INDIAN SPACE ASSOCIATION
Bhumandal Se Brahmaand Tak

Co-Hosted by

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INDIA INTERNATIONAL SPACE CONCLAVE

4TH EDITION | IISC 2025

THE LALIT, NEW DELHI

"Expanding Horizons - Innovation, Inclusion & Resilience in the New Space Age"

Technical Report prepared and compiled by

KNOWLEDGE PARTNER

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About ISpA

ISpA is an apex non-profit industry body, set up exclusively for the successful collaborative development of the Private Space Industry in India. ISpA was created to be the single Voice of the Private Space Industry and act as a bridge between the Government and the Private Industry.

ISpA will undertake Policy Advocacy, Engage and Operate with all Stakeholders and act as a catalyst for accelerating the exchange of knowledge, information and technology of space-related domains amongst all stakeholders of the entire Indian Space ecosystem, including the government and its agencies, to make India self-reliant, technologically advanced and a leading player in the Global Space arena.

Vision

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

Objectives

Ease of Doing Business and Policy Stability

Encourage and Facilitate all Space Domain Activities

Promote and Collaborate

International Partnerships

The Indian Space Association (ISpA) was launched by the **Honourable Prime Minister Narendra Modi** in October 2021 with the vision of nurturing and strengthening India's private space industry ecosystem. ISpA works closely with government bodies, industry leaders, startups, and academic institutions to create an enabling environment that empowers the private sector to play a greater role in the nation's rapidly evolving space sector.

Aligned with the **Honourable Prime Minister's vision** of Atmanirbhar Bharat-a self-reliant and globally competitive India-ISpA is committed to advancing the country's capabilities and positioning India as a leading force across the global space ecosystem. This conclave serves as a dynamic platform that brings together key stakeholders from across the space value chain to collaborate, exchange insights, and build strategic partnerships.

The two-day conclave has been carefully curated to examine the diverse and emerging dimensions of the space industry. The programme is structured around two central themes:

(a) Enabling the Space Ecosystem, and
(b) Services and Opportunities in the Space Sector.

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SKYMAP GLOBAL

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XOVIAN

Other Members

Dr Narayan Prasad

Space Kidz India

Some Highlights










Building on the remarkable success of its previous editions, the Indian Space Association (ISpA), in collaboration with the Indian Space Research Organisation (ISRO) and Indian National Space Promotion and Authorization Center (IN-SPACe), hosted the India International Space Conclave (IISC 2025). The flagship global event was held on 18–19 November 2025 at The Lalit New Delhi.

IISC 2025 was conceived as a premier international platform where policy, innovation, and opportunity converged. The conclave brought together over 1,000 global dignitaries, senior government officials, industry leaders, and pioneers of the NewSpace sector, creating a vibrant forum to deliberate on India's evolving role in the global space economy. Discussions centred on unlocking emerging opportunities, fostering strategic partnerships, and defining pathways that will propel India to the forefront of the international space ecosystem.

As the flagship event of ISpA, co-hosted with ISRO and IN-SPACe, the India International Space Conclave 2025 opened with tremendous energy and momentum, reinforcing India's commitment to playing a larger, more collaborative, and decisive role in shaping the future of the global space economy.

Day 1

Tuesday,
18th November 2025

Theme:
“Enabling the Space Ecosystem: Services & Opportunities"

Fireside Chat: Fuelling Space Innovation: Economic Drivers and Funding Mechanisms

- **Dr PR Jaishankar, Former Chairman & MD , IIFCL, Chairman IIFC (UK); Chairman, IIFCL Projects Ltd., and IIFCL Asset Management Company Ltd.**
- **Dr Ravinder Pal Singh, Member, National Advisory Committee (ISpA), Harvard Business School Alumnus, Award-winning technologist, professor of innovation, deep-tech investor, & global speaker.**
- **Mr Akshat Johri, Assistant General Manager, IIFCL Projects Ltd.**

The fireside chat on "Fuelling Space Innovation: Economic Drivers and Funding Mechanisms" was moderated by **Mr. Akshat Johri, Assistant General Manager, IIFCL Projects Ltd.** The session provided a strategic overview of India's evolving space economy and examined the financial, technological, and policy frameworks required to position India among the world's leading space economies.

Mr. Johri set the context by highlighting the transformation of India's space sector from a mission-driven program to a market-oriented economic strategy. He noted that India's space economy, currently valued at approximately USD 8–8.5 billion, is projected to grow to USD 44 billion by 2033, driven by an expanding private ecosystem comprising over 250 startups across upstream, midstream, and downstream segments. In comparison, the global space economy, valued at USD 596 billion, is expected to reach nearly USD 1.8 trillion by 2035. The discussion therefore, focused on identifying the economic drivers and financing mechanisms necessary for India to emerge as a top-three space economy by 2045.

The panel featured **Dr. P. R. Jaishankar, former Chairman and Managing Director of IIFCL and Chairman of IIFC (UK), IIFCL Projects Ltd., and IIFCL Asset Management Company Ltd., and Dr. Ravinder Pal Singh, Member of the National Advisory Committee of ISpA, Harvard Business School alumnus, award-winning technologist, deep-tech investor, and global speaker.**

Drawing from his extensive experience in infrastructure and project finance, Dr. Jaishankar emphasized that while recent reforms-such as the Indian Space Policy 2023 and the establishment of IN-SPACe-have laid a strong foundation, the next phase of growth requires a focus on bankability of space projects. He underlined the importance of public–private partnerships (PPPs), standardized contractual frameworks, regulatory clarity, and single-window approvals to build investor confidence. According to him, revenue visibility remains a critical concern for lenders, and addressing this through structured finance, credit enhancement mechanisms, and blended finance models is essential. He also highlighted the potential role of multilateral and concessional funding institutions in providing long-term, patient capital to the sector, drawing parallels with the evolution of India's infrastructure financing ecosystem two decades earlier.

Responding to questions on emerging technologies, **Dr. Ravinder Pal Singh** reframed the discussion around economic impact rather than speculative predictions. He cited global empirical evidence indicating that every dollar invested in space yields returns of USD 4–7, arguing that the multiplier effect could be even higher in India due to strong downstream demand. He identified agriculture, logistics, disaster management, and defence-related intelligence, surveillance, reconnaissance (ISR), and navigation as key sectors where space-enabled technologies could act as force multipliers for national productivity and GDP growth. He stressed that startups must move beyond dependence on government demand and align their offerings with scalable, revenue-generating use cases in these sectors.

The discussion also addressed the role of debt financing in a sector traditionally dominated by venture capital and private equity. **Dr. Jaishankar** noted that while equity capital is essential in early stages, long-term growth requires debt and blended finance solutions. He advocated for sovereign-backed blended debt models, similar to the Hybrid Annuity Model (HAM) used in infrastructure, to initially de-risk projects and attract banks and financial institutions. As the sector matures, he suggested a gradual transition to market-driven financing structures.

On policy recommendations, **Dr. Ravinder Pal Singh** emphasized the need for robust, sector-specific investment frameworks tailored to space technologies, noting that conventional first-principles investment logic often fails in deep-tech domains. He argued that space should not be perceived as inherently risky, drawing parallels with the aviation sector, which has been successfully de-risked through regulation, standards, and institutional frameworks.

Complementing this perspective, **Dr. Jaishankar** proposed three immediate policy interventions: the establishment of single-window clearance mechanisms, formal recognition of the space sector as critical infrastructure, and the creation of efficient dispute resolution and insolvency-compliant mechanisms. He further suggested empowering IN-SPACe with mediation and adjudication capabilities to enhance investor confidence.

In his concluding remarks, **Mr Johri** summarised the key takeaways, underscoring the importance of blended finance, recognition of space as critical infrastructure, and a shift in perception away from viewing space as a high-risk domain. The session concluded with a consensus that economic and financial considerations must remain central to the discourse on India's space ambitions, setting a strong tone for the India International Space Conclave.

Industry Presentation by Larsen & Toubro (L&T)

The industry presentation by **Mr. Nanduru Sarath Chandra, Larsen & Toubro (L&T)**, highlighted the company's extensive role in India's space, defence, and strategic manufacturing ecosystem. L&T, a USD 30 billion global conglomerate with operations in over 50 countries and manufacturing facilities across the world, plays a critical role across core sectors of national importance.

Mr. Sarath emphasized L&T's long-standing partnership with the Government of India, including over two decades of collaboration with the Ministry of Defence and more than five decades of engagement with ISRO. L&T has supported a wide range of space programs covering launch vehicles, satellite structures, ground infrastructure such as radars and ground stations, satellite communication systems, and advanced testing facilities. The company has also contributed to space product development through materials testing and qualification for space-grade applications.

He highlighted L&T's integrated aerospace manufacturing and systems complex at Coimbatore, spread over 240 acres, which functions as a one-stop facility for aerospace platforms including missiles, drones, fighter aircraft structures, satellites, and launch vehicles. The facility supports end-to-end capabilities encompassing design, interdisciplinary technology development, system integration, and program management for critical aerospace programs.

In the launch vehicle domain, **Mr. Sarath** noted that L&T has manufactured motor casings for all Indian space launches over the past five decades. Building on this legacy, ISRO has entrusted L&T with the development of the first industry-manufactured Polar Satellite Launch Vehicles (PSLVs), with five launch vehicles currently under production and the first expected to be launched within the current financial year.

In the satellite segment, L&T has supplied satellite bus structures, solar panel substrates, and deployment drive mechanisms for both ISRO and defence programs. He also highlighted the establishment of a world-class Assembly, Integration, and Testing (AIT) facility at Coimbatore, capable of handling satellites of up to two tonnes, supported by experienced manpower engaged in system-level testing for ISRO missions.

The presentation concluded with a reaffirmation of L&T's commitment to collaborative growth and its role as a long-term industry partner in strengthening India's space ecosystem.

Industry Presentation by Vantor

The industry presentation by **Vantor**, delivered by **Mr. Partha Ghosh**, introduced the company as a global geospatial intelligence and space-to-ground analytics provider. While the Vantor brand is relatively new, the organization traces its lineage to DigitalGlobe and Maxar, with operational heritage dating back to 1999.

Vantor operates one of the world's largest commercial Earth observation satellite constellations, with ten satellites currently in orbit. Its fleet includes WorldView and Legion-class satellites, offering high-resolution optical imagery with resolutions up to 30 cm, enhanced to 15 cm through super-resolution products, and revisit capabilities of up to 15 times per day depending on geographic location. The constellation supports coverage of approximately seven million square kilometers per day.

The company offers eight-band multispectral optical imagery alongside Synthetic Aperture Radar (SAR) data through strategic partnerships, enabling all-weather, day-and-night monitoring. Vantor demonstrated advanced change-detection capabilities through high-frequency revisits, enabling monitoring of dynamic environments such as airports, ports, and rail hubs.

Beyond imagery, Vantor delivers a comprehensive suite of analytics and geospatial products. These include high-accuracy mosaics, three-dimensional terrain models, AI-driven feature extraction for roads and buildings, and space object imaging. The company highlighted its capability to image and analyze space-based assets, including international satellites, with centimeter-level accuracy.

Key products showcased included:

- **Vivid: High-resolution optical and 3D mosaic datasets**
- **Raptor: A GPS-denied navigation solution enabling real-time image rectification and navigation support**
- **Sentry: Persistent monitoring solutions for land and maritime domains**
- **VantorHub: A unified platform hosting over 25 years of archival and taskable satellite data**

The presentation emphasized Vantor's ability to deliver integrated space-to-ground intelligence for operational planning, surveillance, and decision support, leveraging high-definition 3D visualization and analytics.

Opportunities for startups building for India's self-reliance in space - Mr. Ravi Jain, Investment Director, TDK Ventures

The expert talk by **Mr. Ravi Jain**, Investment Director at **TDK Ventures**, focused on identifying startup-driven opportunities critical to India's self-reliance in space. TDK Ventures is the corporate venture capital arm of TDK Corporation, managing approximately USD 500 million in assets under management, with a strong focus on deep technologies including materials science, sensors, power electronics, and energy storage.

Mr. Jain highlighted TDK's expanding footprint in India, including multiple manufacturing facilities and the recent inauguration of one of the country's largest gigafactories. He noted that space technology is a key strategic investment theme for TDK Ventures, with nearly USD 300 million currently available for deployment across two active funds.

To frame the concept of space self-reliance, **Mr. Jain** outlined a set of strategic evaluation questions for any nation, including:

- Independent and timely access to orbit
- Scalable and rapid satellite platform manufacturing

- Sovereign control over critical subsystems and supply chains
- Indigenous Positioning, Navigation, and Timing (PNT) capabilities
- Advanced data analytics and ground infrastructure
- End-to-end localization of the space supply chain
- Robust space situational awareness

While acknowledging India's significant progress through institutions such as ISRO, he identified key gaps where startups could play a decisive role. These included reusable medium-lift launch vehicles, modular and rapidly deployable satellite platforms, domestic production of space-grade components such as radiation-hardened semiconductors and optical sensors, and autonomous space situational awareness technologies.

Mr. Jain emphasized that reusability in launch systems represents a critical next frontier, driven by global demand-supply gaps and large addressable markets. He also highlighted opportunities in satellite constellations, Earth observation, and downstream data analytics, which offer both strategic value and global commercial scalability.

From an investment perspective, he advised startups to avoid over-reliance on government and defence procurement due to revenue volatility and instead pursue global markets where scale improves unit economics and business resilience. According to him, building globally competitive solutions inherently strengthens national self-reliance.

In his policy recommendations, **Mr. Jain** suggested long-term government procurement commitments for startups, expanded access to shared testing infrastructure, targeted R&D funding for dual-use technologies, and streamlined export processes to enable startups to achieve global scale.

The session concluded with the view that India's space self-reliance and startup growth agendas are strongly aligned, and that globally oriented, technology-driven startups will be central to achieving both strategic autonomy and sustainable commercial success.

Inaugural Ceremony

The Inaugural Ceremony of the India International Space Conclave 2025 brought together distinguished national and international leaders from government, industry, defence, diplomacy, and space exploration.

The ceremony was graced by **Dr. Jitendra Singh**, **Hon'ble Minister of State (Independent Charge) for Science & Technology and Earth Sciences; Minister of State in the Prime Minister's Office; and Minister of State for Personnel, Public Grievances & Pensions, Department of Atomic Energy, and Department of Space.**

- **Dr. Pawan Goenka, Chairman, IN-SPACe;**
- **H.E. Antonio Bartoli, Ambassador of Italy to India;**
- **Air Chief Marshal V. R. Chaudhari (Retd);**
- **Mr. Takashi Ariyoshi, Minister & Deputy Chief of Mission, Embassy of Japan;**
- **Mr. A. T. Ramchandani, Chairman, ISpA;**
- **Lt Gen Anil Kumar Bhatt (Retd), Director General, ISpA.**

Opening Address by Mr AT Ramchandani, Sr VP & Head - L&T Precision Engg & Sys, and Chairman ISpA

Mr. A. T. Ramchandani, Senior Vice President & Head – L&T Precision Engineering & Systems and Chairman, Indian Space Association (ISpA), delivered the opening address and formally welcomed participants to the fourth edition of the conclave, now renamed the India International Space Conclave to reflect India's expanding global footprint in the space sector.

In his address, he paid tribute to India's early space pioneers and traced the nation's space journey from the launch of the first sounding rocket from Thumba in 1963 to the success of the Mars Orbiter Mission in its maiden attempt in 2014. He highlighted key national milestones, including record satellite launches, successful lunar and solar missions, and India becoming the fourth nation to demonstrate autonomous space docking capability through the successful completion of the SPADEX mission. He also noted India's role as a trusted global space partner, having launched over 390 foreign satellites for 34 countries.

Mr. Ramchandani emphasized that while ISRO has traditionally led India's space programme, recent policy reforms—particularly the new Space Policy—have marked a decisive shift toward enabling private-sector-led commercial innovation. He underscored 2025 as a landmark year for India's space ecosystem, citing several notable developments. These included the successful launch of hyperspectral satellites by Pixxel, the first commercial satellite launch by Dhruva Space, and the awarding of India's first fully commercial Earth Observation public–private partnership under the SBS-3 programme, with a significant share of satellites being developed by private industry.

Further milestones highlighted included Agnikul's unveiling of a large single-piece 3D-printed semi-cryogenic engine and commissioning of a large-format aerospace additive manufacturing facility; Skyroot Aerospace's successful test firing of the Kalam-1200 rocket stage toward its upcoming Vikram-1 orbital mission; and advancements by multiple startups in satellite manufacturing, space situational awareness, and launch services. He also noted regulatory progress by IN-SPACe, including draft guidelines on space situational awareness, third-party liability, safety, and security.

Placing these developments in a global context, **Mr. Ramchandani** stated that the global space economy is projected to reach USD 1.8 trillion by 2035, with India's share expected to grow to approximately USD 100 billion by 2040. He outlined key opportunity areas such as precision agriculture, satellite broadband for remote education and healthcare, climate resilience solutions, and maritime domain awareness. Reaffirming ISpA's commitment, he emphasized collaboration among industry, government, and academia to build an innovative, competitive, and future-ready space ecosystem. He concluded by encouraging participants to leverage the conclave to forge partnerships and contribute collectively to the next chapter of India's space journey.

Welcome Remarks by Lt Gen AK Bhatt PVSM, UYSM, AVSM, SM, VSM(Retd), DG ISpA
Lt Gen Anil Kumar Bhatt (Retd), Director General, Indian Space Association (ISpA),

Lt Gen Anil Kumar Bhatt (Retd), Director General, Indian Space Association (ISpA),delivered the welcome remarks on behalf of ISpA and its member organisations. He expressed appreciation to the Hon'ble Minister for his continued support of the space sector and acknowledged the consistent encouragement received from ISRO and IN-SPACe.

Lt Gen Bhatt highlighted the significance of the presence of ISRO astronaut **Gp Capt Shubhanshu Shukla** and noted the positive developments achieved across multiple verticals of the space sector during the year. He drew attention to upcoming milestones, including planned launches of multi-sensor satellites and orbital rockets by Indian startups, as well as the first privately manufactured PSLV launch.

He also acknowledged recent regulatory developments by IN-SPACe, including draft guidelines on liability, space situational awareness, and security, which provide greater regulatory clarity for industry participants. At the same time, he noted that spectrum allocation for Low Earth Orbit (LEO) systems remains a key issue awaited by industry stakeholders.

Lt Gen Bhatt emphasized the growing international interest in India's space sector, as reflected by the participation of trade delegations from multiple countries, and extended a special welcome to the Japanese delegation. He concluded by welcoming all foreign delegates and expressing confidence that deliberations over the next two days would foster meaningful collaboration across diverse space domains.

Address by Mr. Takashi Ariyoshi, Minister & Deputy Chief of Mission, Embassy of Japan to India

Mr. Takashi Ariyoshi, Minister & Deputy Chief of Mission, Embassy of Japan to India expressed his appreciation to the Indian Space Association, ISRO, and IN-SPACe for hosting the India International Space Conclave 2025 and for creating a dedicated platform to strengthen collaboration between Japan and India in the space domain. He highlighted that Japan and India are long-standing partners sharing fundamental values such as freedom, democracy, and the rule of law, and noted that their relationship has deepened significantly over the past decade under the Special Strategic and Global Partnership framework.

He referred to recent high-level engagements between the leadership of both countries, reaffirming their commitment to cooperation across security, economy, investment, innovation, human exchange, and space. He emphasized that space has emerged as a critical area of bilateral collaboration. Mr. Ariyoshi outlined Japan's recently formulated Basic Plan on Space Policy, structured around four pillars: ensuring national security; strengthening national resilience and addressing global challenges through innovation; advancing space science and exploration; and reinforcing the industrial base supporting space activities. He further noted Japan's objective to double the size of its space industry from approximately ¥4 trillion in 2020 to ¥8 trillion by the early 2030s.

Mr. Ariyoshi underscored the importance of international collaboration in achieving these goals, identifying India as a key partner. He highlighted enhanced cooperation in space security, including the expanded use of space systems for national security, satellite navigation, Earth observation, and consultations on space situational awareness and space debris management. He also cited collaboration in climate change monitoring, including the use of Japanese satellite data by India for submissions to the United Nations, and ongoing cooperation between JAXA and ISRO in satellite data applications for agriculture.

In the area of space exploration, he referred to the successful lunar missions undertaken by both countries and ongoing joint initiatives such as the Chandrayaan–LUPEX mission to investigate lunar water resources, with Japan responsible for the launch vehicle and rover and India for the lander. He also highlighted collaboration on large international scientific projects, including the Thirty Meter Telescope, involving partners from Japan, India, the United States, and Canada.

Concluding his address, **Mr. Ariyoshi** emphasized the importance of translating achievements in space science and exploration into societal and economic benefits through industrial collaboration, entrepreneurship, and startup development. He expressed confidence that Japan–India cooperation would contribute to advancements in emerging fields such as artificial intelligence, quantum technologies, and semiconductors, ultimately strengthening the bilateral space ecosystem. He expressed hope that the conclave would serve as a platform for building networks and fostering a robust, collaborative space ecosystem.

Special Address by Air Chief Marshal VR Chaudhari PVSM AVSM VM ADC (Retd), Former Chief of the Air Staff, Indian Air Force

Air Chief Marshal V. R. Chaudhari PVSM AVSM VM ADC (Retd), Former Chief of the Air Staff, Indian Air Force emphasized the rapidly evolving nature of the space domain and the importance of continuous dialogue to keep pace with technological and strategic developments. He characterised the ongoing transformation of the space sector through four defining trends: increasing diversity with greater global and commercial participation; disruption through the entry of private players and startups; disorder arising from gaps in existing legal and regulatory frameworks; and heightened danger due to the growing vulnerability of space assets to kinetic and non-kinetic threats.

He observed that space has evolved into a fully contested operational domain, with recent geopolitical developments underscoring the decisive role of space assets in shaping strategic, operational, and tactical outcomes of conflicts. He highlighted the critical importance of space situational awareness (SSA) and resilience, noting that future conflicts may begin with actions in space well before conventional hostilities are visible.

Air Chief Marshal Chaudhari stressed the need to develop robust SSA capabilities supported by advanced sensors, secure communication systems, spectral imaging, missile detection technologies, and integrated ground- and space-based monitoring systems. He underscored the importance of shortening decision-making loops through integrated multi-domain operations and called for continuous evolution of military space doctrines in response to emerging threats and technologies.

He emphasized that building a resilient military space ecosystem requires close synergy among the armed forces, scientific institutions, industry, policymakers, and startups. He highlighted the importance of investing in human capital and developing professionals who understand space as an operational environment. He further noted that innovation in space is inherently collaborative and requires coordination among users, developers, researchers, and international partners with shared strategic interests.

Air Chief Marshal Chaudhari acknowledged the government's increasing support for indigenous defence manufacturing and space startups, emphasising that current policy momentum provides a critical opportunity for startups to develop advanced technologies for national defence. He outlined a vision for making India's space sector future-ready, which includes recognising space assets as critical national infrastructure, developing a unified national space doctrine with defined civil–military roles, enabling agile public–private partnerships, and minimising bureaucratic constraints to allow the ecosystem to mature organically.

He concluded by urging participants to view space as an extension of the battlespace and to approach the sector with foresight, jointness, and a whole-of-nation perspective, ensuring that India remains operationally agile and strategically autonomous in the evolving space security environment.

Special Address by Dr Pawan Goenka, Chairman, IN-SPACe

Dr. Pawan Goenka, Chairman, IN-SPACe expressed his appreciation to the Hon'ble Minister for his sustained support of the space sector and acknowledged the critical role played by the Indian Space Association in providing timely and constructive industry inputs to IN-SPACe. He noted that significant progress has been achieved over the past year, particularly in enabling private sector participation across multiple segments of the space value chain.

He highlighted the strengthening of international collaboration, particularly with Italy and Japan, noting multiple engagements and growing cooperation between Indian companies and their counterparts in these countries. He also acknowledged ongoing dialogue with other international partners, including Luxembourg and Jamaica, reflecting increasing global interest in India's space ecosystem.

Dr. Goenka outlined key initiatives undertaken by IN-SPACe, including the operationalisation of the ₹1,000 crore venture capital fund, which is actively pursuing investments in space startups while maintaining rigorous financial evaluation criteria. He encouraged industry stakeholders and co-investors to engage with the fund. He also referred to major projects finalised during the year, including the Earth Observation Satellite constellation under a public–private partnership model, upcoming satellite communication initiatives, and the Satellite Bus-as-a-Service programme, with announcements on successful bidders expected shortly.

