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CONFERENCE REPORT

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INTRODUCTION

The Bengaluru Space Expo 2024 took place from September 18-20, 2024, at the BIEC in Bengaluru. Organized by the Confederation of Indian Industry (CII) in collaboration with the Indian Space Research Organisation (ISRO), Indian National Space Promotion and Authorization Centre (IN-SPACe), and NewSpace India Limited (NSIL), the event attracted over 150 speakers and more than 800 delegates from 14 countries.

The expo featured over 170 companies showcasing their innovations across a 65,000 square foot display area, drawing more than 8,000 business visitors. The event facilitated more than 440 B2B and B2G meetings, marked the launch of new products and services, and led to the signing of over 12 MoUs.

Key sessions at the conference included discussions on Indian space reforms and policies, sectoral business opportunities, the socio-economic impact of space technologies, and emerging technologies in space. The event also featured exclusive sessions for international partners such as Australia, the UK, Italy, Denmark, Singapore, the World Economic Forum, and the European Space Agency.

India's space sector is undergoing significant transformation, with the government introducing visionary reforms to expand the industry. The establishment of institutions such as NSIL and IN-SPACe has marked a new era of growth, driving the commercialization of space technology and fostering a conducive environment for private sector participation.

The expo underscored the importance of collaboration between the government, private industry, and academia to achieve sustainable growth in India's space sector. Public-private partnerships are seen as critical to scaling operations and developing advanced technologies for space exploration, satellite communication, and space tourism.

Karnataka was highlighted as a key hub for space technology in India, with significant contributions from SMEs, MSMEs, and leading academic institutions. The state government is actively developing a comprehensive space policy to support startups and foster innovation.

International cooperation and partnerships were a focal point of the event, with speakers from Italy, the United Kingdom, France, Netherlands and, Australia discussing their countries' collaborations with India in the space sector. These partnerships focus on areas such as satellite manufacturing, space exploration, climate change, and disaster management.

The key outcomes of the 3-day conference can be summarised as follows:

1. **India's Expanding Role in the Global Space Economy:** India's space sector is poised to grow significantly, with its current 2-3% share of the global market projected to reach 10% by 2030. The increase is driven by the expanding involvement of private enterprises and startups, spurred by government reforms, including the Indian Space Policy of 2023.
2. **Public-Private Partnerships (PPPs) Driving Growth**: The critical role of PPPs in space sector growth was a dominant theme, with collaboration between ISRO, NewSpace India Limited (NSIL), and Indian National Space Promotion and Authorisation Centre (IN-SPACe)

highlighted as key drivers of innovation in satellite manufacturing, space exploration, and downstream applications.

3. **Advancements in Space Technologies and Data Utilisation**: Innovations in Earth Observation (EO), satellite communications, and navigation are creating vast opportunities. EO technologies, in particular, are being used for real-time monitoring of disasters, climate change, and agricultural productivity, thus addressing global challenges.
4. **The Rise of Indian Startups in Space**: The exponential growth of Indian space startups was celebrated, growing from a handful to over 300 in the last few years. These companies are pivotal in satellite development, space data services, and launch vehicles, contributing to India's competitive positioning in the global space market.
5. **Karnataka as a Space Innovation Hub**: Bengaluru was recognised as India's premier space innovation hub, housing ISRO, HAL, SMEs, and leading academic institutions. With the government's support, Karnataka aims to strengthen its role in satellite component manufacturing, satellite services, and space R&D through policy initiatives.
6. **Global Collaboration and International Cooperation:** International partnerships, particularly with countries like France, Australia, Italy, and the UK, were highlighted. These collaborations aim to address global challenges, from satellite-based climate monitoring to disaster management, positioning India as a key player in global space initiatives.
7. **Space Reforms and Regulatory Frameworks**: The Indian Space Policy 2023, alongside liberalised FDI regulations, has accelerated private sector involvement. However, the conference also highlighted the need for streamlined regulatory processes to ensure timely approvals and reduce bureaucratic hurdles for space ventures.
8. **Opportunities in Downstream Applications**: The downstream segment of the space sector offers significant potential, especially in sectors like Earth observation and satellite communications. The development of platforms like GIS-based decision systems for agriculture and disaster management shows how space technologies can impact non-space industries.
9. **Capacity Building and Skill Development**: Developing a skilled workforce is critical for sustaining growth in the space sector. Collaborative efforts between academia, industry, and government are needed to build the talent pool necessary for advancing satellite development, space exploration, and data services.
10. **Vision for Future Expansion**: With ambitious goals such as human spaceflights, lunar landings by 2040, and an increased focus on space tourism, the future of India's space sector lies in continued private sector engagement, international partnerships, and innovation in emerging space technologies.

