Highway
Goregaon (E)
Mumbai - 400 063
Tel: + 91 22 6192 0000

3rd Floor, Unit No.301
Building No.1, Mindspace-Gigaplex
IT Park, MIDC, Plot No. IT-5
Airoli Knowledge Park
Airoli West, Navi Mumbai - 400 708
Tel: + 91 22 6192 0003

18th Floor, Altimus
Pandurang Budhkar Marg, Worli
Mumbai - 400 018
Tel: + 91 22 6192 0503

Pune
C-401, 4th Floor
Panchshil Tech Park, Yerwada
(Near Don Bosco School)
Pune - 411 006
Tel: + 91 20 4912 6000

10th Floor, Smartworks
M-Agile, Pan Card Club Road
Baner, Pune - 411 045
Tel: + 91 20 4912 6800

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Confederation of Indian Industry (CII), The Mantosh Sondhi Centre; 23, Institutional Area, Lodi Road, New Delhi 110003, India, Tel: +91-11-45771000; Email: info@cii.in; Web: www.cii.in; and Ernst and Young LLP, Ground Floor, Plot No. 67, Institutional Area, Sector - 44, Gurugram - 122003, Haryana, India.

Reach us via CII Membership Helpline: 1800-103-1244

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EY_India EY EY India EY Careers India ey_india cii.in/facebook cii.in/twitter cii.in/linkedin cii.in/youtube