He expressed satisfaction with the scale of private-sector investment in infrastructure development, citing the establishment of new manufacturing and testing facilities by multiple Indian space startups. **Dr Goenka** observed that the Indian industry is increasingly focused on global business development, as evidenced by strong participation from Indian companies at major international space conferences.

Concluding his address, **Dr. Goenka** stated that the sector is progressing in alignment with its long-term goals and emphasized that continued collaboration among industry, IN-SPACe, ISRO, the Department of Space, and the Government of India will be essential to sustain momentum and realise India's ambitions in the global space economy.

Special Address by H.E. Antonio Bartoli, The Ambassador of Italy to India

H.E. Antonio Bartoli, The Ambassador of Italy to India emphasized India's remarkable ascent as a global space power, noting its achievements as the fourth nation to land on the Moon, the first to reach the lunar south pole, and its record of over 100 launches and more than 130 satellite missions. He highlighted that India's technological capabilities, combined with its global vision, have positioned it as an increasingly influential and reliable partner in the international space ecosystem.

The Ambassador highlighted Italy's strong credentials in the space sector, tracing its journey from the launch of its first satellite, San Marco, in the 1960s to its current status as a leading spacefaring nation. He noted Italy's comprehensive capabilities across the entire space value chain, including satellite and launcher manufacturing, space habitation modules, ground infrastructure, data services, and downstream applications. With a government investment of €7.5 billion and a €3 billion space industry supported by large firms, SMEs, startups, and technology clusters, Italy continues to be a major contributor to the European Space Agency and global missions involving Earth observation, lunar exploration, Mars missions, and environmental monitoring.

H.E. Bartoli highlighted the long-standing and evolving cooperation between the Italian Space Agency and ISRO, describing it as a strong and multifaceted partnership. He referred to the Joint Strategic Action Plan signed by the Prime Ministers of India and Italy in November 2024, identifying space as a top priority area for bilateral collaboration. He emphasized that space cooperation serves as a platform for scientific advancement, industrial collaboration, sustainable development, and the peaceful use of outer space.

The Ambassador outlined recent initiatives to strengthen bilateral engagement, including space-focused business forums in India and Italy, an Italian space delegation visit to India, the appointment of space and science attachés, and plans to establish an innovation platform to foster collaboration among startups, industry, research institutions, and universities. He further identified four key areas for future cooperation: enhanced inter-agency collaboration, strengthened industry-to-industry engagement, expanded cooperation in science, education, and training, and deeper coordination in multilateral forums, including outreach to the Global South, particularly Africa.

He concluded by reaffirming that the India–Italy space partnership is both tangible and forward-looking, rooted in a shared vision of collaboration over competition, and committed to building a sustainable, secure, and inclusive future in space and on Earth.

Shri Jitendra Singh, Hon'ble Minister of State (IC) for Science & Technology; Earth Sciences; Minister of State in the Prime Minister's Office; Personnel, Public Grievances & Pensions; Department of Atomic Energy and Department of Space

Shri Jitendra Singh Ji, Hon'ble Minister of State (IC) for Science & Technology commended the organisers for convening the conclave and for selecting a theme that accurately reflects the transformative phase of India's space sector. He welcomed the participation of international delegations, particularly from Japan and Italy, noting that their presence reaffirmed growing global confidence in India as a preferred destination for space-sector collaboration, especially for private industry engagement.

The Hon'ble Minister traced the rapid evolution of India's space ecosystem over the past five years, attributing this transformation to landmark policy reforms initiated since 2019. He highlighted the establishment of NewSpace India Limited, the introduction of space sector reforms in 2020, the creation of IN-SPACe as a structured interface between public and private stakeholders, and the announcement of the Indian Space Policy in 2023. These measures, he stated, unlocked long-standing potential by enabling private participation, fostering innovation, and encouraging entrepreneurship.

Shri Jitendra Singh Ji emphasized that India's talent and scientific capabilities had always existed, but policy liberalisation and political resolve enabled their full expression. As a result, the number of space startups has grown from single digits to over 300, with several emerging as globally competitive enterprises. India's space economy, currently valued at approximately USD 8 billion, is projected to grow fivefold over the next decade, making it a significant contributor to national economic growth.

He also highlighted India's distinctive global contribution through the extensive application of space technologies for societal benefit, noting that a significant share of India's space activities support governance, infrastructure planning, disaster management, agriculture, healthcare, communications, and public service delivery. He cited examples such as satellite-enabled land mapping, telemedicine, disaster response, railway safety, and regional satellite support extended to neighbouring countries.

Concluding his address, **Shri Jitendra Singh Ji** stated that India's space journey has transitioned from being a niche scientific pursuit to a people-centric and globally relevant endeavour. He expressed confidence that space will continue to enhance India's standing on the world stage, positioning the country as a leading frontline nation in the global space community.

Felicitation of Gp Capt Shubhanshu Shukla, Astronaut, ISRO

ISpA felicitated Gp Capt Shubhanshu Shukla, Astronaut with ISRO in the presence of Dr. Jitendra Singh Ji, Hon'ble Minister of State (Independent Charge) for Science & Technology and Earth Sciences; Dr. Pawan Goenka, Chairman, IN-SPACe; H.E. Antonio Bartoli, Ambassador of Italy to India; Air Chief Marshal V. R. Chaudhari (Retd); Mr. Takashi Ariyoshi, Minister & Deputy Chief of Mission, Embassy of Japan; Mr. A. T. Ramchandani, Chairman, ISpA; and Lt Gen Anil Kumar Bhatt (Retd), Director General, ISpA.

During the felicitation ceremony, **Gp Capt Shubhanshu Shukla** expressed his gratitude to the Hon'ble Minister, senior leadership from the Department of Space, IN-SPACe, the Indian Air Force, and other distinguished dignitaries present. He reflected on his long-standing professional association with the Department of Space and the Indian Air Force, highlighting how these institutions collectively shaped his journey as an astronaut.

Recalling his international training experiences, **Gp Capt Shukla** spoke about his interactions with global space agencies and fellow astronauts. He highlighted his engagement with Italian astronaut Walter Villadei during training, noting their discussions on the future of global cooperation in space. He also referred to his training exposure at the Japan Aerospace Exploration Agency (JAXA), including familiarisation with the Kibo module aboard the International Space Station, underscoring the high standards of professionalism and precision expected in human spaceflight programmes.

Reflecting on his space mission, **Gp Capt Shukla** noted that while he was the 634th human to cross the boundary of space, the true significance of the mission became evident only after his return to India. He shared how interactions with school students revealed the deeper impact of representation and inspiration, as young learners expressed renewed interest in space, engineering, and scientific careers after seeing someone from their own country participate in such missions. He emphasized that this realisation-that visibility inspires aspiration-was among the most meaningful outcomes of his journey.

He acknowledged the unwavering commitment of national leadership toward advancing India's space ambitions and commended the efforts of policymakers, institutions, and industry stakeholders for actively promoting the space sector. **Gp Capt Shukla** particularly recognised the contributions of Indian startups and private-sector pioneers, noting the challenges involved in building a robust space ecosystem and applauding their role in driving innovation and growth.

Looking ahead, he highlighted India's ambitious national goals, including human spaceflight, the development of an indigenous space station, future lunar missions, and the broader vision of achieving a developed nation status by 2047. He stressed that realising these aspirations would require collective responsibility and active participation from all stakeholders across government, industry, academia, and society.

Concluding his address, **Gp Capt Shubhanshu Shukla** described his spaceflight as both a deeply personal and nationally shared achievement. He expressed optimism about India's future in space and reaffirmed his commitment to contributing to the country's journey in this domain. He ended by reiterating his belief that the sky is not the limit for individuals, institutions, or the nation.

MoU Exchange: Novaspace & Indian Space Association (ISpA)

As part of the inaugural session, a Memorandum of Understanding (MoU) was formally exchanged between Novaspace and the Indian Space Association (ISpA), marking the launch of Novaspace India and the beginning of a strategic collaboration aimed at accelerating India's space ecosystem.

Address by Mr. Rainer Horn, Managing Director, Novaspace

Mr. Rainer Horn, Managing Director of Novaspace, introduced the organisation and announced the launch of Novaspace India, describing it as a significant milestone for the company and for India's growing space sector. He noted that while the occasion did not involve a physical rocket launch, it marked the launch of Novaspace's India operations.

He explained that Novaspace is a global space consulting firm with a presence across 11 locations worldwide and a team of approximately 140 professionals, owned and operated by an international partnership representing seven nations. The firm provides management and technology consulting, proprietary market intelligence, and organises some of the world's most prestigious space forums, including the World Space Business Week in Paris, where Novaspace recently hosted several Indian companies.

Mr. Horn expressed appreciation for the partnership with ISpA and highlighted the company's growing engagement with India, noting that the foundation of Novaspace India was laid during interactions at the same conclave the previous year. He emphasized Novaspace's intent to deepen collaboration with Indian stakeholders and support the internationalisation of India's space industry.

Remarks by Ms. Surbhi Patni Dalmia, Director & Country Head, Novaspace India

Ms. Surbhi Patni Dalmia, Director and Country Head of Novaspace India, spoke about her role in expanding Novaspace's presence and impact in India. She reaffirmed the firm's commitment to supporting India's rapidly evolving space ambitions and outlined Novaspace's mission to act as a strategic bridge between international investors and Indian space companies.

She highlighted Novaspace's global network spanning 10 countries and over 40 years of dedicated experience in the space sector, enabling Indian companies to access global markets while attracting international investment into India. **Ms. Dalmia** thanked ISpA leadership and the organising team for providing the platform to launch Novaspace India and expressed optimism about scaling India's space ambitions through sustained collaboration.

The session concluded with the screening of the Novaspace launch video, which outlined the firm's vision for a secure, sustainable, and inclusive global space economy driven by data-backed insights, independent market intelligence, and strategic ecosystem partnerships.

Launch of Viasat Project

Address by Mr. Gautam Sharma, Managing Director, Viasat India

Mr. Gautam Sharma, Managing Director of Viasat India, announced the launch of Viasat's new solution focused on the Low Altitude Economy, addressing airspace operations below 1,000 meters. He explained that this emerging segment includes unmanned aerial vehicles (UAVs), advanced air mobility platforms, air taxis, and air ambulances.

He highlighted Viasat's long-standing role in providing mission-critical L-band satellite communication services to the Government of India, including connectivity for defence forces, disaster response agencies, commercial aviation, and maritime safety services. He noted that these highly reliable L-band capabilities are now being extended to support command-and-control requirements for uncrewed aircraft and advanced mobility systems.

Mr. Sharma outlined key applications of the initiative, including logistics and cargo monitoring, critical infrastructure surveillance, railway track monitoring, and emergency medical services, as well as future passenger mobility solutions. He further highlighted Viasat's collaboration with Indian startups and original equipment manufacturers (OEMs), including companies developing air ambulance platforms, as well as partnerships with international firms manufacturing systems within India.

He noted that the low-altitude economy, currently valued at approximately USD 2 billion, is projected to grow to USD 16 billion by 2030, with the potential to generate over 500,000 new jobs. He concluded by announcing that Viasat has initiated collaboration with BSNL to begin deploying these services in India, reinforcing the country's rapidly expanding aerospace and mobility ecosystem.

Industry Awards

The session witnessed the presentation of prestigious Space Industry Awards, celebrating excellence and recognising outstanding contributions to India's space sector. **The awards encompassed 16 distinct categories, each highlighting different facets of the space industry, including technological innovation, advanced manufacturing, sustainability, and public impact.** Collectively, these categories reflected the key areas where Indian companies are driving innovation, pushing boundaries, and strengthening the nation's space ecosystem.

These awards celebrate transformative achievements in Earth Observation, Geospatial Intelligence, Space Sustainability, Satellite Communications, Advanced Manufacturing, AI for defence, and Academic Excellence, truly reflecting the depth and diversity of India's NewSpace capabilities.

Earth Observation Excellence – GalaxEye - Dr. Deb Jyoti Pal , Sr VP, Business Development

Earth Observation Excellence – Pixxel- Mr. Abhilash Bhat, CoS

Platform for Public Impact - Esri India- Mr. Agendra Kumar, Managing Director, Esri India Technologies Pvt. Ltd.

International Collaboration & Market Expansion – Augsenselab - Mr. Kannan Kesavapillai, Chief Executive Officer

Space Sustainability Champion – Digantara- Mr Mohammed Zayed, Sales Engineer - Government, Digantara

Emerging Technology of the Year - Astrogate Labs- Mr. Nitish Singh, Founder & CEO

AI for Defence & Geospatial Intelligence - CYRAN AI Solutions- Mr. Manan Suri, Founder

Special Award for Operational Imagery Support – Mr. Suhora- Krishanu Acharya, CEO & Co-Founder

Special Award for Operational Imagery Support – Vantor- Mr. Rakesh Verma, Sales Manager D&I

Space Manufacturing & Production Excellence - Larsen & Toubro- Mr. Ravishankar T, General Manager and Head of Strategic Systems at L&T

Special Award for Manufacturing Excellence - Azista Space- Brig Adarsh Bhardwaj, Executive Director, Azista Aerospace

Satcom Industry Award - Eutelsat OneWeb - Mr. Pankaj Agarwal, Sales Engineer SAARC region

Satcom Industry Award - Ananth Technologies- Cdr. V. Sivarao Cherukupalli., Director(Strategic Systems), Ananth Technologies Pvt Ltd.

Academic Excellence in Space Education & Research - Dr.Aseem Chauhan , Addl. president RBEF and Chancellor Amity University Haryana and other Amity Universities and Dr W. Selvamurthy, President Amity Science Technology Innovation Foundation, Chancellor, Amity University Chattisgarh

- **Excellence in Space Technology Innovation - Skyroot Aerospace**
- **Contribution to Space Exploration - AgniKul Cosmos - Ms Umamaheshwari K, Senior Director - Engineering, Agnikul Cosmos**

Release of Publications

Following the awards, the Inaugural Session proceeded with the release of key publications.

The first publication, titled **"Valuation and Fundraising in Aerospace Startups: TRL versus MRL,"** was formally released in the presence of its author, Dr Ravinder Pal Singh. The release was followed by a group photograph with the author to mark the occasion.

Subsequently, the **Technical Report of the Indian Defence Space Symposium 2025** was officially released.

A key highlight of the event was the release of the **Technical Report for the Indian DefSpace Symposium 2025, meticulously prepared by Amity University**, during the Inaugural Session of IISC 2025 in the august presence of **Dr Jitendra Singh Ji, Hon'ble Minister of State, along with Dr. Pawan Goenka, Chairman, IN-SPACe, Mr. Takashi ARIYOSHI, Embassy of Japan; Air Chief Marshal V.R. Chaudhari PVSM, AVSM, VM, ADC (Retd.), Indian Air Force; H.E. Antonio Bartoli, Ambassador of Italy to India; Mr. A.T. Ramchandani, Larsen & Toubro Precision Engineering & Systems, and Lt Gen Anil Kumar Bhatt (retd),PVSM, UYSM, AVSM, SM, VSM (Retd.), ISpA.**

Fireside Chat : Unlocking India's Private Space Industry Potential : An open dialogue with Dr Pawan Goenka, Chairman, IN-SPACe

Moderated by:

- **Mr P J Nath, Managing Director & Chief Executive Officer, Nelco Ltd.**
- **Mr Sanjay Nekkanti , CEO & Founder, Dhruva Space**

The session opened with **Mr. P. J. Nath, Managing Director & Chief Executive Officer**, **Nelco Ltd.** acknowledging **Dr. Pawan Goenka Chairman, IN-SPACe** pivotal role in conceptualizing and articulating India's Decadal Vision for the space sector. He emphasized that while the vision has successfully catalyzed the growth of the startup ecosystem and brought national attention to the space industry, the critical next phase lies in effective implementation. He noted that achieving the ambitious target of a $44 billion space economy by 2033 would depend largely on demand generation, both domestic and international.Responding to the question, **Dr Pawan Goenka, Chairman, IN-SPACe** highlighted that while India possesses the capability, talent, and investment potential to meet the supply side of the $44 billion target, the real challenge lies in building sustained demand.

He explained that the projected demand has been divided into two segments:

- $11 billion from international markets (exports)
- $33 billion from domestic demand

Dr. Goenka outlined two primary contributors to overseas demand:

1. Supply of systems and components by Indian vendors to global companies He emphasized that Indian vendors, nurtured through long-standing collaboration with ISRO, possess strong technical capabilities and adhere to high quality standards. However, these capabilities remain underleveraged in global markets. IN-SPACe is actively facilitating international exposure through trade delegations and participation in global forums. India has organised “Space Days” with countries such as Luxembourg, Italy, Japan, and Australia to promote partnerships and joint ventures.

2. Revenue from new-age space companies Emerging private space companies are beginning to generate international revenue. Though modest for now, these early successes lay the foundation for future export growth.

Dr. Goenka clarified that while the $11 billion export goal remains aspirational, the current momentum, though still in the early stages, indicates a clear pathway forward.

The $33 billion domestic demand component will initially rely heavily on the Government of India as the anchor customer. Dr. Goenka underscored that various government departments are increasingly data-hungry and eager to collaborate with private players. However, he cautioned that private companies must build credibility, as government stakeholders have long-standing trust in ISRO's reliability.

He advised private firms against rushing products to market prematurely, emphasising that credibility in the space sector is difficult to build and easy to lose.

He also highlighted initiatives such as satellite data consortia and application-focused programs to unlock demand across ministries. IN-SPACe has issued multiple Announcements of Opportunity (AOs) to stimulate application development aligned with user ministry requirements.

In the satellite communication domain, demand projections indicate substantial future requirements, potentially necessitating multiple satellite launches. Dr. Goenka noted ongoing efforts to ensure enabling policy conditions, including spectrum availability.

Mr Sanjay Nekkanti , CEO & Founder, Dhruva Space observed that India now hosts approximately 500–600 companies across legacy build-to-print vendors and new-age startups. He questioned whether companies might be operating with limited ambition or "blinders."

Dr. Goenka responded that while he would not characterise the industry as constrained by blinders, he observed that some vendors may lack sufficient aspiration in global markets. He emphasized perseverance, particularly in securing initial overseas orders, where reliability and trust are paramount. He also expressed concern that some startups attempt to pursue too many verticals simultaneously. He encouraged companies to focus on core strengths rather than diversifying prematurely, noting that the market cannot sustain an excessive number of launch vehicle or satellite manufacturers.

Addressing the balance between building sovereign capabilities and expanding exports, Dr. Goenka stressed that India must pursue both objectives simultaneously. With space becoming increasingly critical to strategic national interests, sovereign capability is essential. However, he emphasized avoiding exclusivity between defence and civilian infrastructure. Greater dual-use integration would enhance asset utilisation and commercial viability. As private-sector ownership of space assets increases, commercial justification will naturally encourage broader utilisation.

On the issue of protectionism, **Dr. Goenka** stated clearly that artificial barriers cannot sustain long-term competitiveness. While temporary safeguards may support emerging industries, Indian space companies must ultimately compete on merit—cost, quality, reliability, and execution. Government support would prioritise enabling competitiveness rather than shielding inefficiencies.

Drawing parallels with India's automotive transformation, **Dr. Goenka** highlighted the importance of strategic focus. Just as India emerged as a global hub for small cars through policy alignment and industry collaboration, the space sector is positioning itself as a global hub for launching small satellites.

He noted several aligned developments:

- Dedicated launch infrastructure for small satellites
- Multiple small launch vehicle initiatives
- Expanding satellite manufacturing capabilities
- Policy support for increased launch frequency

He emphasized that global leadership in small satellite launches would require:

1. Competitive launch costs
2. High reliability
3. Predictable timelines

Additionally, he stressed the importance of scaling production capabilities and learning from industries such as automotive manufacturing in achieving operational efficiency.

Dr. Goenka identified space applications as a domain where India holds a natural advantage, given its strong IT and digital ecosystem. IN-SPACe is actively collaborating with user ministries to define problem statements and pilot projects, aiming to translate applications into sustainable commercial demand.

The discussion also addressed scaling challenges. While Indian companies can handle limited production runs, global markets demand scale. Dr. Goenka acknowledged that while space manufacturing would not resemble automotive assembly lines, facilities must evolve to support higher throughput. Emerging AIT (Assembly, Integration, and Testing) infrastructure is already being designed for greater volume capacity.

Key Priorities for Achieving 8% of the Global Space Economy

In concluding remarks, **Dr. Goenka** outlined the industry's essential priorities: Think big, Avoid shortcuts, Persevere and Collaborate. He underscored that collaboration-both within India and internationaly -would be fundamental to sustained growth.

He further identified two overarching priorities for IN-SPACe: Demand creation (highest priority) and Investment mobilisation (second priority). Efforts are underway to sensitise the investor community to the $44 billion opportunity, including participation in investment forums and initiatives such as the proposed venture capital fund for the space sector.

The session concluded with optimism regarding the industry's momentum. **Dr. Goenka** acknowledged the strong entrepreneurial spirit and risk appetite within the ecosystem but cautioned that space remains a complex and capital-intensive sector where success requires long-term commitment.He reiterated that while foundational elements-vision, talent, ambition, and government support-are in place, sustained perseverance will be critical in transforming India into a globally competitive space power.

Session I: "India–Japan Space Partnership: Fostering a Collaborative Space Eco-System"

Keynote Address: Dr Saku Tsuneta, Vice Chair, Committee on National Space Policy, Cabinet Office, Government of Japan

Chair & Moderator: Dr D Gowrisankar, Director, Office International & Interagency Cooperation (OIIC), ISRO

Panelist:

- **Mr Shinichi Higuchi, Director (International Affairs), National Space Policy Secretariat, Cabinet Office, Government of Japan**
- **Mr Tomohiro Oya, Engineer, Lunar Polar Exploration (LUPEX) Project, Human Spaceflight Technology Directorate, Japan Aerospace Exploration Agency (JAXA)**
- **Mr Masayuki Urata, Senior Manager, Business Development Division, iSpace**
- **Mr Kannan Kesavapillai , Chief Executive Officer, Augsenselab Pvt. Ltd.**
- **Mr Mohammed Zayed, Sales Engineer - Government Digantara**
- **Mr Makoto Watanabe, First Secretary (Science & Technology), Embassy of Japan in India**

The first panel discussion of the conclave brought together senior government officials, space agency representatives, and industry leaders from India and Japan to deliberate on strengthening bilateral cooperation and building a resilient, innovation-driven space ecosystem. The session examined policy frameworks, flagship missions, commercial expansion, technological complementarities, and emerging geopolitical realities shaping the future of space collaboration.

Opening the session, **Dr. D. Gowrisankar, Director, Office International & Interagency Cooperation (OIIC), ISRO** described it as a landmark discussion aligned with the broader vision of deepening government–industry partnerships in the global space economy. He noted that India–Japan space cooperation spans more than six decades, beginning with Japanese scientists participating in sounding rocket experiments in Thumba, followed by balloon experiments, joint data analysis, and academic exchanges.

He emphasized that institutional collaboration has matured significantly over time. Nearly sixteen agreements between the two nations now support cooperation across Earth observation, satellite navigation, planetary exploration, and lunar science. Structured engagement mechanisms—including the India–Japan Space Dialogue at the governmental level, ISRO–JAXA Joint Working Groups at the agency level, and project-specific steering committees—have ensured continuity and strategic alignment.

Highlighting the Lunar Polar Exploration (LUPEX) mission, **Dr. Gowrisankar** described it as the "prime example of trust-based collaboration," noting that Japan committed to the project as early as 2016, even before India demonstrated its lunar landing capability in 2023. This, he observed, reflects the depth of confidence underpinning the partnership.

He further remarked that recent industry delegations and bilateral meetings indicate that both countries possess the right technological capabilities and industrial ecosystems to accelerate collaboration at an unprecedented scale.

Keynote Address by Dr. Saku Tsuneta, Vice Chair, Committee on National Space Policy, Cabinet Office, Government of Japan

Delivering the keynote address, **Dr. Saku Tsuneta** provided a compelling historical perspective on Japan's journey into space exploration. He recalled that following World War II, Japan faced restrictions on aerospace research for several years. Despite these limitations, Japanese scientists remained determined to rebuild national technological capacity.

In 1955, Dr. Hideo Itokawa conducted Japan's first post-war rocket experiment using a tiny "pencil rocket" measuring just 23 centimetres—an achievement that symbolised the nation's re-entry into space research. Fifteen years later, in 1970, Japan successfully launched its first satellite, becoming the fourth country to do so.

Dr. Tsuneta reflected on the perception that Japan could never close the technological gap with the United States. Yet decades of sustained investment and innovation enabled Japan to achieve advanced lunar capabilities, culminating in its successful Moon landing in 2024. He drew

parallels with India's Chandrayaan-3 mission, which demonstrated precision landing near the lunar south pole.