The event also addressed the challenges and opportunities in the space sector, emphasizing the need for regulatory frameworks to evolve, improving access to capital for startups, and the creation of a skilled workforce. The session concluded with a vision for the future, highlighting India's expanding role in the global space economy and the importance of private sector participation and international collaboration. Session-wise summaries and key takeaways from each session are detailed in this report.

1. INAUGURAL SESSION

The Bengaluru Space Expo (BSX) 2024 opened with a warm welcome to dignitaries, international delegates, and participants. The event's theme, *"Accelerating Tomorrow: Harnessing the Potential of the Space Sector for Unified Expansion,"* reflected the focus on leveraging innovation, technology, and collaboration to propel India's space industry forward. Emphasis was placed on the growing opportunities for India and global stakeholders to contribute to space exploration and commercial space activities.

India's Growing Role in the Global Space Economy

India's space sector has been undergoing a significant transformation, with the government introducing visionary reforms to expand the industry. Historically led by the Indian Space Research Organisation (ISRO), India's space programme has gained global recognition for its cost-effective and reliable satellite and launch vehicle development. However, recent reforms, including the establishment of institutions such as NewSpace India Limited (NSIL) and the Indian National Space Promotion and Authorisation Centre (IN-SPACe), have marked a new era of growth. These organisations aim to drive the commercialisation of space technology and foster a conducive environment for private sector participation.

India's space industry currently holds a modest 2-3% share of the global space economy. However, projections for 2030 estimate this figure could rise to 10%, representing a major leap in India's role on the global stage. This growth is driven by the increasing involvement of the private sector, with more than 300 startups emerging in recent years. Notable recent successes include the launch of the Skyroot Vikram S rocket and the Agnikul Agnibaan rocket, both developed by Indian private space companies. These developments signal the immense potential for innovation in satellite manufacturing, space launch services, and downstream applications.

Unified Expansion: Collaboration Between Government, Industry, and Academia

The speakers underscored the importance of collaboration between the government, private industry, and academia to achieve sustainable growth in India's space sector. ISRO, traditionally the primary player in the Indian space landscape, continues to lead major missions, such as the Chandrayaan missions, while increasingly encouraging private sector participation in satellite and launch vehicle development.

Speakers noted the need for "unified expansion," which involves cooperation not only between Indian organisations but also with international partners. Public-private partnerships are seen as critical to scaling operations and developing advanced technologies for space exploration, satellite communication, and space tourism. India's private sector is now capable of designing and manufacturing satellites, developing reusable launch vehicles, and offering data services. The reforms introduced by the Indian government in 2020 have played a transformative role in opening up the space sector to private players, fostering innovation, and creating new opportunities for investment and entrepreneurship.

Karnataka's Leadership in Space Innovation

Karnataka was highlighted as a key hub for space technology in India. The state, home to ISRO, HAL, and several other major institutions, has emerged as a leader in space research, manufacturing, and innovation. The state's robust ecosystem includes significant contributions from SMEs, MSMEs, and leading academic institutions such as the Indian Institute of Science (IISc). The government of Karnataka, in collaboration with the private sector and academia, is working to position the state as a global leader in space technology.

The state government is actively developing a comprehensive space policy to support startups and foster innovation. Plans include establishing a Centre of Excellence for Space Technologies, which will focus on research, development, and innovation. Additionally, the government aims to create a thriving ecosystem for component and system manufacturing within the space sector, preparing Karnataka's SMEs and MSMEs to meet global demand. This policy and infrastructure support will strengthen the state's position as a key player in the space industry, not only for India but also globally.

International Cooperation and Partnerships

The event featured several international speakers from Italy, the United Kingdom, France, and Australia, who discussed their countries' partnerships with India in the space sector. These partnerships focus on areas such as satellite manufacturing, space exploration, climate change, and disaster management.

France, a long-standing partner of India in space collaboration, has been working with ISRO since 1964. The two countries have jointly developed satellites for Earth observation and climate monitoring, contributing to global efforts to address climate change. France continues to collaborate with India on major projects, including the Krishna satellite, which will provide high-resolution thermal monitoring for applications such as sustainable agriculture and urban development.

Australia also emphasised its growing partnership with India, particularly in commercial space activities. Australia has committed significant funding to joint satellite missions and collaborative projects, such as the Space Matri Mission, which will launch Australia's largest-ever spacecraft in collaboration with India's NSIL using the Small Satellite Launch Vehicle (SSLV). Australia is also contributing to India's Gaganyaan human spaceflight programme, providing tracking support and exploring potential collaborations in space technology and research.

The United Kingdom highlighted its strategic partnerships with India in areas such as Earth observation and telecommunications. The UK's space sector, which contributes 18% to the country's GDP, is keen to collaborate with India in addressing global challenges like climate change through space technology. The UK also supports India's efforts to harness private sector participation in the space industry, with several UK and Indian companies working together on satellite missions and data-sharing initiatives.

Italy celebrated its long-standing cooperation with India, which began with a space agreement in 2005. Italy's space sector is highly advanced, with expertise in satellite technology, space exploration, and planetary missions. The country is committed to deepening its collaboration

with India, particularly in satellite manufacturing and space propulsion systems. Italy also emphasised the potential for space technology to address global challenges such as food security and environmental monitoring, pointing to its COSMO-SkyMed and PRISMA satellite missions, which contribute to Earth observation and climate change monitoring.

Challenges and Opportunities in the Space Sector

While the growth of India's space sector is promising, speakers noted several challenges that need to be addressed to ensure sustained development. Regulatory frameworks must evolve to keep pace with technological advancements, particularly in areas such as intellectual property rights, technology transfer, and workforce development. Access to capital remains a critical issue for startups, which require investment to scale their operations and develop new technologies. The event introduced a new initiative by CII that provides a platform for startups to showcase their business models to potential investors.

Speakers also discussed the importance of creating a skilled workforce capable of meeting the demands of the rapidly evolving space industry. India needs to cultivate a large pool of scientists, engineers, and entrepreneurs who can drive innovation and expand the country's capabilities in space exploration, satellite development, and commercial space services.

The key takeaways from the Inaugural Session were:

1. **India's Expanding Role in the Global Space Economy**:
    - India's space sector currently holds a 2-3% share of the global space economy, with an ambitious goal of achieving a 10% share by 2030. This expansion represents a significant opportunity for India to elevate its space industry on the global stage.
    - The number of space startups in the country has grown exponentially in recent years, increasing from just a few to over 300, driven by government reforms and policies that support private sector involvement in space activities.
2. **Significance of the 2020 Space Policy**:
    - The 2020 space policy was described as a transformative step for India's space sector, allowing private companies to participate in the full spectrum of satellite development, launch vehicles, and space systems. This policy has spurred the rapid growth of private enterprises and space startups.
3. **Private Sector Collaboration and Innovation**:
    - Public-private partnerships were highlighted as essential in driving innovation within the Indian space industry. Collaboration between ISRO, IN-SPACe, NSIL, private enterprises, and academia is facilitating advancements in satellite manufacturing, space data services, and cutting-edge technology.
    - The session emphasised the importance of private sector involvement in projects such as satellite manufacturing and data services, with potential for further growth and new business models.