Together, these achievements signal what he described as a **paradigm shift in space exploration—from landing where possible to landing where intended.**

Examples of Indo-Japanese Scientific Collaboration

Dr. Tsuneta highlighted several collaborative successes:

- **Thirty Meter Telescope (TMT):** A multinational project involving India, Japan, Canada, and U.S. institutions to build the world's largest optical-infrared telescope. India contributes critical opto-mechanical assemblies, sensors, actuators, mirror polishing, and control software—often in partnership with private industry.
- **Balloon-Based Astronomical Missions:** Joint experiments launched from Hyderabad achieved a high success rate, resulting in multiple scientific publications and postgraduate research outputs.
- **Academic Exchange:** Over the past decade, graduate students from Nagoya University have trained in India, strengthening professional networks and fostering long-term collaboration.

Looking ahead, **Dr. Tsuneta** presented a shared roadmap extending from Low Earth Orbit to lunar exploration and ultimately to Mars. He noted that India's Gaganyaan human spaceflight program, Chandrayaan-4 sample return mission, and earlier Mars Orbiter Mission complement Japan's exploration ambitions.

He stressed that collaboration must now extend beyond space agencies to include private enterprises and startups, enabling joint innovation, technology sharing, and new commercial opportunities.

Addressing the evolving geopolitical landscape, **Dr. Tsuneta** emphasized that rapid technological change—including artificial intelligence applications in space—demands resilient partnerships. He called for early discussions on the next major collaborative endeavour beyond LUPEX and encouraged stronger linkages between commercial entities in both nations.

Japan's Space Policy Architecture – Mr. Shinichi Higuchi, Director (International Affairs), National Space Policy Secretariat, Cabinet Office, Government of Japan

Providing policy insights, **Mr. Shinichi Higuchi, Director (International Affairs), National Space Policy Secretariat, Cabinet Office, Government of Japan** explained that Japan's space strategy is directed by the Space Development Strategy Headquarters under the leadership of the Prime Minister, ensuring whole-of-government coordination.

The **Basic Plan on Space Policy (2023)** establishes four central objectives:

- Ensuring space security
- Strengthening national resilience
- Addressing global-scale challenges
- Driving innovation and industrial growth

To support these goals, Japan has formulated a **Space Technology Strategy** that prioritises technological independence, supply chain autonomy, and leadership across satellites, transportation systems, and exploration technologies.

Space Strategy Fund

A major initiative is the **Space Strategy Fund**, which will provide approximately **1 trillion yen (USD ~6.9 billion)** over ten years to support startups, private companies, and academia. The fund aims to expand the commercial space market while addressing pressing global challenges such as climate change and deep-space exploration.

Mr. Higuchi also highlighted Japan's proactive stance on space security and debris mitigation, including participation in United Nations-led rule-making efforts.

Reflecting on international partnerships, he acknowledged the challenge of balancing national security with collaboration. However, he stressed that no country can independently master all aspects of space technology. Mutual trust, shared values, and complementary strengths therefore form the foundation of effective cooperation—a principle exemplified by India–Japan relations.

He also announced an upcoming India–Japan Space Industry Cooperation event in New Delhi, inviting stakeholders to leverage it for business development and partnership opportunities.

LUPEX Mission: Science, Technology, and Industrial Learning – Mr. Tomohiro Oya, Engineer, Lunar Polar Exploration (LUPEX) Project, Human Spaceflight Technology Directorate, JAXA

Offering a technical deep dive, **Mr. Tomohiro Oya, Engineer, Lunar Polar Exploration (LUPEX) Project, Human Spaceflight Technology Directorate, JAXA** described the LUPEX mission as a transformative joint effort aimed at investigating water resources in the Moon's south polar region—an area considered critical for future human habitation and sustainable exploration.

Mission Objectives

- Determine the quantity, distribution, and physical condition of lunar water ice.
- Demonstrate advanced surface mobility technologies.
- Validate survival systems during extreme lunar night conditions.
- Analyse volatile compounds and elemental distribution at the landing site.

Under the partnership framework:

- **JAXA** will provide the launch vehicle, rover, and key mission instruments.
- **ISRO** will develop the lander along with complementary payloads.

The rover will drill up to **1.5 meters beneath the surface** to collect samples for scientific analysis. The mission duration is expected to be approximately **3.5 months**.

Importantly, **Mr. Oya** emphasized that LUPEX is also a model for agency–industry collaboration. By involving industrial manufacturers in spacecraft development, both agencies and companies gain valuable expertise, accelerating technology transfer and strengthening the broader ecosystem.

He explained that the rover incorporates a unique thermal design capable of withstanding harsh lunar conditions without relying on radioisotope power sources—demonstrating scalable technology for future missions.

Industry Perspectives

Mr. Masayuki Urata , Senior Manager, Business Development Division, iSpace

Mr. Masayuki Urata , Senior Manager, Business Development Division, iSpace outlined Japan's ambition to expand its space economy from **USD 25 billion in 2020 to nearly USD 50 billion in the 2030s**, driven by strong government support and the "san-kaku" model—a triangular partnership among academia, government, and industry.

Founded in 2010, iSpace is transitioning from research to commercial operations with a vision to provide sustainable lunar transportation services. Although its landing attempts encountered technical challenges, the company successfully demonstrated orbital insertion capabilities, marking significant progress.

He observed that Japanese startups are rapidly scaling, with several achieving public listings and a combined market capitalisation of approximately **USD 2.7 billion**.

Comparing ecosystems, **Mr. Urata** noted that India excels in agile manufacturing and speed, while Japan contributes strengths in precision engineering and system architecture. Together, these complementary capabilities create powerful synergy for future collaboration, particularly in developing cis-lunar infrastructure.

Mr Kesavapillai, Chief Executive Officer, Augsenselab Pvt. Ltd. presented Augsenselab's work in quantum sensing and remote sensing technologies, including atomic receivers that could replace conventional RF antennas. The company is also developing a radiometric satellite constellation to support hyper-local weather forecasting, pollution monitoring, and climate intelligence.

Drawing from his long experience working with Japanese firms, he remarked that Japan prioritises high R&D value rather than cost-driven engagements, enabling deeper technological partnerships.

He identified photonics and semiconductor technologies as key areas where India can benefit from Japan's expertise while simultaneously creating large-scale market opportunities for Japanese components—resulting in a mutually beneficial collaboration.

Mr Mohammed Zayed, Sales Engineer - Government Digantara emphasized the growing importance of **Space Situational Awareness (SSA)** in light of the dual-use nature of space assets for commercial and defence applications.

Founded in 2018 and incubated at the Indian Institute of Science, Digantara now operates India's first commercial SSA facility with over 130 professionals.

He explained that SSA is built on three pillars:

- Perception – generating sovereign data
- Comprehension – processing data in-house
- Projection – delivering operational insights

Digantara has established partnerships with Japanese companies such as iSpace and Astroscale to develop capabilities including cis-lunar domain awareness and debris monitoring—missions he described as technologically pioneering and strategically critical.

Key Discussion Insights

Balancing Security and Collaboration

Panellists agreed that safeguarding national interests while pursuing international partnerships requires mutual trust and strategic alignment.

Upstream vs. Downstream Opportunities

Significant potential exists across both domains—from sensing platforms and satellites to data services and analytics. Future competitiveness will depend not only on higher-resolution data but on generating new insights and actionable intelligence.

Technology Complementarity

A recurring theme was the synergy between India's cost-effective innovation and Japan's technological precision—positioning the partnership as a major force in the evolving global space economy.

Session 2: "Geospatial Data Applications: Turning data into actionable insights for governance and industry"

Chair & Moderator: Mr Sanjay Kumar, Founder & CEO, Geospatial World

Panelist:

- **Dr Rajasekhar M, Scientist SG, Chief Meteorologist, ISRO**
- **Mr Agendra Kumar, Managing Director, Esri India Technologies Pvt. Ltd.**
- **Dr Deb Jyoti Pal, Senior Vice President, GalaxEye**
- **Mr Pranjal Prateek, Chief of Staff to the CEO & Director of Business Solutions, Satsure**
- **Lt Col Rakesh Verma (Retd), Sr Manager, Sales & BD (D&I), Vantor**
- **Dr Y Nithiyanandam, Professor & Head, Geospatial Programme, Takshashila**

The second session of the conclave focused on the transformative role of geospatial technologies in converting vast volumes of spatial data into actionable intelligence for governance, industry, and national development. Bringing together leaders from government agencies, private enterprises, startups, and policy think tanks, the discussion highlighted how the convergence of space infrastructure, Earth observation, artificial intelligence, and digital platforms is reshaping decision-making ecosystems.

Opening the session, **Mr. Sanjay Kumar, Founder & CEO, Geospatial World** contextualized geospatial technology within the broader trajectory of the fourth industrial era—an evolution spanning computing, information systems, digitization, and now autonomous technologies. He emphasized that space-based capabilities, including communication, navigation, and Earth observation, form the foundational infrastructure of this emerging ecosystem.

Drawing from everyday experience, he observed that maps today are no longer merely navigational tools but dynamic decision-support systems that enable efficiency, productivity, and optimized resource utilization. He further underscored the growing dependence of geospatial applications on secure and sovereign space infrastructure, describing it as a critical national asset essential for governance, citizen services, and digital economic growth.

At the same time, he cautioned against overlooking vulnerabilities related to cybersecurity, resilience, and sustainability of space-based systems-issues that demand urgent attention in a rapidly evolving geopolitical environment.

Role of Space Technology in Meteorology and Climate Science

Dr. M. Rajasekhar, Scientist SG, Chief Meteorologist, ISRO emphasized that nearly 90% of meteorological observations now originate from satellite systems, making space infrastructure indispensable for weather forecasting and climate monitoring.

He explained that without space-based observations, forecasts for cyclones, monsoon systems, and mesoscale weather phenomena would be limited to only one or two days. Satellites enable real-time monitoring across vast geographic areas—capabilities that drones or terrestrial systems cannot reliably provide, especially during severe weather events.

Dr. Rajasekhar highlighted several critical applications:

- Early warning systems for disasters
- Long-term climate monitoring
- Drought assessment
- Ocean behavior analysis
- Numerical weather prediction using decades of historical data

He noted that advances in data assimilation and cloud-based computing are steadily improving forecasting accuracy, although challenges remain in hyper-local predictions.

Speaking next, **Mr. Agendra Kumar, Managing Director, Esri India Technologies Pvt. Ltd.** described satellite imagery as the foundational layer upon which Geographic Information Systems (GIS) are built. He outlined the expanding application landscape—from disaster management and agriculture to infrastructure planning and governance.

A major focus of his address was the emergence of **"living digital twins."** These are virtual replicas of physical assets—cities, infrastructure, or environments—continuously updated with real-time data to enhance planning and operational efficiency.

Examples included:

- Simulating bridge construction before physical deployment
- Managing urban utilities such as drainage, water supply, and traffic
- Enhancing safety and security planning
- Conducting crop monitoring and insurance assessments

Mr. Kumar explained that while satellite imagery provides the base layer, technologies such as drones and LiDAR enhance vertical accuracy, enabling highly precise models.

He also introduced the concept of a **Living Atlas**, a global geospatial repository integrating authoritative datasets such as administrative boundaries, transportation networks, soil and weather data, census projections, and high-resolution basemaps. Supported by open data policies, the platform processes millions of data requests monthly, demonstrating the scale at which geospatial information is now consumed.

Looking ahead, he predicted deeper integration of artificial intelligence, agentic systems, augmented reality, and gaming engines into geospatial workflows—particularly for simulation and security training environments.

Fusion Imaging and Next-Generation Earth Observation

Dr. Deb Jyoti Pal, Senior Vice President, GalaxEye discussed GalaxEye's pioneering work in combining Synthetic Aperture Radar (SAR) with optical sensors on a single satellite platform—a capability he described as transformative for downstream applications.

While SAR can penetrate clouds and capture data under adverse conditions, optical imagery is easier to interpret. Fusing both enables the creation of colorized, cloud-free imagery suitable for real-time analytics in sectors such as agriculture, disaster response, and defence.

He further clarified the relationship between space and geospatial technologies, noting that Earth observation forms one of the five core pillars of geospatial science alongside photogrammetry, GIS, GNSS, and digital systems. From land-use mapping to defence surveillance, he asserted, effective geospatial applications cannot function without robust Earth observation data.

Problem-First Innovation in Geospatial Solutions

Mr. Pranjal Prateek, Chief of Staff to the CEO & Director – Business Solutions, SatSure outlined SatSure's distinctive strategy of prioritising downstream problem-solving before developing upstream infrastructure. This approach, he explained, allows the company to design solutions grounded in real-world challenges rather than a technology push.

He described geospatial analytics as a transition from subjectivity to objectivity, enabling data-driven decision-making across industries.

Use Cases Highlighted

- **Agricultural Credit:** By integrating geospatial data with socio-economic indicators, banks can generate capability scores for farmers, reducing loan approval timelines from months to minutes. Notably, over half of such loans have reached previously unbanked farmers.
- **Insurance Analytics:** Satellite-derived insights allow insurers to assess risk at granular levels—from regions to individual plots—enabling dynamic premium pricing.

SatSure is also developing digital platforms such as **Digital Forest Stacks, Agri Stacks**, and **Water Stacks** for state governments, illustrating the growing institutional adoption of geospatial intelligence.

Looking ahead, **Mr. Prateek** indicated that upcoming satellite launches will enable the company to operate as a fully integrated upstream–downstream provider with enhanced experimentation capabilities.

Spatial Intelligence and Enterprise Applications

Lt Col Rakesh Verma (Retd.), Senior Manager – Sales & Business Development (Defence & Intelligence), Vantor explained that Vantor emerged from the need to bridge capability gaps faced by geospatial users. Transitioning from a traditional geospatial provider to a spatial intelligence company, Vantor aims to deliver end-to-end analytics—from archival data to actionable insights.

Using examples from high-security event planning, he demonstrated how accurate 2D and 3D data integration can enable seamless coordination among multiple agencies.

He emphasized that high-resolution basemaps are essential for integrating diverse datasets and supporting AI-driven analytics. Beyond defence, he identified telecommunications, navigation, and enterprise visualisation as rapidly expanding markets for spatial intelligence.

Importantly, Vantor is deploying containerised solutions that allow customers to integrate sovereign datasets within secure environments—an approach particularly relevant amid rising geopolitical sensitivities.

Geospatial Policy, Education, and Capacity Building

Representing the Takshashila Institution, **Dr. Y. Nithiyanandam, Professor & Head, Geospatial Programme, Takshashila Institution**, addressed the policy and talent dimensions of the geospatial ecosystem.

He noted that although geospatial education has existed for decades, it remains fragmented across academic disciplines, creating a persistent industry–academia gap. With technologies evolving rapidly, capacity-building must become interdisciplinary and technology-oriented.

Takshashila's initiatives include:

- Training programs for government professionals
- Capsule courses for cross-disciplinary learners
- Policy research on data dissemination frameworks
- Border intelligence analysis using geospatial tools

Looking ahead, the institution plans to launch a **Network of Advanced Geospatial Studies**, aiming to train approximately twenty specialists annually in geospatial intelligence.

Geospatial Applications in the Blue Economy

Returning to sectoral applications, **Dr Rajasekhar M, Scientist SG, Chief Meteorologist, ISRO** highlighted how satellite-based ocean monitoring supports the national Blue Economy mission. One notable example is the identification of Potential Fishing Zones, which directly enhances aquaculture productivity.

He stressed the importance of multi-sensor data fusion—integrating terrestrial, atmospheric, and oceanic datasets—to address climate sustainability challenges effectively. Inter-agency collaboration toward unified platforms is already underway, signalling progress toward a national blue economy framework.

Technology Convergence and Platform Evolution

Throughout the discussion, panelists agreed that future geospatial platforms must incorporate multi-source data—from space to surface and beyond—within AI-enabled ecosystems.

Key technological drivers identified included:

- Digital twins for infrastructure and urban planning
- GeoAI and machine learning for automated feature extraction
- Hybrid cloud architectures
- AR/VR-enabled simulations
- Multi-modal data fusion

Collectively, these innovations are expected to transform geospatial platforms into dynamic intelligence systems rather than static mapping tools.

Special Segment: Release of the ISpA–SatSure Joint Paper on AgriStack

The session featured the formal release of a joint paper on **AgriStack Solutions**, highlighting the role of digital public infrastructure in modernizing agriculture.

The initiative traces its origins to the Government of Uttar Pradesh, which piloted the AgriStack concept at scale. SatSure, selected among the implementing startups, leveraged its operational experience to advocate for a nationwide rollout supported by indigenous technologies.

The paper emphasizes the importance of positioning AgriStack as a digital public infrastructure framework while enabling startups to play a central role in innovation. The broader objective is to enhance farmer livelihoods through data-driven agriculture aligned with national development priorities.

In closing, **Mr. Sanjay Kumar** underscored that technologies such as space systems, geospatial analytics, drones, artificial intelligence, and digital twins are deeply interdependent and must be developed as part of an integrated ecosystem.

He observed that India's geospatial and space sectors are entering a phase of accelerated growth and will play a decisive role in advancing the vision of a technologically empowered nation.

Session 3: "Navigating Spectrum Issues for SatCom and Challenges for India's Private Sector in Providing LEO Satellite Internet Services"

Chair & Moderator: Dr Prafulla Kumar Jain, Director, PMAD, IN-SPACe Panelist:

- **Mr Shivaji Chatterjee, CEO & Managing Director, Hughes Communications**
- **Mr P J Nath, Managing Director & Chief Executive Officer, Nelco Ltd.**
- **Mr Arun Agarwal, DDG(Satellite), Department of Telecommunications**
- **Mr Gautam Sharma, Managing Director, Viasat India**
- **Col Kunwar Varun Singh Tanwar, VSM (Retd), Head – Business Development (Defence), Astrome Technologies Pvt Ltd**
- **Ms Neha Idnani, Regional VP - APAC, Eutelsat OneWeb (Hybrid)**

The third session addressed one of the most critical and debated issues in the evolving satellite communications landscape-**space spectrum allocation** and the operational challenges faced by India's private sector in deploying Low Earth Orbit (LEO) satellite internet services.

Opening the session, **Dr Prafulla Kumar Jain, Director, PMAD, IN-SPACe** commended the organizers for selecting a highly relevant theme centered on two major pillars: spectrum management and Non-Geostationary Satellite Orbit (NGSO) constellations. He noted that satellite communication has remained a vital component of India's communication ecosystem for over three decades, supporting services ranging from VSAT connectivity to Direct-to-Home broadcasting while contributing significantly to the national space economy.

Citing industry estimates, Dr. Jain observed that nearly **50% of India's $8.4 billion space economy** is attributed to satellite communications. Looking ahead, as India targets a **$44 billion space economy by 2030**, satcom alone is expected to contribute approximately $15 billion, underscoring its strategic importance.

He further highlighted that NGSO constellations are unlocking unprecedented opportunities through low latency, high throughput, and dynamic beam capabilities—technologies that can enable broadband connectivity in remote regions and support next-generation applications.

Spectrum: A Critical and Finite Resource

Dr. Jain emphasized that spectrum—whether terrestrial or space-based—is a scarce national resource requiring optimal utilization. With emerging applications such as Direct-to-Device (D2D) communication and Non-Terrestrial Networks (NTN) under global standards like 3GPP Releases 17 and 18, the integration of satellite and terrestrial networks is becoming inevitable.

He also pointed to evolving coexistence challenges between GSO and NGSO systems, noting that regulatory frameworks worldwide are adapting to ensure interference protection and efficient coordination.

Encouragingly, he highlighted several government initiatives that have strengthened the regulatory landscape:

- Space sector reforms
- Indian Space Policy
- Liberalized FDI guidelines
- The Telecommunications Act
- Demand projection exercises for satcom capacity
- Establishment of joint working groups to develop a robust ecosystem

Additionally, the introduction of streamlined authorization processes has significantly reduced administrative burdens—for example, replacing hundreds of annual approvals with a single satellite authorisation mechanism.

Industry Perspective: Urgency Around Spectrum Allocation

Mr Shivaji Chatterjee, CEO & Managing Director, Hughes Communications identified spectrum availability as the foremost challenge delaying the commercialisation of satcom services. While the Telecommunications Act has clarified that satellite spectrum will be administratively assigned rather than auctioned, industry stakeholders are awaiting final decisions on pricing and allocation frameworks.

He remarked that NGSO technologies have evolved rapidly, narrowing the historical performance gap between terrestrial and satellite communications. As regulators attempt to future-proof policies, timely decisions will be crucial to enable what could become one of the fastest satcom rollouts globally.

Echoing these concerns, **Mr P J Nath, Managing Director & Chief Executive Officer, Nelco Ltd.** emphasized that India's satcom industry remains relatively small despite decades of operation. Many operators had anticipated significant growth driven by NGSO capabilities and structured their business strategies accordingly. Delays in spectrum assignment, therefore, directly impact industry viability and expansion.

Regulatory Outlook from the Department of Telecommunications

Providing the regulatory perspective, **Mr Arun Agarwal, DDG(Satellite), Department of Telecommunications** confirmed that the Telecommunications Act offers clear guidance on spectrum assignment through administrative mechanisms.

He noted that:

- The Telecom Regulatory Authority of India (TRAI) has submitted recommendations.
- A back-reference has been issued for reconsideration of pricing aspects.
- Once finalised, commercial spectrum assignment can proceed.
-

Mr. Agarwal also highlighted provisions supporting innovation, including regulatory sandbox frameworks for live testing. Spectrum has already been provisionally assigned for NGSO trials, demonstrating the government's commitment to technological advancement.

He further stressed the importance of coexistence frameworks between GSO and NGSO systems to maximize spectral efficiency while maintaining service quality.

Operational Challenges Beyond Spectrum

While spectrum remains central, panelists identified several additional hurdles.

Mr. P. J. Nath pointed to the need for clarity on remote access guidelines and licensing structures. Current restrictions allowing service providers to sell only directly to end users—rather than through intermediaries—could limit market reach, particularly in remote regions.

Cost was another major concern. Delivering connectivity to underserved areas requires viable pricing models, potentially supported by universal service funds to catalyze early adoption.

Multi-Orbit Strategies and Network Resilience

Mr Gautam Sharma, Managing Director, Viasat India discussed the growing shift toward multi-orbit architectures, combining GEO, MEO, and LEO satellites to enhance resilience and optimise bandwidth economics.

He explained that such hybrid solutions:

- Reduce operational costs
- Improve service continuity
- Provide redundancy for mission-critical applications

Illustrating this approach, he referenced maritime and aviation connectivity solutions integrating multiple frequency bands and orbital layers.

However, he cautioned that spectrum policies must remain equitable, particularly to safeguard sovereign satellite assets that predominantly operate in geostationary orbit.

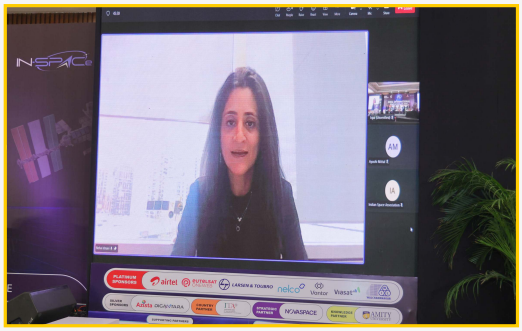
Use Cases and Market Evolution

Addressing the applicability of NGSO systems, **Mr. Shivaji Chatterjee** noted that while LEO networks offer superior latency and performance, their suitability varies by use case.

For example:

- Low-bandwidth applications such as ATMs may remain better served by existing technologies.
- High-performance requirements-such as enterprise connectivity, mobility, maritime, and defence-stand to benefit significantly from NGSO deployments.

He predicted that although some migration from traditional VSAT networks may occur, the majority of growth will likely stem from entirely new applications rather than the displacement of existing ones.



Global Operator Perspective

Joining virtually, **Ms Neha Idnani, Regional VP - APAC, Eutelsat OneWeb (Hybrid)** emphasised India's strategic importance for Eutelsat OneWeb, citing both market potential and shareholder ties.

She outlined three key enablers necessary for accelerating deployment:

Efficiency

Rapid and transparent spectrum allocation is essential. With services already operational across numerous countries and pilots conducted in India, the company is prepared for immediate rollout.

Economics

Regulatory frameworks should encourage investment by recognizing that the broader economic value of satcom lies in digital inclusion and resilient connectivity rather than spectrum monetization alone.

Effectiveness

Satellite services should complement—not compete with—terrestrial networks by addressing scenarios where fiber or cellular connectivity is technically or economically impractical.

Startups, Innovation, and Regulatory Balance

Representing the startup ecosystem, **Col Kunwar Varun Singh Tanwar, VSM (Retd), Head – Business Development (Defence), Astrome Technologies Pvt Ltd** acknowledged that policy reforms have enabled emerging companies to participate in the space sector. However, he cautioned that excessive regulation could stifle innovation.

From a defence perspective, he stressed the need for secure communication architectures, suggesting that while shared infrastructure may be

practical today, India should progressively develop dedicated sovereign assets for strategic applications.

Toward a Sovereign NGSO Capability

In the concluding exchange, panelists broadly agreed on the strategic necessity for India to establish its own NGSO constellation. Reliance solely on globally controlled networks could pose risks during geopolitical disruptions, making domestic capability a matter of national resilience.

The discussion referenced ongoing efforts toward an indigenous NGSO system, reflecting growing recognition of space infrastructure as a strategic asset.

Summarising the deliberations, Dr. Prafulla Kumar Jain emphasized that collaborative efforts between government and industry are vital to realise the full potential of satellite communications.

With regulatory reforms underway and technological capabilities advancing rapidly, India stands at a pivotal moment in shaping its satcom future. Ensuring timely policy decisions, fostering innovation, and building sovereign capacity will be central to positioning the country as a leader in next-generation connectivity.

Key Takeaways from India International Space Conclave (IISC) 2025
Day 1 : 18 Nov 2025

1. Financing and Economic Foundations of the Space Sector

- The bankability of space projects remains a central challenge; investors require predictable revenue models before committing long-term capital.
- India's space economy is projected to grow from USD 8–8.5 billion to USD 44 billion by 2033, necessitating large-scale financial innovation and infrastructure investment.
- Public–Private Partnerships (PPPs) and structured finance models will be critical in scaling the space industry, similar to India's infrastructure sector.
- Financial mechanisms such as blended finance, credit enhancement, and sovereign-backed financing frameworks can de-risk investments in early-stage space ventures.
- Recognition of space as critical infrastructure would enhance investor confidence and enable institutional financing.

2. Economic Impact and Commercial Opportunities in Space

- Global studies show that every dollar invested in space generates USD 4–7 in economic return, indicating strong multiplier effects for national economies.
- Space-enabled technologies will significantly transform sectors such as agriculture, logistics, disaster management, and defence ISR capabilities.
- Indian startups must move beyond dependence on government procurement and focus on globally scalable business models.
- Investment frameworks designed for traditional sectors may not suit deep-tech domains like space, requiring specialised evaluation models.

3. Industrial Capability in India's Space Ecosystem

- Indian industry has developed strong capabilities in space manufacturing, system integration, and aerospace infrastructure.
- L&T's aerospace manufacturing complex at Coimbatore provides end-to-end capabilities, including design, integration, and testing of space platforms.
- The company has manufactured motor casings for every Indian launch vehicle over the last five decades, reflecting deep industry involvement in the space programme.
- ISRO has entrusted L&T with industry-led manufacturing of PSLV launch vehicles, marking a major shift toward private participation.

4. Commercial Earth Observation and Geospatial Intelligence

- Commercial Earth observation constellations can provide high-resolution imagery up to 30 cm with multiple daily revisits, enabling continuous monitoring of critical infrastructure.
- Integration of optical imagery, SAR data, and AI-based analytics allows comprehensive geospatial intelligence for security and planning.
- Advanced platforms enable applications such as change detection in transportation hubs, defence surveillance, and disaster monitoring.

5. Startup Opportunities in India's Space Sector

- Key technology gaps where startups can contribute include:
  - Reusable launch vehicles
  - Modular satellite platforms
    - Radiation-hardened electronics and sensors
    - Space situational awareness systems.
- Launch system reusability and satellite constellations represent major global market opportunities.
- Startups should focus on global markets to achieve scale and economic viability rather than relying solely on domestic demand.

6. Strategic Importance of Space for National Security

- Space has become a fully contested operational domain influencing modern warfare and strategic competition.
- Future conflicts may begin with actions targeting space infrastructure before conventional hostilities emerge.
- Developing Space Situational Awareness (SSA) capabilities is essential for national security and protection of space assets.
- Collaboration among military institutions, industry, and academia is necessary to build resilient space capabilities.

7. India's Space Policy Reforms and Private Sector Growth

- Space sector reforms since 2019–2023 have enabled private participation and innovation in the Indian space ecosystem.
- The number of Indian space startups has grown from single digits to over 300 following liberalisation.
- Space technologies are increasingly applied in governance, agriculture, healthcare, disaster management, and communication infrastructure.

8. India–Japan Strategic Cooperation in Space

- India–Japan collaboration represents a trust-based partnership spanning more than six decades of scientific cooperation.
- Joint projects such as the LUPEX lunar mission demonstrate deep technological integration between ISRO and JAXA.
- Future collaboration should expand beyond agencies to include startups, private companies, and research institutions.

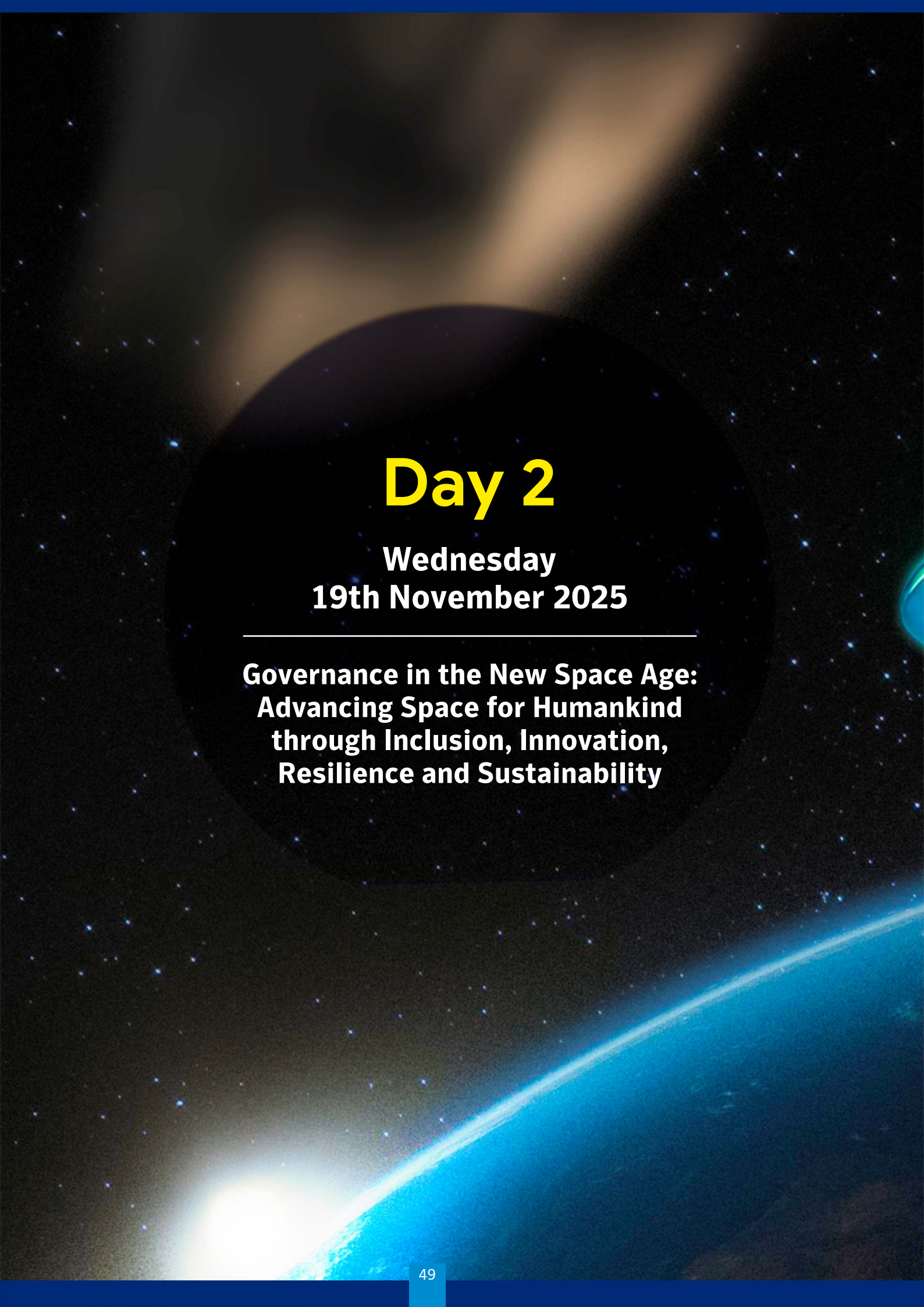
9. Geospatial Data as Strategic Infrastructure

- Geospatial technologies are becoming core infrastructure for digital governance and economic decision-making.

- Space-based systems underpin emerging digital ecosystems, including navigation, communication, and Earth observation platforms.

10. Satellite Communications and Spectrum Policy

- Satellite communications account for nearly 50% of India's current space economy, highlighting its strategic economic importance.
- The emergence of NGSO constellations and LEO satellite internet services will significantly expand broadband connectivity.
- Efficient spectrum management and regulatory clarity are essential for accelerating satcom deployment and private investment. 11. Measuring the Economic Contribution of the Space Sector
- India's space economy currently stands at approximately USD 8.4 billion and is projected to grow to USD 44 billion in the coming decade.
- Space technologies act as cross-sector enablers, supporting agriculture, telecommunications, transport, environmental monitoring, and disaster response.
- A standardised national statistical framework is required to accurately measure the economic contribution of the space sector.



Day 2

Wednesday
19th November 2025

Governance in the New Space Age: Advancing Space for Humankind through Inclusion, Innovation, Resilience and Sustainability

Session: "Estimation of Space Economy Contributions to National GDP," delivered by Mr. Brijesh Soni, Deputy Director, Promotion Directorate (PD), IN-SPACe.

The morning began with a special presentation titled **"Estimation of Space Economy Contributions to National GDP,"** delivered by **Mr. Brijesh Soni, Deputy Director, Promotion Directorate (PD), IN-SPACe**. In his address, **Mr. Soni** highlighted the strategic importance of quantifying the economic impact of the space sector as India advances toward its national aspiration of becoming a developed economy by 2047. He explained that the country's space economy, currently valued at approximately $8.4 billion, is projected to grow to nearly $44 billion in the coming years, with exports expected to contribute significantly to this expansion. Space technologies, he noted, already serve as critical enablers across sectors such as agriculture, telecommunications, transportation, disaster management, environmental monitoring, and urban planning. However, because these technologies are deeply embedded across industries, their true economic contribution often remains underrepresented in national accounting frameworks.

Mr. Soni emphasized that recent reforms-particularly the liberalization of the space sector and the increasing participation of private players-have dramatically expanded the ecosystem. The number of space startups has surged from single digits to more than 380, signaling a transformative shift in industry dynamics. Despite this growth, existing economic estimates are largely derived from market research studies rather than standardized statistical methodologies. He therefore stressed the need for a robust, government-backed framework that would enable evidence-based policymaking and strategic planning. Among the major challenges identified were the absence of a unified national definition of the space economy, limited availability of structured datasets, and the growing complexity of space applications, which now extend into emerging domains such as space tourism, reusable launch vehicles, and advanced satellite services.

To address these gaps, IN-SPACe has established a Joint Working Group comprising representatives from the Ministry of Statistics and Programme Implementation, the Department of Space, the Department of Telecommunications, the Department of Science and Technology, and leading industry associations. The group is tasked with developing standardized definitions, measurement methodologies, and data collection processes. Mr. Soni elaborated on the proposed methodological framework, which includes identifying both governmental and non-governmental actors, mapping space-related activities to the National Industry Classification (NIC 2008), and creating thematic satellite accounts that will ultimately inform national economic statistics. Notably, 137 space-related activities have already been identified for classification, and recommendations have been submitted to revise existing NIC codes so they better reflect the realities of the modern space economy.

He further explained that a dedicated digital portal has been developed to facilitate structured data submission from industry participants. Organizations are expected to provide information across multiple parameters, including revenue streams, employment figures, investment patterns, intermediate consumption, and production metrics. Startups that have not yet achieved revenue generation are encouraged to submit data related to investment and operational expenditures. This comprehensive dataset, once compiled, will allow policymakers to reliably quantify value addition, output, employment generation, and broader socioeconomic impact. Concluding his presentation, **Mr. Soni** urged all stakeholders to actively participate in the data collection initiative, noting that accurate economic measurement would enable targeted policy interventions, support investment decisions, and strengthen India's competitiveness in the global space economy.

Inaugural Session

Following the presentation, the conclave transitioned into the inaugural session with welcome remarks by **Lt Gen A.K. Bhatt, PVSM, UYSM, AVSM, SM, VSM (Retd.), Director General of ISpA.** Reflecting on the successes of the previous day-including ministerial addresses, industry recognitions, and the Indo-Japanese dialogue-he observed that the increasing presence of international partners reflects deepening global engagement with India's space ambitions. He outlined the agenda for the day, which would explore themes such as international cooperation, future launch technologies, in-orbit servicing, sustainability, and the expansion of the NavIC ecosystem. **Lt Gen Bhatt** emphasized that the conclave is designed not merely as a forum for discussion but as a catalyst for actionable outcomes that can guide both industry strategy and governmental policy.

The session then featured a special address by **Air Chief Marshal R.K.S. Bhadauria, PVSM, AVSM, VM, ADC (Retd.), Former Chief of the Air Staff, Indian Air Force**, who provided a strategic perspective on the evolving space environment. While acknowledging that "space for the common good" remains a widely shared aspiration, he cautioned that the domain is increasingly shaped by geopolitical competition and national security considerations. For India to command influence on the global stage, he argued, it must build substantial space assets and treat space infrastructure as a component of national critical infrastructure deserving sustained governance and financial support. He stressed the importance of indigenous constellations and warned against excessive reliance on imported systems, drawing parallels with lessons learned from the aerospace and defence sectors. Highlighting the transformative potential of space technologies—from telemedicine and disaster warning systems to nationwide broadband connectivity—he observed that the ultimate objective should be to deliver tangible benefits to every citizen. He also called upon startups to master emerging technologies such as artificial intelligence, quantum systems, edge computing, advanced solar technologies, and cybersecurity architectures, as these will define leadership in next-generation space capabilities.

In his address, **Shri A.S. Kiran Kumar, Member of the Space Commission and Former Chairman of ISRO**, emphasized that global recognition is earned through demonstrated competence rather than asserted capability. Reflecting on India's technological evolution, he recalled the 1975 Satellite Instructional Television Experiment, conducted using a borrowed NASA satellite, which showcased how a developing nation could harness advanced technology for societal transformation. Today, he noted, India collaborates as an equal partner on sophisticated missions such as the NASA-ISRO Synthetic Aperture Radar satellite, an achievement made possible by decades of indigenous capability development. He described space as humanity's "fourth frontier," supporting activities ranging from exploration and tourism to planetary sustainability. However, he warned that increasing congestion and debris pose serious risks, necessitating coordinated global governance. Nations, he argued, must simultaneously strengthen domestic capabilities while collaborating internationally to ensure that space remains accessible and beneficial to all humankind.

The Chief Guest, Smt. Meenakshi Lekhi, Former Minister of State for External Affairs and Culture, delivered a wide-ranging address positioning India as both a technological power and a representative voice of the Global South. She asserted that while established spacefaring nations have historically dominated orbital resources, India occupies a unique centrist position, capable of bridging technological advancement with equitable governance. Stressing that technological progress must be complemented by legal frameworks, she called for stronger mechanisms governing arbitration, resource allocation, and orbital traffic management. India, she argued, should actively shape global regulations rather than remain a passive participant. She also highlighted the country's capacity for high-quality innovation at comparatively low cost, encouraging global investors to engage more deeply with Indian startups. Emphasizing sustainability and collaboration in areas such as climate monitoring and remote sensing, she advocated policy support for women-led enterprises, noting that diversity enhances innovation outcomes. Concluding her address, she remarked that India's progress contributes directly to global welfare, affirming that "if India does well, the world does well."

A recorded message from **H.E. Marjolijn Van Deelen, European Union Special Envoy for Space**, reinforced India's importance as a strategic partner for Europe. Observing that India and the EU together represent nearly one-quarter of global GDP and population, she described the inaugural EU–India Space Dialogue as a milestone in bilateral cooperation. With space becoming increasingly contested, congested, and competitive, she emphasized the need for transparency, responsible behaviour, and multilateral engagement. The European Union, she affirmed, looks forward to deepening structured cooperation with India in the years ahead.

One of the most inspiring moments of the session was the felicitation of **India's astronaut designates, Group Captain Prasanth Balakrishnan Nair, Gaganyatri, Astronaut and Group Captain Angad Pratap, Gaganyatri, Astronaut. Group Captain Nair** described the forthcoming Gaganyaan mission as a historic milestone that will make India the fourth nation capable of independent human spaceflight. He argued that sustained human presence in space will ensure that India has a seat at the table when future space laws are drafted. **Group Captain Pratap** highlighted the clarity of India's strategic intent and acknowledged the decades of scientific effort by ISRO that have made human spaceflight possible. He credited domestic industry partners as co-architects of national capability and noted that expanding opportunities in microgravity research and space tourism could unlock new economic frontiers. Both astronauts emphasized that India stands at an inflection point, with strong governmental support and growing international collaboration shaping the trajectory of its human spaceflight ambitions.

The inaugural session also witnessed several significant institutional announcements. **A Letter of Intent between ISpA and the European Space Agency signaled expanding cooperation between India and Europe.**

A significant milestone for Azista and Take Me 2 Space. The two companies have signed an MoU, officially uniting their teams under a shared vision for the future of New Space. This collaboration brings together Azista's industry-leading space systems manufacturing capabilities with Take Me 2 Space's AI-driven CubeSat technologies to pave the way for a smarter, more accessible space ecosystem.

Amity University and ISpA underscored the importance of academia–industry partnerships in building future talent and research capacity. In further strengthening this bilateral engagement, this MOU was reaffirmed and shared in the presence of Dr. W. Selvamurthy, Dr. A.K. Singh, and Dr. Neeraj Sharma under the Amity Space Mission, reinforcing joint efforts in research, innovation, capacity building, and policy support.

Additionally, the release of a joint publication on In-Space Assembly and Manufacturing (ISAM) highlighted emerging technological capabilities expected to redefine satellite servicing and deep-space infrastructure.

Panel Discussion:
From Vision to Reality: Challenges and Solutions in Realizing India's Space Decadal Vision
Moderator: Mr Pankaj Sharma, Partner – Regulatory Consulting, EY LLP

Panelist:

- **Ms Surbhi Patni Dalmia, Country Head and Director, Novaspace**
- **Brig Adarsh Bhardwaj (Retd) Executive Director, Azista BST Aerospace (ABA)**
- **Mr Abhilash Bhat, Chief of Staff (COS), Pixxel**
- **Ms Geetanjali Kamat, Manager-Legal & Policy, Digantara**
- **Mr Vinay Paliwal, Deputy Director, PMAD, IN-SPACe**

The panel discussion titled “From Vision to Reality: Challenges and Solutions in Realizing India's Space Decadal Vision” brought together policymakers, industry leaders, startups, and legal–policy experts to critically examine the pathways, bottlenecks, and enablers required to translate India's ambitious space decadal vision into tangible outcomes. The session was moderated by **Mr Pankaj Sharma, Partner – Regulatory Consulting at EY LLP**, who set the context by noting that while the opening sessions of the conclave had focused on past achievements and future aspirations, this discussion would concentrate on the “how”—specifically the regulatory, financial, technological, and ecosystem challenges that must be addressed to achieve India's global space ambitions.

Mr. Sharma outlined that India's space decadal vision represents a decisive shift from a government-centric model to a collaborative ecosystem involving academia, startups, private industry, and international partners. He highlighted the strategic move from “Make in India” to “Innovate in India,” emphasizing that recent geopolitical developments have underscored the critical importance of indigenous capability in the space sector. Referring to figures shared earlier in the day, he noted that India's space economy currently stands at approximately USD 8.4 billion and must scale to nearly USD 44 billion, a transition that would require a carefully structured regulatory runway, policy coherence across ministries, and sustained capital inflows.

Responding to the moderator’s opening remarks, **Mr Vinay Paliwal, Deputy Director, PMAD at IN-SPACe**, provided an overview of the Space Decadal Vision and Strategy document released in September 2023. He clarified that the document is not merely aspirational but is anchored in a structured growth plan with clearly identified initiatives and a “whole-of-nation” approach. Beyond the headline target of growing the space economy from USD 8 billion to USD 44 billion, the vision seeks to position India as a strategic space power by strengthening space-based capabilities and maximizing the use of space applications for Earth-centric services. He explained that the strategy is organized around a three-tier framework—space for Earth, access to space, and space for space—with the bulk of economic impact expected to come from Earth observation, satellite communications, navigation, and associated ground infrastructure, followed by launch and satellite manufacturing, and finally emerging domains such as space situational awareness and the in-orbit economy.

Mr. Paliwal further detailed the policy and regulatory initiatives already underway, including the Indian Space Policy 2023, the release of norms, guidelines, and procedures for authorization of space activities, and enhanced access to orbital resources through ITU filings. He noted that non-governmental entities can now file independently or leverage ISRO-origin filings, citing the transfer of a filing to a private operator as an example of faster market entry. Liberalization of foreign direct investment in the space sector, upcoming rules for operationalization, seed funding schemes, and inter-ministerial coordination on royalty rationalization and capacity assessment were highlighted as critical enablers. He emphasized that these measures are designed not only to grow the space economy but also to catalyze broader national economic development through space-enabled services.’

Providing a global market perspective, **Ms Surbhi Patni Dalmia, Country Head and Director at Novaspace**, observed that the pace of progress in India's space sector over the past three years has been unprecedented when compared with other regulated sectors. She described the decadal vision as a potential launchpad, provided certain structural levers are put in place. Chief among these, she argued, is the absence of a long-term, granular demand assessment. Investors, she noted, are unlikely to commit capital to satellite subsystems or component manufacturing without clarity on future demand and financial returns. She advocated for a 20–25 year national demand study covering satellites, subsystems, and components, accompanied by year-on-year supply-chain gap analysis and financial modelling. She also highlighted the need for a coherent national talent strategy, citing international examples such as China's talent-attraction programs, and suggested the creation of a nodal mechanism to integrate fragmented research, centers of excellence, and industrial capability into a unified national roadmap.

From the manufacturing and industrial capability perspective, **Brig Adarsh Bhardwaj, Executive Director at Azista Aerospace**, traced the evolution of India's private space ecosystem to the foundational capabilities built by ISRO over decades. He emphasized that the government's policy direction—particularly the Prime Minister's emphasis on transferring mature capabilities to private industry while ISRO focuses on advanced missions—has been instrumental in enabling scale. Drawing comparisons with global leaders such as the United States and China, he noted that 70–80% of space assets in those countries are operated by private entities, a benchmark India must aspire to. He described Azista's journey from supplying space-grade electronic subsystems to ISRO over the past 15 years to establishing state-of-the-art satellite manufacturing facilities, composite material capabilities, and launching its own satellite as a proof of concept. He stressed that mass manufacturing infrastructure, particularly for low-Earth-orbit satellites, is essential if India is to close the gap in satellite numbers and support both domestic and international demand.

Representing the startup ecosystem, **Mr Abhilash Bhat, Chief of Staff Pixxel**, reflected on the parallel evolution of Pixxel and India's space reforms since 2019. He highlighted that recent policy measures—such as a single-window regulator, clarity on authorization, FDI liberalization, and the creation of a dedicated venture fund—have significantly reduced barriers for private players. He emphasized that achieving the USD 44 billion target requires not only commercialization but global competitiveness, urging Indian companies to build best-in-class technologies rather than limiting themselves to domestic markets. Using Pixxel's hyperspectral satellite constellation as an example, he demonstrated how Indian startups are creating entirely new markets, from precision agriculture and crop disease detection to mineral mapping, while serving both Indian government agencies and global customers such as NASA. He underscored that the decadal vision also acknowledges the need for approximately USD 22 billion in investment, much of which must be mobilized in the early years through strong government procurement and anchor contracts, similar to how the U.S. government supported early aerospace and space companies.

The discussion then turned to emerging and strategic domains with **Ms Geetanjali Kamat, Manager – Legal & Policy at Digantara**, focusing on space situational awareness (SSA). She described SSA as the orbital equivalent of traffic management systems, critical for space security, safety, and sustainability in an increasingly congested orbital environment. She highlighted the progress India has made since the release of the Indian Space Policy 2023, which explicitly encourages non-governmental entities to undertake SSA activities, followed by the development of dedicated SSA

guidelines by IN-SPACe. Drawing comparisons with global practices in the United States, European Union, and Japan, she emphasized the importance of aligning India's SSA framework with international standards while avoiding regulatory overreach that could stifle innovation. She advocated for preferential consideration of indigenous SSA providers, protection of sensitive data, and a consultative, whole-of-nation approach in finalizing guidelines.