4. **International Cooperation and Partnerships**:
    - India's growing partnerships with countries such as France, Australia, Italy, and the UK were a focal point of the session. International collaboration in space exploration, climate monitoring, satellite data sharing, and technology exchange is driving innovation and strengthening India's global standing in the space sector.
    - France and India's 60-year partnership were emphasised, with future collaborations such as the TRISHNA satellite for climate monitoring set to deepen ties.
    - Australia and the UK reaffirmed their support for India's Gaganyaan human spaceflight programme, alongside new joint projects for satellite missions and Earth observation.
5. **Bengaluru as an Innovation Hub**:
    - Karnataka, particularly Bengaluru, was recognised as India's hub for space and tech innovation, with its ecosystem of government entities, private enterprises, SMEs, and leading research institutions such as ISRO and IISc driving advancements in the sector.
    - The state's contributions to aerospace, defence, and technology innovation were celebrated, positioning Bengaluru as a leader in space-related R&D, satellite manufacturing, and startup development.
6. **Focus on Sustainability and Global Challenges**:
    - The importance of space technology in addressing global challenges such as climate change, disaster management, and sustainable development was underscored. Earth observation and satellite data were seen as key tools in supporting efforts to monitor and mitigate environmental impacts.
    - The session also stressed the need for sustainability in space missions, with increasing concerns about space debris and the responsible use of space.
7. **Opportunities in the New Space Economy**:
    - The session recognised the growing potential in various segments of the space economy, including satellite communications, Earth observation, data services, and downstream applications in sectors such as agriculture, healthcare, and education.
    - Discussions highlighted the need for continued investment, research, and infrastructure development to fully harness the space sector's potential, with a focus on fostering long-term partnerships and innovative solutions.
8. **Capacity Building and Skill Development**:
    - The development of a skilled workforce in areas such as space science, engineering, and technology was seen as critical to the sector's growth. Speakers emphasised the need for investment in talent and the creation of educational opportunities to meet future demands in the space industry.
9. **Vision for the Future**:
    - The theme "Accelerating Tomorrow: Harnessing the Potential of the Space Sector for Unified Expansion" captured the session's forward-looking vision of a globally integrated

and collaborative space sector, focusing on driving innovation, economic growth, and exploring new frontiers in space.

2. TECHNICAL SESSIONS AND KEYNOTE PRESENTATIONS

A. Session on Indian Space Reforms & Policies: Influence on Indian Space Sector

The session focused on the transformative impact of recent reforms on India's space industry. The introduction of the Indian Space Policy 2023 marked a pivotal change by clearly defining the roles of the Department of Space, ISRO, IN-SPACe, NSIL, and private companies. This separation of responsibilities has fostered a more focused and collaborative environment, enhancing innovation and sector growth. In addition to these policy changes, the liberalisation of foreign direct investment (FDI) in the space sector has opened doors for foreign investment and partnerships. The sector has seen remarkable growth, particularly in startups. From just one space-related startup in 2014, India now has over 200 startups actively involved in satellite development, rocket launches, and the creation of value-added products using space data. In 2023 alone, investments in India's space sector surpassed ₹1,000 crore, highlighting the heightened interest and potential of the industry.

New Space India Limited (NSIL) has played a significant role by transitioning to a demand-driven model, attracting multiple orders for satellite manufacturing and launches. This includes the highly anticipated PSLV launch under the NC-LED industry consortium, which is expected to be a game-changer. NSIL is also progressing with the technology transfer of the Small Satellite Launch Vehicle (SSLV) and developing new public-private partnership models for the realisation of LVM3 launch vehicles. The opening of Earth Observation (EO) data through IN-SPACe and various initiatives to commercialise this data has further supported the sector's growth. The collaborative efforts between private industry, academia, and government bodies reflect the evolving dynamics of the Indian space ecosystem.

In terms of India's space exploration ambitions, the government has laid out a clear vision for 2047. This includes launching multiple Gaganyaan (human spaceflight) missions, developing a new generation of launch vehicles, establishing a space station, and aiming for an Indian landing on the Moon by 2040. Achieving these goals will require significant participation from the private sector, particularly in developing downstream applications and the ground segment, which account for 90% of the total space economy. The sector is targeting a substantial growth trajectory, aiming to increase its share of the global space economy from the current 2% to 8% by 2033, and further to 15% by 2047. This will require a compound annual growth rate (CAGR) of 16%, which presents both opportunities and challenges.

While the rapid rise of startups and MSMEs has been encouraging, the discussion highlighted the need for larger industry houses to invest in the sector to support sustainable growth. Government efforts to support the private sector are expected to expand, with ongoing work on comprehensive FDI guidelines, the drafting of the Space Bill, and new schemes to incentivise investment and participation. However, some concerns were raised about the

potential consequences of 100% FDI in certain areas of the space sector, as it could lead to foreign dominance in some companies. Participants suggested that while the FDI policy is a positive step, the government may need to impose some restrictions to safeguard domestic companies and maintain a balance between foreign and local players.