A recurring theme across the discussion was the challenge of capital mobilization and demand creation. Panelists collectively noted that while startup funding has increased and policy reforms are moving in the right direction, large domestic conglomerates have yet to fully commit to the space sector at scale. Fiscal incentives, coordinated state-level policies, predictable government procurement, and long-term demand visibility were identified as key levers to attract both domestic and foreign investment. Technological gaps—particularly in space-grade semiconductors, solar cells, propulsion systems, sensors, optics, and launch capacity—were acknowledged as ongoing challenges, with panelists emphasizing the need for targeted R&D support and infrastructure development to reduce external dependence.

Audience Interaction

The session also featured an active audience interaction, with participants highlighting the importance of commercialization milestones such as authorization of launch vehicles, scaling private manufacturing of launch systems, and creating transparent indicators of technological maturity to guide investors. Questions on regulatory independence, inter-agency coordination, and balancing ISRO's dual role as enabler and participant were addressed by reiterating the need for streamlined, single-window processes while maintaining national oversight.

Observation from an Industry Expert:

The speaker commended IN-SPACe for rapidly establishing essential regulatory building blocks, including a national registry and authorization processes. However, they noted that true commercial momentum would begin only when launch vehicle authorizations accelerate and more satellites generate revenue. They suggested creating measurable indicators—such as technology readiness levels and patent benchmarks—to guide investors toward promising ventures.

- **Question by Mr Sachin Sharma, Namra Consulting:** Does hyperspectral imaging have the potential to create entirely new markets for Earth observation where India could lead globally?

- **Answer by Mr Abhilash Bhat:** Mr. Bhat affirmed that hyperspectral imaging is not merely an incremental improvement but a transformative technology capable of unlocking previously inaccessible applications, such as crop disease detection, mineral mapping, and environmental diagnostics. Rather than competing in saturated markets, Pixxel aims to create new ones, positioning India as a technology exporter.

- **Question by Mr Prashant, Aritra Legal:** Should regulatory responsibilities eventually be separated so that ISRO operates on equal footing with private companies?

- **Answer by Ms Geetanjali Kamat:**
  Ms. Kamat explained that the Indian Space Policy already delineates organizational roles but agreed that a streamlined single-window approval mechanism would enhance efficiency. She emphasized that governments worldwide balance public infrastructure with commercial participation, often collaborating with domestic providers to strengthen market pathways while maintaining regulatory oversight.

In his concluding remarks, the **Mr. Pankaj Sharma** summarized that India has made remarkable progress in laying policy, regulatory, and institutional foundations, but achieving the decadal vision will depend on closing gaps in demand creation, investment scale, technological self-reliance, and satcom spectrum availability. He emphasized that satellite communications and Earth observation—together accounting for a significant share of the projected space economy—must be prioritized to unlock the full USD 44 billion potential. The session concluded with a shared optimism that sustained coordination among government, regulators, industry, startups, and investors will enable India not only to realize its decadal vision but also to emerge as a globally competitive and responsible space power.

Session steered by Suhora Technologies

From Data to Decision: Multi-Sensor High-Resolution Earth Observation Insights at Your Fingertips

- **Mr Swan Pant, Vice President Operations at Suhora**
- **Brig Anshuman Narang, 'Atma Nirbhar Soch' Think Tank Startup Founder & Director, Advisor Suhora Technologies**
- **Dr Sultan Singh, Director, Haryana Space Applications Centre (HARSAC), Hisar**
- **Mr Vishwanathan K. Ganapathy, Director, Suhora Technologies**

The session focused extensively on how Earth observation data can be transformed into decision-ready intelligence through integration, analytics, and automation. The session brought together the Suhora team, defence experts, and state-level governance representatives to demonstrate how satellite data aggregation and intelligent analytics platforms are reshaping both civil and strategic decision ecosystems.

The session opened with welcome remarks from **Lt Gen A.K. Bhatt (Retd.), Director General of the Indian Space Association**, who reflected on the evolution of the Suhora team over the past few years. He observed that the organization had grown from being primarily a satellite imagery distributor into a comprehensive solutions provider capable of delivering not just data but contextual intelligence. He emphasized that modern Earth observation is no longer about accessing a single satellite or supplier but about intelligently leveraging multiple constellations, multiple sensor types, and multiple resolutions in a unified manner. This aggregation approach, he noted, enables users to obtain relevant imagery on demand, supported by analytical outputs aligned to operational needs.

The technical presentation was delivered by **Mr Swan Pant, Vice President Operations at Suhora** who began by outlining the structural limitations of earlier satellite-based systems. Traditionally, a satellite provided a limited overpass window—often 20 to 25 minutes—over a specific territory. Revisit times were constrained, cloud cover affected optical sensors, and users had to coordinate manually with vendors to identify acquisition opportunities. Although global satellite operators responded by increasing constellation size, improving swath coverage, and enhancing turnaround time, each constellation typically solved only one operational dimension—either rapid response, wide-area mapping, or high-resolution capture.

Mr. Pant explained that this fragmented model led to inefficiencies. Users would often contact one satellite provider, assess feasibility, and if that option failed due to weather or orbital limitations, move to another provider—resulting in delays and uncertainty. Recognizing this

structural gap, the Suhora team conceptualized SPADE (Space-based Persistent Analytics and Dissemination Environment), an indigenous aggregator platform designed to unify multiple constellations into a single operational interface.

Importantly, **Mr. Pant** clarified that not every available constellation was included in SPADE. The onboarding process was strategic. One of the foremost criteria was daily coverage capability. Natural disasters and critical incidents do not come with pre-alerts, making persistent monitoring essential. Even if imagery captured on a given day is not immediately utilized, it becomes invaluable for retrospective baseline comparison during subsequent analysis. This unique persistent capture capability ensures that users never lack reference data when an unforeseen event occurs.

Another critical selection parameter was turnaround performance. During a critical national event in April and May, SPADE's performance was tested under operational stress conditions. The fastest data delivery achieved was 21 minutes from tasking to receipt. Approximately 92 percent of imagery was delivered within seven hours, with an average turnaround time of close to three hours. Such responsiveness would have been nearly impossible under a fragmented vendor approach. By consolidating constellation A, B, C, and others into a unified platform, SPADE eliminated sequential delays and provided users with parallel acquisition opportunities.

The platform also integrates both day and night imaging, including optical imagery captured under low-light conditions, expanding operational applicability. Furthermore, large-area mapping capabilities allow coverage exceeding 6,000 kilometers through sequential imaging—conceptually enabling mapping from Sri Lanka to near northern China in a structured sequence. While these capabilities originate from satellite and sensor owners, the Suhora team focused on building intelligence around selection and usability.

To enhance decision-making autonomy, SPADE incorporates analytical tools such as the Opportunity Analyzer. This feature provides users with forward-looking acquisition windows—typically up to seven days—without requiring back-and-forth communication with resellers. Users can examine potential capture times, drill down into timestamps, select preferred windows, and directly task satellites. Orders are automatically queued within OEM systems, minimizing latency between user intent and satellite execution.

Another usability innovation is the multi-tasking feature. Recognizing that many organizations require monitoring of corridors or belts rather than single-point imagery, SPADE allows bulk uploading of multiple coordinates and simultaneous tasking in one action. Pant illustrated unified intelligence through a scenario: analyzing a specific location on a particular date revealed six acquisition opportunities from one constellation. By adding additional constellations, this number expanded to twenty-one opportunities, significantly improving acquisition probability.

Role-based access control further strengthens enterprise usability, enabling organizations to deploy internal hierarchies and manage access rights. Commercially, SPADE offers subscription-based access models, tender-based procurement, government marketplace options, and even platform-as-a-service deployments where organizations can host and manage their own instance.

Operational case studies highlighted the platform's practical value. During flash floods in Kishtwar, imagery and analytics were delivered within two days despite cloud challenges. In Punjab, flood extent mapping was completed within forty-eight hours following government request. In Dharali, unexplained water inflow prompted overnight SAR acquisition and damage assessment delivery within twenty-four hours. Within its first year, SPADE facilitated imagery coverage of over one million square kilometers—nearly one-third of India's geographic territory.

The presentation also outlined future enhancements. At least four new sensors are being

onboarded, including capabilities previously unavailable over Indian territory, such as methane emission detection, advanced hyperspectral imaging, and specialized SAR sensors. Planned upgrades include large language model–based natural language query interfaces, SAR layover analysis tools to assess terrain distortion risk before purchase, integrated weather prediction models for cloud-free planning, AIS integration, full-resolution visualization, and readiness for missions such as NISAR.

Following the data acquisition discussion, **Brig Anshuman Narang, 'Atma Nirbhar Soch' Think Tank Startup Founder & Director, Advisor Suhora Technologies** expanded the session toward the transformation of data into intelligence. He emphasized that modern environments are characterized by "swimming in sensors and drowning in data." The real challenge is not acquisition but extraction of meaningful insights. Through platforms like Mirka integrated with SPADE, machine learning engines enable automated feature extraction, road detection, water body monitoring, change detection, deformation analysis, ship and aircraft detection, and infrastructure stability monitoring. He demonstrated how coherent change detection, amplitude analysis, and INSAR-based displacement studies can identify early warning signatures for landslides, structural failures, or strategic movements.

Narang stressed that no single source of intelligence is sufficient; geospatial data must converge with electronic intelligence, open-source intelligence, and human intelligence. Automated data libraries containing thousands of ships, aircraft, and infrastructure patterns enable classification and corroboration, supporting high-value and high-payoff target identification. The overarching objective, he explained, is rapid decision-making within compressed timelines—a concept aligned with the OODA loop.

Providing a governance perspective, **Dr Sultan Singh, Director, Haryana Space Applications Centre (HARSAC), Hisar** discussed how Earth observation supports citizen-centric administration in Haryana. With over 90 percent of the state under agriculture, satellite monitoring supports crop lifecycle tracking, water budgeting at village levels, urban expansion control, environmental compliance enforcement, and flood management. He emphasized democratization of geospatial data and integration across more than thirty departments. While acknowledging challenges such as data overload, institutional fragmentation, policy interpretation variability, and capacity gaps, he highlighted the importance of building enforcement-linked systems and citizen demand-driven services.

The session concluded with remarks from **Mr Vishwanathan K. Ganapathy, Director, Suhora Technologies** who underscored the importance of the Observe–Orient–Decide–Act (OODA) loop in both defence and governance contexts. He explained that platforms like SPADE automate the early stages of this loop—data collection, collation, and contextualization— thereby accelerating decision cycles. Comparing SPADE to an aggregator model similar to ride-hailing services, he noted that users can marshal satellite resources efficiently while maintaining spatial and temporal awareness. When integrated with operational analytics platforms, such systems act as force multipliers across domains.

Overall, the session demonstrated that the future of Earth observation lies not in isolated satellite capabilities but in unified, intelligent ecosystems. By strategically integrating constellations, embedding analytical tools, and empowering users with autonomy, the Suhora team presented a compelling model for bridging the gap between data acquisition and decision-making. The discussions made it evident that the next phase of geospatial intelligence will be defined by intelligent orchestration—where persistent monitoring, rapid turnaround, automated analytics, and multi-domain convergence collectively enable faster, evidence-based action across civil and strategic landscapes.

Panel Discussion: India and Asia in Orbit – Enhancing Regional Cooperation in Space Exploration and Technology

Keynote & Chair: Lt Gen Dushyant Singh, PVSM, AVSM (Retd), Director General, CLAWS
Moderator: Mr Tejas Bharadwaj, Senior Research Analyst, Carnegie India
Panelist:

- **Ms Sujatha Deepak, Head– SATCOM, Alpha Design Technologies (ADTL)**
- **Dr Sarath Raj, Director – Laboratories, Project Director Amity Dubai Satellite Ground Station and AmiSat Amity University Dubai**
- **Dr (c) Sandya Bhat Asnotikar, State President, Karnataka Aerospace Council, WICCI**
- **Mr Jean-Baptiste Thepaut, Principal at Novaspace**
- **Mr Masayuki Urata, Senior Manager, Business Development Division, iSpace**

Lt Gen Dushyant Singh, **PVSM, AVSM (Retd), Director General, CLAW** Sopened the session with a strategic keynote that placed India's space journey within a broader Asian and global context. Recalling India's first satellite launch in 1975, he highlighted how India has progressed to planetary exploration and human spaceflight ambitions through vision, patience, and resource optimization. He emphasized that outer space, once viewed as a global commons, is increasingly becoming a contested domain with military, economic, and strategic dimensions. In this environment, he argued, cooperation in space is no longer optional but essential.

He cited global projections indicating that the space economy has crossed USD 600 billion and may reach USD 1–1.8 trillion by the mid-2030s, with commercial actors accounting for nearly 78% of this growth. Against this backdrop, Asia has emerged as a serious space actor, with India, Japan, South Korea, and ASEAN nations all expanding their capabilities. However, he cautioned that asymmetries—particularly China's overwhelming space capacity, Pakistan's collaboration with China, and North Korea's militarized launches—pose challenges to equitable regional cooperation.

Lt Gen Singh stressed that future collaboration must be grounded in trust, transparency, and shared values rather than naïve optimism. He proposed confidence-building measures such as transparent launch practices, shared satellite data platforms, regional norms for responsible space behavior, and inclusive forums that allow smaller Asian nations to participate meaningfully. A notable proposal from his keynote was the idea of an **Asian Space Station**, envisioned as a shared orbital facility that could democratize access to space research for smaller nations and symbolize Asia's unity in orbit. He concluded by reiterating that space must ultimately serve Earth—supporting disaster management, food security, connectivity, and education—and quoted Dr. A.P.J. Abdul Kalam to remind the audience that "the stars are not divided by borders."

Mr Tejas Bharadwaj, **Senior Research Analyst, Carnegie India** framed the discussion by noting that traditional geopolitics has now expanded into astropolitics. As space becomes integral to national security, supply chains, and economic resilience, Asian countries are increasingly seeking trusted partnerships to co-develop technologies, share infrastructure, and reduce external dependencies. He emphasized that Asia's diversity—ranging from advanced spacefaring nations to emerging actors—creates both opportunities and challenges for cooperation.

Industry Perspective: Satellite Manufacturing, Launch, and Ground Infrastructure

Ms. Sujatha Deepak, Head – SATCOM at Alpha Design Technologies (ADTL), shared the Indian industry's experience in supporting both national and regional space missions. She outlined ADTL's 23-year legacy across defence, aerospace, and space, highlighting its pioneering role as the first Indian private company to undertake assembly, integration, and testing (AIT) of satellites for ISRO. She cited ADTL's work on IRNSS satellites, GSAT-30, and launch vehicle programs including PSLV, GSLV, SSLV, and cryogenic engines.

From a regional cooperation perspective, **Ms. Deepak** emphasized ADTL's role in establishing ground stations and communication networks across South Asia, Bhutan, and Africa, including support for the GSAT-9 regional satellite initiative. She underlined that these projects often have a humanitarian dimension, enabling tele-education, tele-medicine, and disaster connectivity. According to her, India is well-positioned to emerge as a satellite manufacturing and services hub for Asia due to supportive policies such as the creation of IN-SPACe, access to ISRO infrastructure, technology transfer mechanisms, and public–private partnership models.

Academic and Capacity-Building Perspective

Dr. Sarath Raj, Director – Laboratories and Project Director of the Amity Dubai Satellite Ground Station at Amity University Dubai, highlighted the critical role of academia in fostering regional cooperation. He described the Amity Dubai ground station as a fully operational facility where students manage real satellite passes, thereby bridging the gap between theoretical education and industry requirements.

Dr. Raj detailed collaborations with international agencies such as **Japan Aerospace Exploration Agency, Roscosmos**, ISRO, and the Saudi Space Agency. He emphasized that shared infrastructure, common standards, and collaborative training programs are essential for building a skilled Asian space workforce. He also noted that "ground station as a service" offers a scalable cooperation model, allowing countries to access capabilities without duplicating expensive infrastructure.

Data, AI, and the Downstream Space Economy

Dr. Sandya Bhat Asnotikar, State President of the Karnataka Aerospace Council at WICCI and industry leader at SAP, focused on the downstream segment of the space economy. She pointed out that while most investments currently flow into upstream manufacturing, nearly 70% of global space-driven economic value arises from downstream applications such as agriculture, logistics, manufacturing, and disaster management.

She stressed the importance of trusted data ecosystems, sovereign cloud platforms, and AI-driven analytics to transform satellite data into actionable insights for governments and businesses. According to her, regional cooperation should prioritize shared outcomes—economic, societal, and environmental—rather than merely shared infrastructure. She also emphasized the need for startups to build sustainable, recurring revenue models by partnering with large enterprises.

Global Market and Satellite Communications Perspective

Mr. Jean-Baptiste Thepaut, Principal at Novaspace, provided a detailed assessment of the satellite communications sector. He explained how the emergence of large LEO constellations, particularly Starlink, has disrupted the traditional GEO-centric market. With LEO expected to dominate global capacity in the coming decade, regional operators can no longer function independently.

Mr. Thepaut argued that cooperation is now a necessity rather than a choice. He cited examples from Europe and Asia where operators and governments are forming partnerships to share costs, reduce risk, and maintain sovereignty. He proposed that Asia could adopt a federated constellation model, where governments act as anchor customers while commercial operators jointly invest, manufacture, and distribute capacity across domestic and international markets.

Lunar and Cis-Lunar Economy Perspective

Mr. Masayuki Urata, Senior Manager, Business Development at iSpace, discussed emerging opportunities in the lunar and cis-lunar economy. He highlighted ongoing Japan–India collaboration such as the LUPEX mission, which focuses on lunar water exploration. He outlined future commercial opportunities in lunar transportation, technology demonstration, and resource utilization, including water ice and helium-3.

Mr. Urata emphasized that no single nation or company can independently build a sustainable lunar ecosystem. He advocated for strong public–private and international collaboration, supported by government-backed funding programs similar to Japan's space strategy fund. He expressed optimism that aligned ambitions between India and Japan could lead to joint lunar missions and shared cis-lunar infrastructure.

Challenges and Closing Reflections

Across the discussion, panelists acknowledged challenges including regulatory harmonization, spectrum coordination, cybersecurity, geopolitical tensions, and cultural differences across Asia. However, successful initiatives such as Sentinel Asia were cited as proof that cooperation is achievable, particularly in disaster management and Earth observation.

In his closing remarks, **Lt Gen Dushyant Singh** summarized the discussion around three key ideas: first, Asia must leverage collective strength rather than fragmented capabilities; second, geopolitics will persist, so cooperation should begin in low-risk, high-impact domains; and third, extensive data sharing is essential to unlock societal and economic benefits. He concluded by emphasizing that despite Asia's complex history, sustained engagement and trust-building can enable the region to emerge as a collective leader in global space governance.

Panel Discussion: Launch Vehicles and Propulsion Technologies for Space Exploration, LV Markets and the Emerging Challenges

Chair & Moderator: Dr Sudheer Kumar, Former Director CBPO, ISRO HQ

Panelist:

- **Mr Raghavendra BM, Joint General Manager & Head Space Business at L& T Precision Engineering Systems, L&T**
- **Mr George Weinmann, Founder, AstroWorks Ventures**
- **Mr Ashwin Mahavadi, Senior VP, Business - Skyroot Aerospace**
- **Mr Neeraj Khandelwal, Co-founder, Astrobase**
- **Ms Umamaheswari K, Senior Director - Engineering, Agnikul Cosmos**

The session on **"Launch Vehicles and Propulsion Technologies for Space Exploration, LV Markets and Emerging Challenges"** brought together senior industry leaders, policymakers, and startup founders to deliberate on one of the most critical pillars of the modern space economy — reliable, cost-effective, and scalable launch capability. The discussion was chaired and moderated by Dr. Sudheer Kumar, an engineering veteran with over 25 years of contribution to India's space program and current Vice President (Operations & Supply Chain) at XDLINX Space Labs.

Opening Remarks by the Chair

Dr. Sudheer Kumar, Former Director CBPO, ISRO HQ began by acknowledging the rapid transformation of India's space ecosystem following sectoral reforms that encouraged private participation. Startups are now entering satellite manufacturing, applications, and launch services, signaling a strong shift from a government-dominated model to a collaborative industrial ecosystem. He highlighted major government-backed initiatives such as the SBS-III program, which involves satellites being manufactured outside Indian Space Research Organisation support structures — a historic departure from five decades of centralized production.

However, he framed the central dilemma as a "chicken-and-egg" problem: satellite operators need reliable and affordable launch vehicles, but launch providers require sufficient satellite demand to justify scale and investment. While India has operational launch capability, small satellites often fly as piggyback payloads rather than dedicated missions. Ride-sharing, common globally through aggregators like Exolaunch, is still evolving within India due to limited volume.

Dr. Kumar also raised concerns about the future of the small satellite market. By the time emerging launch vehicles mature and build reliability heritage, regulatory shifts and technological changes could potentially compress that market segment. Constellation operators typically prefer launching multiple satellites simultaneously, favoring larger vehicles — another structural challenge for small-launch startups.

Cost emerged as a decisive factor. Piggyback rides are estimated around $10,000 per kg, whereas dedicated launches can cost significantly more. International providers such as Rocket Lab reportedly charge upwards of $25,000 per kg, posing affordability questions for startups. Timeline certainty was another concern — satellite developers must know whether launch opportunities will be available when required.

He emphasized that developing a launch vehicle is a long and capital-intensive journey. Drawing from his experience on heavy-lift programs, he noted that technological maturity, reliability validation, and insurance acceptance typically require multiple successful launches. The industry therefore stands at a crossroads where technological ambition must align with market realism.

Industry Perspectives Manufacturing Strength and Ecosystem Development

Mr Raghavendra BM, L&T Precision Engineering Systems outlined the deep industrial foundation already supporting India's space sector. For over five decades, L&T has partnered with ISRO on launch vehicles, satellite hardware, ground infrastructure, deep-space antennas, hypersonic wind tunnels, and semi-cryogenic engines. More than 70 satellites have flown using their deployment mechanisms.

Drawing parallels with India's defense sector liberalization in 2001, he argued that private participation can rapidly transform capability. Within two decades, India shifted from 90% defense imports to nearly 80% domestic production - a trajectory he believes the space sector could replicate within five to seven years.

A key focus for L&T is supply-chain resilience. Instead of placing fragmented orders, the company provides long-term visibility to vendors, enabling them to scale manufacturing and invest confidently. Maintaining ISRO's rigorous quality systems is seen as essential to preserving the reliability that has historically defined India's launch success.

Global Market Lessons

Mr George Weinmann, Founder of AstroWorks Ventures and former Blue Origin Executive, brought an international perspective. Reflecting on his early work with the multinational Sea Launch program, he observed that transformative aerospace ideas often require decades to mature. Many promising concepts — from early broadband constellations to next-generation launch systems — initially fail before being revived successfully by later innovators.

He urged stakeholders to question whether emerging markets such as space-based solar power or orbital data centers are immediate opportunities or long-term prospects. Large reusable vehicles, for example, only become viable when sufficient demand exists to utilize their massive lift capacity.

Weinmann identified **market aggregation** as the core strategic challenge. No single country outside the United States currently has enough demand to sustain multiple launch providers independently. Rather than mandating domestic launches through policy — which could trigger reciprocal protectionism globally — nations should collaborate to build scale.

According to him, achieving approximately **20 launches per year** is the threshold for global competitiveness. The solution lies not in choosing between companies but in expanding the market so multiple players can thrive while ensuring assured access to space.

Small Launch Strategy and Market Segmentation

Mr Ashwin Mahavadi, Senior Vice President at Skyroot Aerospace, emphasized that the launch sector is not monolithic; it spans small, medium, and heavy vehicles with distinct economics. Skyroot's orbital launcher, Vikram-1, is targeting its maiden launch soon and is primarily focused on the dedicated small-satellite segment.

He argued that India holds a strategic advantage in small launch vehicles, where Rocket Lab is currently the dominant operator. However, the dedicated-launch market is niche, and timing is critical — companies entering early capture the most value.

Ride-share economics remain difficult to match because SpaceX offers prices starting near $7,000 per kg. Achieving similar competitiveness requires either reusable technology or radically optimized manufacturing.

Mahavadi also underscored a broader business reality: satellite operators view launch as a cost center. Lower transport cost directly improves their profitability, making cost reduction a non-negotiable priority for launch providers.

Medium-Lift Vision and Economic Sustainability

Mr Neeraj Khandelwal, Co-founder of Astrobase, presented a financial lens. Using broadband satellites as an example, he noted that a satellite may generate roughly $20,000 per kg across its operational life. For a business to survive, manufacturing, launch, and operational expenses must remain below that threshold.

His company is developing a liquid-fueled medium-lift vehicle capable of carrying around three tons to low Earth orbit, targeting dedicated launches. He stressed that solving launch economics is essential not only for company viability but also for enabling the broader national space ecosystem.

Engineering Innovation and Startup Preparedness

Ms Umamaheswari K , Senior director of Engineering, Agnikul Cosmos contributed to the broader discussion on innovation readiness and emerging launch architectures, representing the growing confidence of Indian startups entering orbital-class capabilities after successful suborbital demonstrations.

Strategic Themes Emerging from the Panel

1. Demand Creation is Fundamental

Panelists agreed that technology alone cannot sustain launch providers. Governments must actively stimulate upstream demand — whether through defense constellations, environmental monitoring, maritime surveillance, or national broadband infrastructure.

2. Policy Support Without Protectionism

Rather than enforcing domestic launch mandates, policymakers should consider mechanisms similar to early NASA contracts that helped American companies survive their formative years.

3. Collaboration Over Competition

India's ecosystem — manufacturers, launch providers, satellite builders, and application developers — must evolve collaboratively. Vertical integration, as demonstrated by global leaders, enhances competitiveness.

4. Cost Optimization Through Manufacturing Scale

Reusable systems, optimized infrastructure, and industrial-scale production are essential to lowering launch costs and attracting international customers.

5. Reliability and Heritage Still Matter

Insurance markets and satellite operators demand proven flight records. Building this heritage requires sustained launch cadence — reinforcing the need for aggregated demand.

Concluding Observations

Dr. Sudheer Kumar summarized the discussion by emphasizing that India must accelerate demand generation, particularly for sovereign capabilities such as ISR constellations, maritime monitoring, and defense networks. Rapid policy execution — rather than prolonged evaluation cycles — will be crucial in supporting emerging launch providers during their formative years.

The session ultimately highlighted that India's launch vehicle ecosystem is transitioning from aspiration to operational reality. Yet its long-term success will depend on synchronized action across policy, industry, finance, and technology. With startups approaching production readiness and government recognizing the urgency of demand creation, the coming decade may determine whether India evolves into a globally competitive launch powerhouse.

"Habspace" Concept – A New Model for International Human Space Infrastructure

The session featured a forward-looking presentation by **Mr George Weinmann** of **Astroworks Ventures**, who introduced the innovative "**Habspace**" concept—an internationally owned and commercially operated space habitat designed to support the next era of human spaceflight after the retirement of the **International Space Station (ISS)**.

Mr. Weinmann began by acknowledging the growing global momentum toward human space exploration, particularly efforts such as **India's Gaganyaan program**. He emphasized that culture, cooperation, and shared ambition will be as important as technology in shaping humanity's expansion into space. According to him, human culture is not merely a social force but also a powerful economic driver that must be integrated into future space strategies.

The Post-ISS Challenge

Mr. Weinmann noted that the ISS—built on decades of collaboration following earlier stations such as Salyut, Skylab, and Mir—has served as humanity's most successful orbital platform for over 25 years. However, its eventual retirement raises a critical question: **what infrastructure will replace it, and how will international partners participate?**

While **NASA** plans to transition toward commercially operated Low Earth Orbit (LEO) destinations—where private companies build stations and governments become customers—this shift introduces new complexities. Historically, space partnerships operated on barter-style government cooperation, exchanging resources and capabilities. In contrast, commercial platforms function on financial liquidity, requiring agencies to purchase services.

This model presents a dilemma for non-U.S. governments: countries prefer investing domestically rather than sending large financial outflows abroad. Therefore, a new collaborative framework is needed—one that balances commercial efficiency with national strategic interests.

Learning from History – The Intelsat Analogy

To address this challenge, Weinmann drew inspiration from Intelsat, the international satellite communications consortium formed in the 1960s. At a time when satellite telecommunications were unproven, Intelsat succeeded by making participating nations both **users and owners** of the infrastructure.

Its governance structure included three layers:

- A **political layer** ensuring cooperation and policy alignment
- An **investment layer** funding satellite development
- A **management and user layer** maintaining commercial viability

This cooperative ownership model expanded rapidly—from seven founding members to over 100 countries within a decade—and demonstrated that shared infrastructure could drive global adoption of emerging technologies.

Weinmann proposed applying this same framework to human spaceflight.

Introducing Habspace – An Internationally Owned Orbital Habitat

The Habspace initiative envisions a consortium of nations jointly financing and operating a habitat module that would attach to an existing commercial space station. Unlike purely national or private platforms, Habspace would be international from inception.

Key structural features include:

- Project financing led by investors from participating countries
- Space agencies as primary users, ensuring guaranteed utilization
- Shared ownership, allowing nations to invest in infrastructure rather than merely purchasing access

Weinmann stressed that similar financing structures already support large terrestrial projects such as pipelines, ports, and power plants—suggesting that extending this approach to space is both feasible and logical.

The benefits are threefold:

1. Lower participation costs through shared investment
2. Enhanced technological collaboration
3. Development of a broader commercial ecosystem supporting private missions

Design Philosophy – Neutral, Expandable, and Resource-Rich

The proposed habitat would prioritize compatibility with multiple commercial LEO station providers rather than aligning with a single operator. This neutrality ensures that participating nations retain flexibility while maintaining cooperation with major partners such as NASA.

Mr Weinmann highlighted two resources that space infrastructure can never have in excess: **ports and power**. Accordingly, the station would be designed with abundant docking interfaces and energy capacity to support expansion.

The architecture is modular and phased:

1. **Habspace-1** – a living and working habitat
2. **Logistics node** – expanding operational space
3. **Laboratory and factory modules** – transitioning from basic science to applied engineering and production

4. **Large-scale logistics carriers and warehouse facilities**

Ultimately, the station could exceed **1,470 cubic meters in volume** with approximately **400 kilowatts of power**, surpassing the capabilities of the ISS. Such scale would enable not only research but also manufacturing in orbit.

Governance Model – Three Operational Levels

Echoing the Intelsat structure, Habspace would operate across three governance tiers:

- **Community of nations** setting policy and strategic direction
- **Investor board** providing capital and fiduciary oversight
- **User framework** defining allocation of onboard resources

This structure aims to balance political cooperation with commercial discipline—ensuring both accountability and operational efficiency.

Financial Accessibility – Expanding Participation

Mr Weinmann proposed an initial membership of **8–12 countries**, each contributing capital toward construction and paying annual utilization fees. Over time, membership could expand as more nations develop space ambitions.

Recognizing disparities in national budgets, he suggested a tiered model where smaller countries could form consortia and jointly purchase participation rights. This approach could reduce annual costs from roughly **$150 million to about $20 million per country**, dramatically broadening access to human spaceflight.

Commercial Growth and Return on Investment

Economic modeling presented during the session indicated that even if only government agencies used the facility, the project would remain viable. However, the true growth driver is the expanding private astronaut market.

Human space missions have increased from roughly one per year two decades ago to multiple privately funded missions annually. If this trajectory continues into the 2030s and 2040s, Habspace could generate substantial financial returns for member nations—mirroring Intelsat's transformation into a profitable global enterprise.

Preparing for the Logistics Revolution

Mr Weinmann underscored that falling launch costs—driven by next-generation heavy-lift vehicles—will fundamentally reshape orbital economics. Large cargo systems will reduce transportation costs from tens of thousands of dollars per kilogram to far lower levels.

Yet logistics remain the largest expense in space station operations. A small station paired with massive cargo capacity would be inefficient; therefore, future habitats must be designed for expansion to fully leverage these logistical advances.

Orbital destinations, he argued, will function as hubs aggregating talent, capital, and experimentation—but their success will depend on scalable transport infrastructure.

Global Industrial Participation

A notable aspect of the Habspace vision is its openness to international manufacturing. Mr Weinmann remarked that relevant capabilities already exist across India, Japan, Europe, the Middle East, and other regions. The challenge is no longer technological readiness but organizational coordination.

By structuring cooperation effectively, countries can collectively build the next generation of orbital infrastructure while ensuring domestic economic benefits.

Strategic Significance

The Habspace concept represents a shift from purely government-led stations toward **shared commercial sovereignty**-where nations invest in assets they co-own rather than purchasing access from external providers.

Its broader implications include:

- Democratizing participation in human spaceflight
- Lowering entry barriers for emerging space nations
- Accelerating commercialization of orbital manufacturing
- Strengthening multinational governance frameworks

Mr George Weinmann concluded by announcing that discussions with prospective partner nations have already begun following the project's launch at an international forum. He invited feedback from stakeholders worldwide, expressing optimism that coordinated global effort could deliver a scalable, economically viable successor to the ISS.

The presentation reinforced a central message of the conclave: **the future of human spaceflight will not belong to any single nation-it will be built through structured international collaboration, shared investment, and commercially sustainable infrastructure.**

Panel Discussion: "International Partnerships in Space: Catalyzing Growth in the Global Space Economy"

Chair & Moderator: Dr Vinod Kumar, Director, Promotion Directorate, IN-SPACe

Panelist:

- **Mr Noel Ballot, Senior Vice-President Sales & Marketing, Safran Space**
- **Dr Sergio Ledda, Scientific Attache' Embassy of Italy in India**
- **Mr Rainer Horn, Partner & MD, Novaspace**
- **Mr Jérémy Hallakoun, Dir. Strategy, Legal and External Affairs European and External Relations Department DG Cabinet – Member States relations ESA HQ**
- **Mr Nathan Davis, Trade & Investment Commissioner , Australian Trade & Investment Commission (Austrade)**
- **Mr Louis Vermersch, Trade Advisor, Business France, Embassy of France in India**

Dr. Vinod Kumar, **Director, Promotion Directorate, IN-SPACe** began by emphasizing that India has entered a transformative phase in its space journey following the government's decision in 2020 to open the sector to private participation. With the creation of IN-SPACe as both regulator and promoter, India has defined clear roles for major stakeholders including **Indian Space Research Organisation (ISRO), NewSpace India Limited**, and non-government entities.

He outlined India's strategic vision of capturing nearly **8% of the global space economy**, supported by policies that enable access to finance, infrastructure, and technology. Key initiatives include seed funding grants, a technology adoption fund, venture capital support, and the development of manufacturing clusters in partnership with state governments such as

Gujarat, Tamil Nadu, and Karnataka. Capacity-building efforts—ranging from specialized training programs to academic curricula—are nurturing a skilled workforce essential for sustaining growth.

Dr. Kumar addressed that while domestic capabilities are expanding, international collaboration remains indispensable. Space, he noted, transcends national borders, and partnerships will be critical for innovation, commercialization, and scaling India's space ecosystem.

India–Italy Cooperation – Complementarity and Co-Production

Dr Sergio Ledda, Scientific Attache' Embassy of Italy in India, highlighted the strengthening relationship between the two nations following the joint action plan announced by their prime ministers. He confirmed that Italy is in the process of appointing a dedicated space attaché in India to deepen institutional and industrial engagement.

Dr. Ledda reflected on a recent Italian business delegation comprising 13 companies—ranging from large aerospace firms to small enterprises—that toured Hyderabad, Bengaluru, and Delhi. The delegation interacted with over **200 Indian companies**, resulting in technology exchanges, knowledge sharing, and the groundwork for future collaborations. Several firms even expressed interest in relocating manufacturing activities to India.

He identified three priority areas for joint research and development: Earth observation constellations, heliophysics, and lunar exploration. Notably, India and Italy already share satellite data and scientific talent through longstanding cooperation between their space agencies. Looking ahead, **Dr. Ledda** advocated shifting from procurement-based relationships toward **co-production models**, enabling both nations to jointly develop technologies that enhance civilian applications and improve quality of life.

Supply Chains and Manufacturing – Safran's Perspective

Mr Noel Ballot, Senior Vice-President for Sales and Marketing at Safran, discussed the importance of resilient supply chains amid geopolitical disruptions. He noted that Safran has already begun manufacturing in India and delivered its first products to Indian space organizations, calling the move mutually beneficial.

However, he pointed to challenges in sourcing high-quality mechanical suppliers—particularly in surface processing and coatings—despite strong capabilities in electronics and software development. Ballot emphasized that India has a significant opportunity to attract component manufacturers currently concentrated in Taiwan and the United States, many of whom are exploring diversification into Vietnam and India.

From a market perspective, he identified the Indo-Pacific, Middle East, Singapore, and Vietnam as promising growth regions. Safran is actively encouraging design and manufacturing in India not only for domestic use but also as an export base for these emerging markets.

Investor Sentiment – Why Global Capital Is Watching India

Mr. Rainer Horn, Partner and Managing Director at Novaspace, provided insights into how global investors perceive India's private space sector. He distinguished between strategic investors—who view India as a large market with rising demand for telecommunications and

Earth observation—and financial investors, who prioritize return on investment regardless of geography.

Mr Horn explained that venture capital operates on a high-risk model, expecting only a few startups to deliver substantial returns. To attract such capital, governments must mitigate early-stage risks through grants, contracts, and co-investment mechanisms. He advised India to lower export barriers and target markets in the Middle East, East Asia, and the Global South, particularly in areas restricted by U.S. export controls such as ITAR. Building indigenous capabilities in these domains could position India as a competitive alternative supplier.

European Space Agency – Building Long-Term Strategic Partnerships

Representing the **European Space Agency, Mr. Jeremy Hallakoun** emphasized that strengthening cooperation with India is central to ESA's long-term strategy. With over five decades of collaboration with ISRO, the partnership is expanding beyond Earth observation and navigation to include exploration missions—both human and robotic.

Mr Hallakoun noted that ESA's internal structure already embodies international cooperation among its 23 member states, offering valuable lessons for managing complex multinational programs. He stressed the need for institutions to remain competitive by improving relations with industry; for example, ESA has reduced contract timelines by 50%, enabling faster project execution.

He also highlighted the growing intersection between space, diplomacy, and geopolitics, arguing that reliability and long-term commitment are essential traits of successful partners. Future collaborations with India, he suggested, will focus on balanced contributions where both sides bring complementary strengths.

Australia – Geography as a Strategic Advantage

Mr. Nathan Davis, Trade and Investment Commissioner at the Australian Trade and Investment Commission (Austrade), outlined Australia's value proposition as a global space partner. Its southern hemisphere location, stable regulatory framework, strong research institutions, and incubator ecosystem position the country as a critical node in the global space architecture.

He identified three underutilized opportunities:

- **Ground and launch services**, supported by clear skies, minimal radio interference, and low air traffic.
- **Space situational awareness**, driven by increasing orbital congestion and supported by advanced radio telescope infrastructure.
- **Climate and maritime data services**, where satellite analytics help address drought, extreme weather, illegal fishing, and regional security challenges.

Mr Davis also explained that while free trade agreements do not directly target the space sector, they create enabling conditions by lowering tariffs and facilitating supply chains. Complementary frameworks—such as economic roadmaps and commercialization partnerships—then translate these agreements into tangible space collaborations.

France – From Historic Technology Transfer to Industrial Integration

Mr. Louis Vermersch, Trade Advisor at Business France, traced the India–France partnership back to 1964, highlighting the French-origin technology behind the Vikas engine as a symbol of enduring cooperation. Today, the relationship has expanded to include missions such as TRISHNA and collaboration on India's human spaceflight program.

Mr Vermersch argued that the partnership is entering a new phase driven by startups and industry alliances. French firms are exploring joint manufacturing opportunities with Indian suppliers in avionics, propulsion, deployable structures, and satellite subsystems. Launch collaboration is also evolving, with emerging players on both sides supporting small constellation deployments.

He summarized three strategic priorities:

1. Joint manufacturing and industrial integration
2. Shared launch infrastructure
3. Stronger private-sector partnerships

By combining French engineering expertise with India's industrial scale, he suggested, both countries could build a resilient and globally competitive supply chain.

Audience Interaction – Trade Agreements and the Space Sector

An audience question addressed whether space plays a role in free trade negotiations between India and European countries. Responding from the Australian perspective, **Mr. Nathan Davis** clarified that trade agreements typically establish the economic foundation—reducing tariffs and enabling flows of goods—while sector-specific collaboration emerges through complementary frameworks and bilateral initiatives built upon that base.

In his concluding remarks, **Dr. Vinod Kumar** highlighted several themes emerging from the discussion:

- Strong participation from Italian companies signals growing industrial synergy.
- Supply chain resilience requires deeper investment in manufacturing capabilities within India.
- Export facilitation and regulatory alignment will help startups scale globally.
- Partnerships must increasingly involve private industry alongside national agencies.
- Australia and France offer promising models for collaborative innovation and commercialization.

He reaffirmed India's commitment to creating a level playing field through supportive policies, tax incentives, and dialogue on export controls, while encouraging international partners to expand manufacturing and technology development within India.

MoU Exchanges – Translating Dialogue into Action

The session concluded with the announcement of strategic Memoranda of Understanding, including a partnership between **Inbound Aerospace and Research Sat** focused on

microgravity research and space-based biotechnology, as well as another agreement with Blue Ocean Innovations to conduct stem-cell experiments aboard the **International Space Station**. These agreements demonstrated how international partnerships are already translating into tangible scientific and commercial initiatives.

Sustaining Space Operations: In-Orbit Technologies, Debris Management, and Space Weather Hazard Mitigation

Moderator: Mr Akshat Johri, Assistant General Manager, IIFCL Projects Ltd.

Panelist:

- **Prof Varun Sheel, Senior Professor & Head-Planetary Science, Physical Research Laboratory, Ahmedabad. (Dept. of Space, GoI)**
- **Mr Sakthikumar R, Founder & CEO, OrbitAID Aerospace**
- **Mr Aditya Singh, Founding Member, VP Growth, BQP**
- **Mr Ray Fielding, Head of Sustainability & ISAM, UK Space Agency (Hybrid)**
- **Mr Zayed Mohammed , Sales Engineer - Digantara**
- **Ms Alisha Contractor, Chief Mission Operations at Kepler Aerospace**

The session on **"Sustaining Space Operations: In-Orbit Technologies, Debris Management, and Space Weather Hazard Mitigation"** highlighted one of the most pressing challenges confronting the global space ecosystem — ensuring that orbital activities remain safe, sustainable, and operational despite the rapid increase in satellite launches and technological complexity.

The session was moderated by **Mr. Akshat Johri from the India Infrastructure Finance Company Limited (IIFCL)**. The panel brought together scientists, industry leaders, startup founders, and international policymakers, collectively emphasizing that sustainability in space is no longer a theoretical discussion but an operational necessity requiring coordinated global action.

Providing a scientific perspective, **Prof. Varun Sheel, Senior Professor and Head of Planetary Science at the Physical Research Laboratory (PRL), Ahmedabad**, described space weather as a domain that is becoming as important as terrestrial weather forecasting. He explained that solar activity is the primary driver of disturbances in near-Earth space, manifesting through electromagnetic radiation such as X-ray flares and coronal mass ejections, as well as streams of charged particles known as solar wind.

These phenomena can disrupt satellite communication, damage onboard electronics, and pose risks to astronauts. India has made significant progress in this field through the Aditya-L1 mission, positioned at a Lagrange point that enables uninterrupted observation of the Sun. Equipped with multiple payloads, the spacecraft continuously measures radiation and particle

flux, generating data that is transmitted daily to ground stations for analysis. Complementing this are terrestrial monitoring networks consisting of magnetometers and atmospheric sensors that help forecast geomagnetic storms. Prof. Sheel explained that although Earth's magnetosphere shields the planet from most solar radiation, extreme events can penetrate this barrier, making predictive modeling essential. Advances in physics-based simulations, supported by high-performance computing, are steadily improving forecasting capabilities. As observational datasets expand, these models are expected to achieve greater accuracy, marking a major step toward reliable space weather prediction.

Discussing the technological and commercial landscape, **Mr. Sakthikumar R, Founder and CEO of OrbitAID Aerospace**, outlined the major challenges faced by startups working in the emerging field of In-Orbit Servicing, Assembly, and Manufacturing (ISAM). He identified three critical gaps - technology readiness, financing, and regulatory clarity. Transitioning from laboratory validation to flight demonstration requires sophisticated infrastructure such as microgravity testing facilities and rendezvous simulation platforms, which have historically been limited in India. Consequently, early experiments had to be conducted abroad before indigenous facilities were developed. Financing remains another hurdle because ISAM represents a nascent market that demands high capital investment with long gestation periods. Initial support from a state government helped establish credibility and attract private investors, demonstrating the catalytic role of public funding in emerging sectors. Mr. Sakthikumar stressed that regulatory frameworks must evolve in parallel with technological progress; while several countries have begun developing ISAM policies, India must establish similar guidelines to remain globally competitive. OrbitAID's long-term vision involves building a globally accessible servicing ecosystem capable of refueling satellites, performing inspections, and enabling docking operations. Achieving interoperability through standardized docking ports and refueling interfaces will be essential for seamless international collaboration.

Offering an international policy perspective, **Mr. Ray Fielding, Head of Sustainability and ISAM at the UK Space Agency**, emphasized that debris mitigation is fundamentally a global responsibility. The United Kingdom initially focused on debris prevention but has since expanded its strategy into a comprehensive ISAM capability roadmap that aligns national technology investments, establishes operational standards, and supports demonstration missions. A flagship debris removal initiative aims to capture multiple defunct objects while remaining refuelable for extended operations. Mr. Fielding highlighted the urgent need for regulatory alignment across nations; without it, servicing another country's satellite could be misinterpreted as hostile action. Technical standardization is equally critical to prevent incompatibility in docking and refueling systems. He also underscored the importance of private capital, noting that governments alone cannot sustain the financial demands of large-scale debris removal programs. Innovative regulatory approaches — including liability incentives and insurance-linked mechanisms — could encourage responsible practices while attracting commercial investment. Ultimately, partnerships, shared standards, and collaborative missions will be essential for scaling sustainable orbital operations.

From a computational innovation standpoint, **Mr. Aditya Singh, Founding Member and Vice President (Growth) at BQP**, discussed how advanced technologies such as quantum computing and artificial intelligence can transform space safety. Managing tens of thousands of objects — and potentially millions of smaller fragments — introduces enormous uncertainty that traditional models struggle to address. Quantum-enabled simulations allow simultaneous evaluation of multiple probabilities, significantly enhancing predictive reliability compared to sequential classical methods. When combined with AI and physics-based algorithms, these tools can improve collision avoidance strategies, maneuver planning, and space weather forecasting. Mr. Singh emphasized that reducing uncertainty is the central objective and that achieving it will require strong collaboration between data providers, modeling platforms, and national space agencies.

Highlighting the infrastructure required for predictive capabilities, **Mr. Zayed Mohammed, Sales Engineer at Digantara**, described space situational awareness as the foundational layer of sustainable operations. Satellite movement is influenced by several variables, including atmospheric drag, solar radiation pressure, and geomagnetic disturbances, making accurate tracking indispensable. Digantara employs a multi-sensor architecture integrating optical systems, radar, radio-frequency monitoring, and laser-ranging technologies across global locations, complemented by space-based sensors capable of observing vast orbital regions. The organization is also developing indigenous space weather density models that estimate atmospheric drag — information that is often restricted internationally — thereby improving predictive accuracy. By combining hardware, analytics, and weather intelligence, such infrastructure enables safer navigation and supports emerging ISAM activities.

Operational sustainability was further examined by **Ms. Alisha Contractor, Chief Mission Operations at Kepler Aerospace**, who emphasized that sustainability must be embedded into mission architecture rather than treated as a compliance requirement. Her organization operates a globally distributed network of ground stations to ensure uninterrupted telemetry and reduce the need for emergency maneuvers. Continuous integration of situational awareness data allows autonomous conjunction screening, fuel optimization, and predictive health monitoring. Importantly, end-of-life strategies are incorporated from the earliest design stages, reinforcing the idea that responsible orbital behavior must begin at mission conception.

During the interactive segment, the moderator raised concerns about the possibility of the Kessler Syndrome, a cascading collision scenario in which debris fragments trigger further impacts and potentially render certain orbital regions unusable. Panelists acknowledged that such events are scientifically plausible and noted the increasing frequency of collision-avoidance maneuvers, which consume fuel and shorten satellite lifetimes. Preventive strategies

such as active debris removal, satellite refueling, improved tracking infrastructure, and enhanced global data sharing were identified as critical countermeasures.

The session concluded with a strong consensus that sustaining space operations will require a multidimensional approach integrating scientific research, technological innovation, regulatory harmonization, and international cooperation. Predictive modeling, advanced sensing infrastructure, and in-orbit servicing technologies are poised to become central pillars of orbital sustainability. Equally important is the recognition that outer space is a shared domain; safeguarding it demands collective responsibility from governments, private enterprises, and research institutions alike. As satellite constellations expand and commercial activity accelerates, the ability to maintain a secure and sustainable orbital environment will ultimately shape the future of space exploration and the global space economy.

Panel Discussion : "The Future of Space Exploration: Humans in space, Space Stations, Habitation on Moon & Mars, Deep Space missions, Human physiology and Health Systems for Space Missions."

Keynote Address: Shri D K Singh, Director, Human Space Flight Centre (HSFC), ISRO
Moderator: Gp Capt TH Anand Rao (Retd), Director ISpA
Panelist:

- **Ms Naoko Yamazaki, Former JAXA Astronaut**
- **Gp Capt PB Nair, Astronaut Designate, ISRO**
- **Gp Capt Angad Pratap, Astronaut Designate, ISRO**
- **Air Vice Marshal A Agarwal, VSM (Retd), Former ACAS (Med), Air HQ, Indian Air Force**
- **Dr Sowgandhi N Chaturvedula, Registered Clinical Psychologist (Associate), Dept of Aviation and Space Psychology, Institute of Aerospace Medicine, Indian Air Force**
- **Mr Hanamantray Baluragi, Director, DHSP ISRO HQ**

The concluding session of the conclave shifted attention from the commercial dimensions of space toward the long-term human future beyond Earth. **Shri D. K. Singh, Director of the Human Space Flight Centre (HSFC)** opened the session by contextualizing humanity's place within the vast universe, emphasizing that space exploration is both a humbling reminder of cosmic scale and a powerful driver of technological ambition. Addressing the long-standing debate between robotic and human missions, he argued that the future lies in synergy—robots can validate technologies and reduce risks, but humans remain indispensable for handling unknown scenarios and advancing exploration.

He outlined the scientific and societal returns of human spaceflight, highlighting breakthroughs in medicine, materials science, robotics, and life-support engineering. Such systems, designed for extreme efficiency and circular resource usage, could transform sustainability practices on Earth.

Singh presented India's **Vision 2047 roadmap**, structured around four progressive stages:

- Building Low Earth Orbit capability through the Gaganyaan mission
- Developing an indigenous space station, beginning with a technology demonstrator by 2028
- Expanding capabilities for sustained orbital habitation

- Preparing for a crewed lunar mission by 2040

Critical enabling technologies include heavy-lift launch vehicles, docking systems for lunar orbit, and in-situ resource utilization. He concluded that success will depend on four pillars: government vision, private-sector agility, academic knowledge, and international collaboration.

Global Perspective – International Cooperation in Human Spaceflight

Ms Naoko Yamazaki, Former JAXA Astronaut reflected on her mission aboard the **Space Shuttle Discovery** and work on the International Space Station (ISS), emphasizing that the coming decade will be defined by multinational cooperation. She highlighted complementary strengths between India and Japan—ranging from astronaut training to life-support technologies—and envisioned future missions where Asian astronauts work together on lunar and deep-space exploration.

Yamazaki also compared training approaches: NASA emphasizes practical operational skills, while Russian systems focus deeply on technical principles. Across agencies, however, astronauts devote nearly 80–90% of training to anomaly management and emergency preparedness. Cultural understanding and trust-building—often cultivated through outdoor leadership programs—are essential for mission success.

India's Human Spaceflight Philosophy – Innovation, Inclusion, and Resilience

Astronaut-designate Prashanth Balakrishnan Nair argued that India's cultural and educational ecosystem naturally fosters resilience and inclusion—traits critical for long-duration missions. He called for a "whole-of-nation approach," integrating government, private industry, and civil-military collaboration.

Drawing from philosophical traditions, Nair linked innovation to intellect (buddhi), resilience to physical and mental strength, and inclusion to expanded ego beyond individual interests. He urged stakeholders to adopt geopolitical thinking, ensuring technologies are designed with global strategic relevance.

The Astronaut Mindset – Beyond a Profession

Astronaut Angad Pratap described being an astronaut not merely as a role but as an attitude characterized by multidisciplinary excellence. According to him, astronauts must balance scientific knowledge, physical fitness, communication skills, and behavioral competence while constantly pushing personal boundaries.

As members of India's early human spaceflight cohort, astronauts are directly involved in spacecraft design, simulator development, and human-machine interface optimization—responsibilities rarely faced by astronauts in mature programs. This pioneering role demands adaptability and continuous learning.

Team Dynamics and Trust in Space Missions

Astronaut Angad Pratap further emphasized that astronauts function as intelligent subsystems within a larger operational architecture that includes mission control. Effective teamwork requires significant "unlearning," as professionals from diverse fields must recalibrate their expertise to operate cohesively.

Nair added that the most striking lesson from international training programs was the process oriented culture underpinning space operations. He advocated civil-military fusion as a model for India, arguing that seamless integration of defence and civilian innovation has accelerated space progress globally.

Psychological Selection and Human Factors

Dr Sowgandhi N Chaturvedula, Registered Clinical Psychologist (Associate), Dept of Aviation and Space Psychology, Institute of Aerospace Medicine, Indian Air Force provided rare insights into astronaut psychological screening. Key attributes include curiosity, emotional stability, fear management, and the ability to cope with uncertainty -including fear of death. She stressed that coping strategies must be individualized; psychological resilience cannot be standardized.

Training incorporates mindfulness, behavioral monitoring, and AI-assisted analysis of speech and body language to detect early warning signs. For long-duration missions—such as those exceeding a year in orbit—astronauts rely heavily on trust in their training and strong interpersonal support systems.

Status Update – India's Human Spaceflight Program

Mr Hanumantharayappa Baluragi delivered a technical overview of India's progress toward its first crewed mission. Development efforts currently focus on four pillars:

- Human-rated launch vehicle
- Crew escape system for emergency scenarios
- Orbital module enabling safe travel and return
- Rigorous astronaut training

Multiple tests-including parachute-based deceleration from hypersonic speeds—have been completed. An uncrewed mission is planned soon, with the first crewed flight targeted for 2027. Key challenges include ensuring astronaut safety, validating life-support systems, and aligning industrial production with program requirements.

Aerospace Medicine and Commercial Opportunities

Air Vice Marshal A Agarwal, VSM (Retd), Former ACAS (Med), Air HQ, Indian Air Force highlighted a frequently overlooked reality: rockets account for only about **25% of human spaceflight expenditure**, while **75% lies in non-rocket domains** such as life-support, habitats, and human-use technologies. With the commercial space economy projected to expand significantly, industries ranging from textiles to healthcare could participate—even in areas as specialized as space suits or onboard consumables.

His message to industry was unequivocal: the human-centered segment of the space economy represents a multi-billion-dollar opportunity.

Engineering Safety – Radiation and Orbital Debris

Mr Hanumantharayappa Baluragi also addressed spacecraft safety. The commonly used orbital band around 370–450 km represents a balance between atmospheric drag and debris density. Protective strategies include multi-layer shielding, specialized materials such as Kevlar, radiation barriers, and designated safe zones within spacecraft. Objects larger than 10 cm are tracked, while shielding protects against smaller high-velocity particles.

Future Astronaut Training Ecosystem

Responding to audience queries, Shri Singh explained that India is gradually building domestic training infrastructure in collaboration with national agencies. As missions expand toward lunar exploration, astronaut corps size will increase, necessitating advanced facilities and specialized trainers.

Lessons from International Missions

When asked about insights from private orbital missions, Shri Singh noted that researchers gained valuable experience designing microgravity experiments and understanding human-machine interaction in modern spacecraft. While some program-specific learnings remain confidential, the mission contributed significantly to India's operational preparedness.

Strategic Takeaways

In his closing remarks, **Shri D. K. Singh** distilled the session into several guiding principles:

- Adopt a **civil-military fusion** model to accelerate innovation
- Cultivate an "**astronaut mindset**" that pushes boundaries in every domain
- Prioritize human-centered technologies within the space economy
- Strengthen global partnerships for long-term exploration

He emphasized that the defining trait of astronauts is their capacity to navigate uncertainty—an ability that will shape the future of deep-space missions.

Panel Discussion : Building India's NavIC Ecosystem: Industry Adoption, Market Challenges, and Strategic Positioning in the Global GNSS Landscape

Keynote Address: Air Marshal BR Krishna PVSM AVSM SC ADC (Retd), Former Chief of Integrated Defence Staff (CISC)

Chair & Moderator: Air Vice Marshal Pawan Kumar VM (Retd), Former DG DSA

- **Dr Ashish Agarwal, Chief Scientist and Head of Time and Frequency Metrology, CSIR-National Physical Laboratory (NPL)**
- **Mr. Sajith P., Associate Director at the Satellite Communication and Navigation Program Office, ISRO**
- **Maj Gen Sanjeev Grover (Retd) , Elena Geo Systems Col Sandeep Rao (Retd) – Senior DGM, PMG L&T Precision Engineering and Systems, L&T**
- **Prof (Dr) Shivani Verma, Professor, Amity Institute of Space Science & Technology**
- **Col. Sandeep Rao (Retd.), L&T Precision Engineering**

The session titled "**Building India's NavIC Ecosystem: Industry Adoption, Market Challenges, and Strategic Positioning in the Global GNSS Landscape**" focused on India's indigenous navigation system and its growing importance for technological sovereignty, economic expansion, and national security.

The keynote address was delivered by **Air Marshal B. R. Krishna (Retd.)**, **former Chief of Integrated Defence Staff**, and the panel was chaired by

Air Vice Marshal Pawan Kumar (Retd.), **former Director General of the Defence Space Agency**. Bringing together experts from ISRO, CSIR–National Physical Laboratory, industry, defense, and academia, the discussion examined the readiness of India's NavIC constellation, the urgency of ecosystem development, and the need for deeper collaboration across sectors to unlock its full potential.

In his keynote address, **Air Marshal B. R. Krishna** provided a comprehensive overview of the global navigation satellite system landscape, noting that four major global constellations currently dominate — GPS, GLONASS, Galileo, and BeiDou — alongside regional systems such as Japan's and India's NavIC. He emphasized that NavIC is designed to provide accurate positioning within India and up to approximately 1,500 kilometers beyond its borders, offering both standard civilian services and restricted strategic services with accuracy near 20 meters and highly precise timing capabilities. Highlighting the system architecture, he explained that NavIC integrates space, ground, and user segments, with satellites supported by control centers, reference stations, and integrity monitoring networks. While the first-generation satellites faced configuration challenges and some are nearing end-of-life, the second-generation Navigation Series (NVS) satellites incorporate additional frequency bands to enhance civilian usability. With the launch of NVS-I already completed and further launches planned, the constellation is expected to achieve full operational capability soon.

Air Marshal Krishna stressed that the true value of NavIC lies not merely in launching satellites but in enabling downstream applications. India's heavy dependence on foreign navigation systems underscores the strategic necessity of indigenous capability. Government mandates encouraging NavIC-enabled chipsets in smartphones, along with adoption in transportation and logistics sectors, indicate that industry participation will be critical. He pointed out that navigation services alone are projected to contribute nearly nine billion dollars to India's space economy by 2033, presenting a major opportunity for startups and private enterprises. According to him, the downstream segment — encompassing receivers, chipsets, analytics platforms, and user applications — offers the fastest growth potential and should attract significant investment. He concluded by expressing confidence that NavIC could eventually expand beyond regional coverage and support neighboring countries, opening pathways for technological exports.

Opening the panel discussion, **Air Vice Marshal Pawan Kumar VM (Retd), Former DG DSA**, highlighted the strategic origins of NavIC, recalling that technology denial during the Kargil conflict demonstrated the risks of relying on foreign positioning systems. This realization led to the development of India's own navigation infrastructure. He noted that precise positioning underpins over 90 percent of modern applications, from defense operations to civilian logistics, and emphasized the importance of integrating private industry into both satellite and ground-based Positioning, Navigation, and Timing (PNT) services. The possibility of combining geostationary NavIC satellites with emerging Low Earth Orbit PNT constellations was identified as a promising direction for improving latency, redundancy, and signal resilience. He further underscored the need for a collaborative consortium involving academia, industry, and government agencies to accelerate technological maturity from laboratory research to orbital deployment.

Providing insight into the foundational role of timing, **Dr. Ashish Agarwal, Chief Scientist and Head of Time and Frequency Metrology at CSIR–National Physical Laboratory (NPL)**, explained that atomic clocks form the backbone of any navigation system. NPL is responsible for generating India's official time standard, synchronized to global coordinated time within a few

nanoseconds. Because even a one-nanosecond deviation can translate into positional errors of approximately 30 centimeters, maintaining stable timing is essential. He described the synchronization of satellite clocks with ground stations through highly precise satellite links and redundancy mechanisms. Beyond navigation, he highlighted multiple sectors dependent on nanosecond-level accuracy, including telecommunications, high-frequency financial trading, data centers, cybersecurity infrastructure, power grids, and broadcast systems.

Dr. Agarwal also addressed future challenges, emphasizing the need for robust timing infrastructure supported by redundant atomic clocks, advanced measurement systems, and nationwide optical fiber networks capable of transmitting precise timing signals. He discussed the “One Nation, One Time” initiative, which aims to mandate the use of Indian Standard Time rather than foreign sources. Capacity building remains another priority, as expertise in time metrology is limited within the country. Looking ahead, he advocated for next-generation optical atomic clocks and stronger collaboration with industry to commercialize indigenous technologies.

Representing **ISRO, Mr. Sajith P., Associate Director at the Satellite Communication and Navigation Program Office, ISRO** elaborated on the operational framework of NavIC. While public attention often focuses on satellites, he emphasized that the ground segment performs the critical task of calculating precise orbital positions and transmitting navigation data. The system currently includes multiple range and integrity monitoring stations, timing centers, and navigation data facilities operating continuously. With four satellites delivering positioning services and others supporting messaging capabilities, the constellation is expected to be fully completed within the next two years.

Mr. Sajith highlighted the progress made in standardization, including international maritime recognition and compliance with global technical standards that enable NavIC integration into smartphones and communication devices. Over sixty mobile models already support the system through chipsets manufactured by leading semiconductor companies. Importantly, NavIC has transitioned into a user-funded model, meaning ISRO will continue expanding capabilities based on demand from government and industry stakeholders.

From a strategic defense perspective, **Maj Gen Sanjeev Grover (Retd) , Elena Geo Systems Col Sandeep Rao (Retd) – Senior DGM, PMG L&T Precision Engineering and Systems, L&T** emphasized that NavIC enhances national self-reliance by protecting critical infrastructure from foreign control and ensuring uninterrupted military capability. He pointed to the rising importance of resilient navigation amid incidents of GPS spoofing worldwide. Stressing the role of startups and MSMEs, he described them as agile innovation hubs capable of bridging technological gaps with limited resources. According to him, NavIC should not remain an optional system but must evolve into the default navigation platform for India, supported by strong policy backing and national commitment.

Speaking from an industry standpoint, **Col. Sandeep Rao (Retd.) of L&T Precision Engineering** outlined the vast demand for NavIC-enabled receivers across defense platforms such as artillery systems, surveillance equipment, and communication networks. He estimated that nearly half of India’s armed personnel could eventually rely on such technologies. Beyond defense, he identified enormous civilian opportunities, citing logistics services, e-commerce delivery platforms, and transportation networks that

currently depend on foreign navigation signals. To accelerate adoption, he recommended expanding testing facilities, certification labs, and supply-chain ecosystems so startups can qualify their products more efficiently. Larger corporations, he added, should provide demand visibility and silicon-based security solutions to strengthen domestic manufacturing.

Offering an academic perspective, **Prof (Dr) Shivani Verma, Professor, Amity Institute of Space Science & Technology** described universities as active partners rather than observers in NavIC's evolution. She highlighted the role of academic research in developing new algorithms, receiver architectures, and AI-driven signal processing methods. Universities are also critical for workforce development, as the growing adoption of navigation technologies will require engineers trained in sensor fusion, satellite navigation, and quantum timing. She encouraged stronger collaboration between academia and industry to accelerate field trials and prototype development. Importantly, she clarified that NavIC data formats are compatible with global standards, reducing barriers to industrial adoption.

During the interactive session, participants raised concerns about constellation gaps, GPS spoofing incidents, and the need for resilient ground-based timing solutions. Responding to these queries, experts noted that India has already established terrestrial timing centers equipped with atomic clocks to provide backup precision through fiber networks. Multi-constellation receivers capable of using signals from multiple GNSS systems were identified as an effective resilience strategy. Panelists acknowledged the urgency of completing the satellite network while emphasizing that technical setbacks are part of complex space programs rather than indicators of flawed design.

Industry representatives also called for improved certification processes, shared testing infrastructure, financial incentives, and stronger policy support to make NavIC competitive with established global systems. Risk-sharing mechanisms and assured production orders were suggested to encourage startups to invest in receiver development. At the same time, academia emphasized the importance of integrating GNSS concepts into engineering curricula to address the current talent gap.

The session concluded with a synthesis of key takeaways: precise timing is fundamental to national infrastructure; collaboration between government, industry, and academia is essential; startups must be integrated into the operational ecosystem; and NavIC adoption should gradually shift from optional to default usage across sectors. Participants agreed that while the constellation's gestation period has been long, private-sector involvement and emerging technologies such as quantum navigation could significantly accelerate progress. Ultimately, NavIC represents not only a technological asset but a strategic instrument of autonomy — one that positions India to strengthen regional leadership and potentially expand its navigation services on a global scale.

Closing Session – India International Space Conclave

The Closing Session of the India International Space Conclave marked the culmination of two days of intensive deliberations, reflections, and forward-looking dialogue across policy, industry, defence, law, academia, and international cooperation. The session brought together senior leaders to consolidate the outcomes of the conclave and articulate pathways for action.

The session featured addresses by

- **Address by Mr Amit Ghosh, IAS, Addl Chief Secretary – Medical Health & Family Welfare and Medical Education Department, UP Govt**
- **Address by Dr Ranjana Kaul , Vice President, International Institute of Space Law; Partner, Dua Associates, Advocates & Solicitors**
- **Address by Dr W Selvamurthy, President, Amity Science, Technology & Innovation; Foundation, DG for Amity Directorate of Science & Innovation & Chair Professor for Life Sciences; Chancellor, Amity University, Chhattisgarh.**
- **Vote of Thanks by Gp Capt Anand Rao (Retd), Director, ISpA**

Address by Mr. Amit Ghosh, IAS – Policy, Partnerships, and the Human Dimension

Mr. Amit Ghosh opened the closing session by reflecting on the evolution of the India International Space Conclave, noting with pride that the fourth edition had matured into a truly international forum. He congratulated ISpA for successfully bringing together astronauts, ISRO scientists, defence experts, regulators, startups, industry leaders, researchers, and global partners on a single platform—an achievement that underscored the growing cohesion of India's space ecosystem.

He emphasized that India's space sector has decisively moved beyond siloed functioning, aligning with the intent of recent space policy reforms and liberalization. Space, he noted, is no longer defined merely by launch vehicles and propulsion systems but by a continuum that integrates policy, industry, academia, global cooperation, responsible operations, and long-term sustainability.

Highlighting the importance of partnerships, **Mr. Ghosh** stressed that space exploration inherently requires collaboration—across institutions, disciplines, and nations. He drew attention to emerging domains such as geospatial analytics and multi-sensor data fusion, identifying them as critical capabilities for a geographically and administratively complex country like India.

He further underscored the need for **balanced regulation**—regulatory frameworks that are liberal enough to encourage innovation and investment, yet robust enough to ensure safety, competitiveness, and global credibility. Addressing the growing human dimension of space, he emphasized astronaut training, mission health, space medicine, psychology, and habitation beyond Earth as key areas where engineering must intersect with medical and life sciences, offering significant opportunities for skill development in India.

Concluding his remarks, **Mr. Ghosh** highlighted sustainability as a shared global responsibility—spanning debris mitigation, space situational awareness, spectrum optimization, and space weather risk management. He called upon all stakeholders—industry, academia, government, and international partners—to move from discussion to implementation, reaffirming that India's space ambitions are outward-looking, collaborative, and globally connected.

Special Address by Air Vice Marshal Manu Midha – Space, Security, and Sovereign Capability

Air Vice Marshal Manu Midha delivered a strategic and candid address, situating the economic promise of India's space sector within the broader context of national security and geopolitics. He observed that India's space economy, currently valued at approximately USD 2 billion, is projected to grow to USD 44 billion by 2035 and potentially USD 100 billion by 2040—representing a major wealth-creation opportunity.

Drawing on historical perspectives, he emphasized that every domain exploited by humanity—land, sea, air—has eventually become a domain of conflict, and space is no exception. While acknowledging that there has been no direct war in space so far, he cautioned against complacency, noting that space is already central to 21st-century international relations.

He highlighted the promulgation of India's Joint Space Doctrine in September as a landmark step, formally recognizing space as an integral component of national security. Emphasizing the concept of aerospace power, he argued that India's space strength must emerge from the synergistic integration of civil agencies, industry, academia, and defence.

Air Vice Marshal Midha encouraged industry and academia to actively engage with defence-led innovation frameworks such as iDEX, noting that these challenges have catalysed an unprecedented innovation ecosystem involving startups, researchers, and R&D institutions. He called upon industry to take bold steps, leapfrogging technology cycles rather than merely following established paths.

Concluding, he asserted that India's long-term space posture must be defined by **sovereign capability**, not strategic dependence. Ensuring unhindered access to and use of space, supported by indigenous innovation and a young talent base, was identified as essential to safeguarding both national security and economic opportunity.

Special Address by Dr. Ranjana Kaul – Space Law, Governance, and Strategic Clarity

Dr. Ranjana Kaul provided a deeply insightful legal and governance perspective, emphasizing that India's 2020 space reforms have fundamentally reshaped national engagement with space, including the open participation of military stakeholders within transparent and collaborative forums such as this conclave.

She traced the historical evolution of space programmes, noting that India and Japan were unique in establishing **purely civil space programmes**, unlike other spacefaring nations that began with military objectives. However, she emphasized that contemporary realities necessitate the development of parallel civil, commercial, and military space strategies.

Dr. Kaul underscored the urgent need for a **coherent commercial space strategy,** distinct from policy declarations, with clear focus on manufacturing, applications, and market development. Equally important, she argued, is a well-defined military space strategy that clearly articulates capability requirements.

A central theme of her address was **space governance**. She highlighted that the Outer Space Treaty and its associated instruments form a high-stakes geopolitical status quo built on voluntary restraint. As India advances toward human spaceflight, space stations, and lunar exploration, she stressed the importance of deeply understanding treaty obligations related to liability, damage, search and rescue, and sustainability.

She called for greater engagement with the Ministry of External Affairs and emphasized that space situational awareness must evolve into comprehensive space domain awareness, integrating civil, commercial, and defence considerations. Dr. Kaul concluded by advocating for future conclaves to include focused sessions on regulatory and legal frameworks, ensuring common understanding across all stakeholders.

Special Address by Dr. W. Selvamurthy – Innovation, Human Capital, and Institutional Models

Dr. W. Selvamurthy delivered a reflective yet forward-oriented address, drawing on decades of experience in defence research and national science leadership. He commended ISpA for the meticulous organization of the conclave and highlighted India's remarkable achievements in launch vehicles, satellite systems, planetary missions, and cost-effective innovation.

He emphasized that India's success rests on strong scientific foundations, frugal engineering, and a vast human capital base. Acknowledging global partners from Japan, Europe, and the United States, he stressed that India's space journey has been deeply collaborative and should continue to deepen international partnerships.

Looking ahead, **Dr. Selvamurthy** proposed concrete recommendations, including the creation of a Special Purpose Vehicle (SPV) to nurture and handhold India's growing space startup ecosystem, which currently comprises over 300 startups. He advocated scaling this ecosystem to thousands by focusing equally on upstream and downstream sectors.

He further proposed establishing thematic Centres of Excellence in critical areas such as propulsion, navigation, guidance, and control—modeled on successful national missions like green hydrogen and defence research centres. These hubs, he argued, would act as force multipliers by integrating academia, industry, startups, and government agencies.

Emphasizing human resource development, **Dr. Selvamurthy** called for universities to significantly expand space science and technology programmes, leveraging India's demographic advantage. He highlighted Amity's role in this ecosystem through its Institute of Space Science and Technology, AI and quantum initiatives, and close collaboration with ISRO and national agencies.

He concluded by reaffirming India's civil–military fusion approach and the philosophy of Vasudhaiva Kutumbakam, asserting that collaborative innovation is essential not only for national advancement but for global benefit.

Vote of Thanks – Gp Capt Anand Rao (Retd.)

Delivering the Vote of Thanks, **Group Captain T H Anand Rao (Retd)** expressed sincere gratitude to the dignitaries for their insightful closing addresses and acknowledged the patience and engagement of participants over the two days. He highlighted the evolution of the conclave into an international forum and thanked international delegations, strategic partners, sponsors, and the audience.

He placed special appreciation on the ISpA organizing team for their tireless efforts over several months and invited applause for the team's contribution. The conclave formally concluded with an invitation for networking over tea, marking the transition from dialogue to continued collaboration.

The Closing Session powerfully reinforced that India's space future rests on integrated vision, sovereign capability, responsible governance, global partnerships, and human capital development. The addresses collectively underscored a decisive shift from aspiration to execution—positioning India as a confident, collaborative, and responsible space power.

Key Takeaways from India International Space Conclave (IISC) 2025

Day 2: 19 November 2025

Inaugural Session:

1. Develop a National Framework for the Space Economy
Establish standardized definitions and statistical frameworks to accurately measure the space sector's contribution to GDP, employment, and exports.

2. Strengthen Data Collection Mechanisms
Implement a centralized digital system for structured industry data submission to support evidence-based policymaking and long-term planning.

3. Accelerate Private Sector Participation
Continue regulatory reforms and provide financial and institutional support to nurture startups and expand the commercial space ecosystem.

4. Recognize Space as Critical National Infrastructure
Prioritize sustained investment, security frameworks, and resilience measures for national space assets and satellite constellations.

5. Promote Indigenous Technologies
Encourage domestic development in emerging areas such as AI-enabled systems, quantum technologies, cybersecurity, and advanced satellite capabilities.

6. Enhance Global Leadership in Space Governance
Actively contribute to international regulations on orbital traffic management, resource governance, and responsible space operations.

7. Strengthen International Partnerships
Expand strategic collaborations with global partners in areas such as Earth observation, climate monitoring, and advanced space missions.

8. Prioritize Space Sustainability
Develop policies for debris mitigation, in-orbit servicing, and sustainable use of orbital resources.

9. Invest in Human Spaceflight and Microgravity Research
Support long-term programs that advance human spaceflight capabilities and enable new scientific and commercial opportunities.

10. Build a Skilled and Inclusive Space Workforce
Promote academia–industry partnerships and encourage diverse participation, including women-led enterprises, in the space sector.

Panel Discussion II:

1. Provide Long-Term Demand Visibility
Conduct a 20–25 year national demand assessment for satellites, launch services, and components to guide investment and industry planning.

2. Strengthen and Streamline Regulatory Processes
Accelerate single-window approvals and authorization processes for launch vehicles, satellites, and commercial space activities.

3. Mobilize Large-Scale Investment
Introduce fiscal incentives and government anchor contracts to attract domestic conglomerates and global investors into the space sector.

4. Build Indigenous Manufacturing Capacity
Support large-scale satellite manufacturing, launch systems, and component supply chains to reduce import dependence.

5. Develop Strategic Technologies and SSA Capability
Invest in critical technologies and space situational awareness (SSA) to enhance national capability, security, and sustainability.

6. Prioritize High-Growth Segments
Focus policy support on satellite communications and Earth observation, which will drive the majority of India's projected $44 billion space economy.

Panel Discussion III:

1. Promote Multi-Sensor Data Integration Platforms
Encourage development of indigenous platforms that aggregate multiple satellite constellations and sensor types to provide unified, real-time Earth observation access for government and strategic users.

2. Strengthen Rapid Decision-Support Systems
Invest in AI- and analytics-driven geospatial intelligence systems that convert satellite data into actionable insights for disaster management, defence, agriculture, and urban governance.

3. Expand Government Adoption of EO Analytics
Integrate Earth observation–based monitoring across multiple government departments for applications such as crop monitoring, flood management, environmental compliance, and infrastructure planning.

4. Enhance National Geospatial Data Infrastructure
Support persistent monitoring capabilities and faster data turnaround mechanisms to enable rapid response during emergencies and national security situations.

5. Build Institutional Capacity in Geospatial Analytics
Strengthen training, institutional coordination, and data-sharing frameworks to address data overload and ensure effective use of satellite intelligence for governance and policy implementation.

Panel Discussion IV:

1. Promote Multi-Sensor Data Integration Platforms
Encourage development of indigenous platforms that aggregate multiple satellite constellations and sensor types to provide unified, real-time Earth observation access for government and strategic users.

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Panel Discussion V:

1. Strengthen Regional Space Cooperation in Asia
Collaboration among Asian nations is essential to address shared challenges in space exploration, satellite communications, and emerging space markets.

2. Leverage India's Space Capabilities for Regional Partnerships
India can position itself as a regional hub for satellite manufacturing, launch services, and ground infrastructure, supporting neighboring countries.

3. Promote Shared Infrastructure and Capacity Building
Joint initiatives such as ground stations, training programs, and academic collaborations can help build a skilled regional space workforce.

4. Expand the Downstream Space Economy
Greater focus is needed on AI-driven satellite data applications across sectors like agriculture, disaster management, and logistics, where most economic value is generated.

5. Encourage International Collaboration in Emerging Domains
Partnerships in LEO constellations, satellite communications, and lunar exploration will be critical for building sustainable space ecosystems.

6. Develop Trust-Based Regional Frameworks
Transparent practices, data sharing, and cooperative mechanisms are key to strengthening responsible space governance and regional stability in Asia.

Panel Discussion VI:

1. Create Sustained Launch Demand
Government-driven missions (defence constellations, EO satellites, maritime monitoring) are essential to generate steady launch demand for emerging private launch providers.

2.Support Private Launch Ecosystem
Early-stage policy support, procurement contracts, and faster approvals are needed to help

Indian launch startups build flight heritage and reliability.

3. Focus on Cost-Competitive Launch Solutions
Reducing launch costs through manufacturing scale, optimized infrastructure, and reusable technologies is critical to compete globally.

4. Strengthen Industrial Supply Chains
Long-term vendor visibility and strong manufacturing ecosystems are required to ensure quality, reliability, and scalable production.

5.Encourage Ecosystem Collaboration
Closer coordination between launch providers, satellite manufacturers, and application developers will strengthen India's end-to-end space capabilities.

6.Build Launch Reliability and Cadence
Achieving frequent launch cycles and proven mission success is essential for attracting commercial customers and gaining insurance market confidence.

Panel Discussion VII:

1. International Collaboration for Post-ISS Infrastructure
The retirement of the International Space Station (ISS) requires new cooperative models for future orbital habitats.

2. Shared Ownership Model for Space Infrastructure
The Habspace concept proposes an internationally owned, commercially operated space habitat, allowing nations to invest in and co-own orbital infrastructure rather than only purchasing access.

3. Lowering Barriers to Human Spaceflight Participation
A consortium-based investment model can reduce costs and enable wider participation from emerging space nations.

4. Modular and Expandable Orbital Habitat Design
Future space habitats should be modular, scalable, and equipped with high docking capacity and power, enabling research, manufacturing, and commercial missions.

5. Commercialization as a Key Growth Driver
The expanding private astronaut and commercial spaceflight market will play a crucial role in sustaining future orbital stations.

6. Global Industrial Participation
International collaboration in manufacturing, technology development, and operations can accelerate the creation of next-generation human space infrastructure.

Panel Discussion VIII:

1. International Partnerships are Essential for Space Growth
Collaboration between governments, industry, and research institutions is crucial for scaling innovation and expanding the global space economy.

2. Shift from Procurement to Co-Production Models
Future partnerships should emphasize joint manufacturing, technology development, and industrial integration, rather than traditional buyer–supplier relationships.

3. Strengthen India's Space Manufacturing and Supply Chains
India has strong capabilities in electronics and software, but greater investment in advanced manufacturing and component supply chains is needed to support global demand.

4. Enhance Export and Investment Ecosystems
Simplifying export processes, enabling global market access, and providing early-stage government support can help Indian startups attract international investors and scale globally.

5. Leverage Strategic Partnerships with Key Countries
Countries such as Italy, France, Australia, and European partners offer opportunities for collaboration in areas like satellite systems, launch infrastructure, exploration missions, and space situational awareness.

6. Encourage Industry-Led Global Collaboration
Future space cooperation will increasingly be driven by private-sector partnerships and joint commercial ventures, supported by enabling government policies.

Panel Discussion IX:

1.Space Sustainability is an Operational Priority
Rapid growth in satellite launches requires stronger systems for debris mitigation, collision avoidance, and long-term orbital sustainability.

2. Advance Space Weather Monitoring and Forecasting
Missions such as Aditya-L1 and ground-based sensor networks are critical for predicting solar activity that can disrupt satellites, communications, and astronaut safety.

3. Develop In-Orbit Servicing and ISAM Capabilities
Technologies for satellite refueling, repair, inspection, and debris removal will play a key role in extending satellite lifetimes and reducing orbital congestion.

4. Strengthen Space Situational Awareness (SSA)
Multi-sensor tracking systems integrating optical, radar, RF, and space-based sensors are essential to accurately monitor objects and prevent collisions.

5. Leverage Advanced Technologies for Space Safety
AI, quantum computing, and predictive modeling can significantly improve collision prediction, maneuver planning, and space weather forecasting.

6. Promote Global Cooperation and Standards
International coordination, regulatory alignment, and standardized docking and servicing interfaces are necessary to ensure safe and responsible space operations.

Panel Discussion X:

1. Human–Robot Synergy in Future Exploration
Future space exploration will rely on a combination of robotic missions and human presence to manage risks, explore unknown environments, and expand scientific discovery.

2. India's Human Spaceflight Roadmap (Vision 2047)
India plans to progress from the Gaganyaan mission to an indigenous space station by 2028 and a crewed lunar mission by 2040, supported by advanced launch, docking, and life-support technologies.

3. Human Factors are Central to Space Missions
Psychological resilience, teamwork, physical fitness, and multidisciplinary expertise are critical for astronauts, especially for long-duration missions.

4. Growing Opportunities in Human-Centric Space Technologies
Areas such as life-support systems, habitats, space suits, healthcare, and astronaut safety technologies represent major future segments of the space economy.

5. Importance of International Collaboration
Partnerships among global space agencies will be essential for space stations, lunar exploration, deep-space missions, and astronaut training.

6. Industry and Academia Must Support Human Spaceflight
A whole-of-nation approach involving government, private industry, academia, and defense collaboration is vital for advancing long-term human space exploration.

Panel Discussion XI:

1. NavIC as a Strategic Sovereignty Asset
India's indigenous navigation system NavIC strengthens technological independence and reduces reliance on global GNSS systems such as GPS, GLONASS, Galileo satellite navigation system, and BeiDou Navigation Satellite System.

2. Expansion Through Next-Generation Satellites
The Navigation with Indian Constellation (NavIC) NVS series satellites add new frequency bands and improved civilian usability, helping the constellation reach full operational capability.

3. Downstream Market is the Biggest Opportunity
Growth will come from chipsets, receivers, navigation services, and analytics platforms, with navigation services projected to become a major contributor to India's space economy by the next decade.

4. Precise Timing Infrastructure is Critical
Atomic clocks maintained by CSIR–National Physical Laboratory underpin navigation accuracy and support sectors such as telecom, finance, cybersecurity, and power grids.

5. Industry–Academia–Government Collaboration Needed
Adoption of NavIC requires stronger testing facilities, certification labs, startup support, and GNSS-focused education programs.

Closing Session:

1. Integrated Vision for India's Space Future
The conclave emphasized a whole-of-ecosystem approach, bringing together government, industry, academia, defense, and international partners to drive India's space ambitions.

2. Space as a Strategic and Economic Domain
India's space economy is projected to grow significantly in the coming decades, highlighting the need for sovereign capability, indigenous innovation, and strong industry participation.

3. Importance of Policy, Governance, and Legal Frameworks
As India advances toward human spaceflight, space stations, and deep-space missions, robust regulatory systems and alignment with global space law frameworks will be essential.

4. Strengthening Startups and Innovation Ecosystems
Expanding the space startup ecosystem, Centres of Excellence, and industry–academia collaboration will accelerate technology development and commercialization.

5. Human Capital and Multidisciplinary Collaboration
Future growth depends on skilled talent across engineering, medicine, psychology, geospatial analytics, and data science, reflecting the increasingly human-centric nature of space activities.

6. Global Cooperation and Responsible Space Operations
Sustainability, debris management, space situational awareness, and international partnerships remain critical to ensuring safe and collaborative use of outer space.

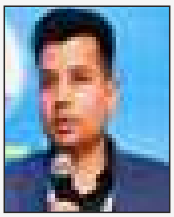
SPEAKERS

Day -1: Tuesday, 18 November 2025
Theme: “Enabling the Space Ecosystem: Services & Opportunities"

Fireside Chat: Fuelling Space Innovation: Economic Drivers and Funding Mechanisms

Dr P R Jaishankar,
Former Chairman & MD , IIFCL, Chairman IIFC (UK); Chairman, IIFCL Projects Ltd., and IIFCL Asset Management Company Ltd.

Dr Ravinder Pal Singh,
Member, National Advisory Committee (ISpA),



Mr. Akshat Johri
Assistant General Manager, IIFCL Projects

Industry Presentations

Mr. Nanduru Sarath Chandra
Larsen & Toubro (L&T)

Mr. Partha Ghosh
Vantor

Mr. Ravi Jain
Investment Director at TDK Ventures

Inaugural Ceremony

Dr. Jitendra Singh
Hon’ble Minister of State (Independent Charge) or Science & Technology

Dr. Pawan Goenka
Chairman, IN-SPACe

H.E. Antonio Bartoli
Ambassador of Italy to India

Air Chief Marshal V. R. Chaudhari
PVSM AVSM VM (Retd)

Mr. Takashi Ariyoshi
Minister & Deputy Chief of Mission, Embassy of Japan

Mr. A. T. Ramchandani
Chairman, ISpA

Lt Gen Anil Kumar Bhatt (Retd)
Director General, ISpA

Fireside Chat : Unlocking India's Private Space Industry Potential : An open dialogue with Dr Pawan Goenka, Chairman, IN-SPACe

Dr Pawan Goenka,
Chairman, IN-SPACe

Mr P J Nath
Managing Director & Chief Executive Officer, Nelco Ltd.

Mr Sanjay Nekkanti
CEO & Founder, Dhruva Space

SPEAKERS

Day -1: Tuesday, 18 November 2025
Theme: "Enabling the Space Ecosystem: Services & Opportunities"

Session I: India Japan Space Partnership: Fostering a Collaborative Space Eco-System

Dr Saku Tsuneta,
Vice Chair, Committee on National Space Policy, Cabinet Office, Government of Japan

Dr D Gowrisankar
Director, Office International & Interagency Cooperation (OIIC), ISRO

Mr Shinichi Higuchi
Director (International Affairs), National Space Policy Secretariat, Cabinet Office, Government of Japan

Mr Tomohiro Oya, Engineer
Lunar Polar Exploration (LUPEX) Project, Human Space flight Technology Directorate, Japan Aerospace Exploration Agency (JAXA)

Mr Masayuki Urata
Senior Manager, Business Development Division, iSpace

Mr Kannan Kesavapillai
Chief Executive Officer, Augsenselab Pvt. Ltd.

Mr Mohammed Zayed,
Sales Engineer - Government Digantara

Session 2: Geospatial Data Applications: Turning data into actionable insights for governance and industry

Mr Sanjay Kumar
Founder & CEO, Geospatial World

Dr Rajasekhar M,
Scientist SG, Chief Meteorologist, ISRO

Mr Agendra Kumar
Managing Director, Esri India Technologies Pvt. Ltd.

Dr Deb Jyoti Pal
Senior Vice President, GalaxEye

Mr Pranjal Prateek,
Chief of Staff to the CEO & Director of Business Solutions, Satsure

Lt Col Rakesh Verma (Retd),
Sr Manager, Sales & BD (D&I), Vantor

Dr Y Nithiyanandam,
Professor & Head, Geospatial Programme, Takshashila

Session 3: Navigating Spectrum Issues for SatCom and Challenges for India's Private Sector in Providing LEO Satellite Internet Services

Dr Prafulla Kumar Jain,
Director, PMAD, IN-SPACe

Mr P J Nath,
Managing Director &
Chief Executive of cer,
Nelco Ltd.

Mr Shivaji Chatterjee,
CEO & Managing Director,
Hughes Communications

Mr Arun Agarwal,
DDG(Satellite),
Department of
Telecommunications

Mr Gautam Sharma,
Managing Director,
Viasat India

Col Kunwar Varun Singh Tanwar,
VSM (Retd), Head Business
Development (Defence),
Astrome Technologies Pvt. Ltd.

Ms Neha Idnani,
Regional VP - APAC,
Eutelsat OneWeb (Hybrid)

SPEAKERS

Day -2: Wednesday, 19 November 2025
Theme: "Governance in the New Space Age: Advancing Space for Humankind through Inclusion, Innovation, Resilience and Sustainability "

Session: Estimation of Space Economy Contributions to National GDP, delivered by Mr. Brijesh Soni, Deputy Director, Promotion Directorate (PD), IN-SPACe.

Mr. Brijesh Soni,
Deputy Director,
Promotion Directorate (PD), IN-SPACe.

INAUGURAL ADDRESS

Smt. Meenakshi Lekhi,
Former Minister of State for External Affairs and Culture

Shri A.S. Kiran Kumar,
Member of the Space Commission and Former Chairman of ISRO

H.E. Marjolijn Van Deelen,
European Union Special Envoy for Space

Lt Gen A.K. Bhatt, PVSM, UYSM,
AVSM, SM, VSM (Retd.),
Director General of ISpA

Air Chief Marshal R.K.S. Bhadauria,
PVSM, AVSM, VM, ADC (Retd.),
Former Chief of the Air Staff,
Indian Air Force

Panel Discussion: From Vision to Reality: Challenges and Solutions in Realizing India's Space Decadal Vision

Mr Pankaj Sharma,
Partner Regulatory Consulting, EY LLP

Ms Surbhi Patni Dalmia,
Country Head and Director, Novaspace

Brig Adarsh Bhardwaj (Retd)
Executive Director,
Azista BST Aerospace (ABA)

Mr Abhilash Bhat,
Chief of Staff (COS), Pixxel

Ms Geetanjali Kamat,
Manager-Legal & Policy, Digantara

Mr Vinay Paliwal,
Deputy Director,
PMAD, IN-SPACe

From Data to Decision: Multi-Sensor High-Resolution Earth Observation Insights at Your Fingertips

Mr Swan Pant,
Vice President Operations at Suhora

Brig Anshuman Narang,
'Atma Nirbhar Soch'
Think Tank Startup Founder & Director,
Advisor Suhora Technologies

Mr Vishwanathan K. Ganapathy,
Director, Suhora Technologies

Dr Sultan Singh,
Director, Haryana Space Applications Centre (HARSAC), Hisar

SPEAKERS

Day -2: Wednesday, 19 November 2025
Theme: "Governance in the New Space Age: Advancing Space for Humankind through Inclusion, Innovation, Resilience and Sustainability "

Panel Discussion: India and Asia in Orbit Enhancing Regional Cooperation in Space Exploration and Technology

Lt Gen Dushyant Singh,
PVSM, AVSM (Retd),
Director General, CLAWS

Mr Tejas Bharadwaj,
Senior Research Analyst,
Carnegie India

Ms Sujatha Deepak,
Head SATCOM,
Alpha Design Technologies (ADTL)

Dr Sarath Raj,
Director Laboratories, Project Director
Amity Dubai Satellite Ground Station
and AmiSat Amity University Dubai

Dr (c) Sandya Bhat Asnotikar,
State President,
Karnataka Aerospace Council,
WICCI

Mr Jean-Baptiste Thepaut,
Principal at Novaspace

Mr Masayuki Urata,
Senior Manager,
Business Development Division, iSpace

Panel Discussion: Launch Vehicles and Propulsion Technologies for SpaceExploration, LV Markets and the Emerging Challenges

Dr Sudheer Kumar,
Former Director CBPO,
ISRO HQ

Mr Raghavendra BM,
Joint General Manager &
Head Space Business at
L&T Precision Engineering
Systems, L&T

Mr George Weinmann,
Founder, AstroWorks Ventures

Mr Ashwin Mahavadi,
Senior VP, Business -
Skyroot Aerospace

Mr Neeraj Khandelwal,
Co-founder, Astrobase

Ms Umamaheswari K,
Senior Director -
Engineering, Agnikul Cosmos

SPEAKERS

Day -2: Wednesday, 19 November 2025
Theme: "Governance in the New Space Age: Advancing Space for Humankind through Inclusion, Innovation, Resilience and Sustainability "

Habspace Concept A New Model for International Human Space Infrastructure

Mr George Weinmann
of Astroworks Ventures

Panel Discussion: International Partnerships in Space: Catalyzing Growth in the Global Space Economy

Dr Vinod Kumar,
Director, Promotion Directorate,
IN-SPACe

Mr Noel Ballot, Senior
Vice-President Sales & Marketing,
Safran Space

Dr Sergio Ledda,
Scientific Attache'
Embassy of Italy in India

Mr Rainer Horn,
Partner & MD, Novaspace

Mr Jérémy Hallakoun,
Dir. Strategy, Legal and
External Affairs European
and External Relations Department
DG Cabinet Member States
Relations ESA HQ

Mr Nathan Davis,
Trade & Investment Commissioner,
Australian Trade & Investment
Commission (Austrade)

Mr Louis Vermersch,
Trade Advisor,
Business France,
Embassy of France in India

Sustaining Space Operations: In-Orbit Technologies, Debris Management, and Space Weather Hazard Mitigation

Mr Akshat Johri,
Assistant General Manager,
IIFCL Projects Ltd

Prof Varun Sheel,
Senior Professor &
Head-Planetary Science,
Physical Research Laboratory,
Ahmedabad.
(Dept. of Space, GoI)

Mr Sakthikumar R,
Founder & CEO,
OrbitAID Aerospace

Mr Ray Fielding,
Head of Sustainability &
ISAM, UK Space Agency
(Hybrid)

Mr Zayed Mohammed,
Sales Engineer - Digantara

Ms Alisha Contractor,
Chief Mission Operations at
Kepler Aerospace

SPEAKERS

Day -2: Wednesday, 19 November 2025
Theme: "Governance in the New Space Age: Advancing Space for Humankind through Inclusion, Innovation, Resilience and Sustainability "

Panel Discussion : The Future of Space Exploration: Humans in space, Space Stations, Habitation on Moon & Mars, Deep Space missions, Human physiology and Health Systems for Space Missions.

Shri D K Singh, Director,
Human Space Flight Centre (HSFC), ISRO

Gp Capt TH Anand Rao (Retd),
Director ISpA

Ms Naoko Yamazaki,
Former JAXA Astronaut

Gp Capt PB Nair,
Astronaut Designate, ISRO

Gp Capt Angad Pratap,
Astronaut Designate, ISRO

Air Vice Marshal A Agarwal, VSM (Retd),
Former ACAS (Med),
Air HQ, Indian Air Force

Dr Sowgandhi N Chaturvedula,
Registered Clinical Psychologist (Associate), Dept of Aviation and Space Psychology, Institute of Aerospace Medicine, Indian Air Force

Mr Hanamantray Baluragi,
Director, DHSP ISRO HQ

Panel Discussion : Building Indias NavIC Ecosystem: Industry Adoption, Market Challenges, and Strategic Positioning in the Global GNSS Landscape

Air Marshal BR Krishna
PVSM AVSM SC ADC (Retd),
Former Chief of Integrated Defence Staff (CISC)

Air Vice Marshal
Pawan Kumar VM (Retd),
Former DG DSA

Dr Ashish Agarwal,
Chief Scientist and
Head of Time and Frequency Metrology, CSIR National Physical Laboratory (NPL)

Maj Gen Sanjeev Grover (Retd)
Elena Geo Systems

Col Sandeep Rao (Retd)
Senior DGM, PMG L&T Precision Engineering and Systems, L&T

Prof (Dr) Shivani Verma
Professor, Amity Institute of Space Science & Technology

Closing Session India International Space Conclave

Mr Amit Ghosh, IAS,
Addl Chief Secretary
Medical Health & Family Welfare and Medical Education Department,
UP Govt

Dr Ranjana Kaul,
Vice President,
International Institute of Space Law;
Partner, Dua Associates,
Advocates & Solicitors

Dr W Selvamurthy,
President, Amity Science, Technology & Innovation; Foundation,
DG for Amity Directorate of Science & Innovation & Chair Professor for Life Sciences;
Chancellor, Amity University, Chhattisgarh.

Gp Capt Anand Rao (Retd),
Director, ISpA