The discussion also emphasised the importance of fostering a balanced ecosystem where technology development and business demand are synchronised. While Indian startups have made significant progress, the industry still faces challenges in scaling up technology readiness and ensuring a consistent demand for space-based products and services. The cost of failure in space-related ventures is high, and there remains a need for government support to drive demand, promote technology development, and ensure smoother inter-ministerial coordination. The anticipated Space Act, expected to address issues such as export control, telecom services, and spectrum management, will be a crucial next step in shaping the sector's future.

Panellists noted that while the space reforms have created excitement and opportunity, gaps remain. These include the need for more streamlined regulatory processes, a single-window system for approvals, and better integration of the multiple ministries and agencies that oversee various aspects of the space sector. For example, the process of obtaining approvals for services such as in-flight connectivity is cumbersome and can take over a year, during which time a significant portion of satellite life may already be consumed. Streamlining this process would be critical, particularly given the rapid technological advancements and shorter lifespans of new satellite technologies such as LEO (Low Earth Orbit) constellations.

In addition to domestic policies, India's role in international space missions and collaborations was also discussed. It was emphasised that India must focus on enhancing reciprocity in international trade and investment laws to enable Indian companies to participate more actively in the global space economy. The reforms have already improved India's global standing, with companies such as ViaSat, which recently signed an MOU with NSIL, recognising the positive business environment created by these changes.

The session concluded by acknowledging that while India is on the right track, continued government intervention, technology transfers, incentivisation of R&D, and strong international collaborations are needed to achieve the ambitious goals set for 2047. The reforms are a work in progress, but they have laid a solid foundation for India's emergence as a significant global player in the space sector.

Key takeaways from the session were:

1. **Indian Space Policy 2023**: This policy marks a significant turning point for India's space sector, clearly defining the roles of the Department of Space, ISRO, IN-SPACe, and private companies. By delineating responsibilities, the policy fosters a collaborative environment, enhancing innovation and growth within the sector.
2. **Liberalisation of FDI in Space**: The reforms have opened up the space sector to foreign direct investment, which is expected to boost investment and collaboration. Start-ups in the space industry have flourished, growing from just one in 2014 to over 200 today, supported by a range of new business models and ventures.

3. **New Public-Private Partnerships (PPPs)**: The session highlighted ongoing efforts to create new models for private sector involvement in space activities, including the development of the PSLV through an industry consortium, as well as advancements in small satellite launch vehicles (SSLV). These initiatives are aimed at strengthening the role of the private sector in building launch vehicles and meeting the increasing demand for space services.
4. **Technology Transfer**: The transfer of space technology from ISRO to private companies has accelerated. Efforts such as the Technology Transfer of SSLV to private entities are expected to bolster local manufacturing and innovation.
5. **Earth Observation and Communication**: The space sector is working to improve access to Earth observation data, offering free access to coarser data, while high-resolution data remains available at a nominal cost for private users. This initiative opens up data for research and commercial purposes.
6. **Venture Capital Fund**: The Indian Government has announced a ₹10 billion venture capital fund dedicated to supporting the space industry, particularly start-ups, demonstrating the government's commitment to fostering innovation in the sector.
7. **Focus on Space Exploration**: The session emphasised that India has ambitious plans for space exploration, including multiple Gaganyaan and Chandrayaan missions, and the development of the New Generation Launch Vehicle (NGLV). The long-term goal is an Indian lunar landing by 2040.
8. **Growth Targets for Space Economy**: India's current share in the global space economy stands at 2%, and the aim is to increase this to 8% by 2033, and 15% by 2047. Achieving this target will require a compounded annual growth rate (CAGR) of 16%, making it a challenging but ambitious goal.
9. **Balancing Demand and Supply**: As the space industry grows, ensuring a balance between the supply of space technologies and demand for these services will be crucial. The government will need to play a key role in promoting space solutions to meet growing industry needs.
10. **Collaborative Global Approach**: India's participation in global space initiatives and international missions is crucial for growth. Efforts to simplify regulatory frameworks and encourage partnerships between Indian and international space companies are seen as critical to sustaining India's long-term competitiveness in the global space market.
11. **Need for Simplified Regulations**: The session pointed out the challenges posed by India's complex regulatory environment. Simplification and streamlining of processes, particularly for services like in-flight connectivity, are essential to reduce delays and maximise the efficiency of satellite use.

B. Keynote Address/ Presentation – Indian Space Reforms and Policies: Norms Guidelines and Procedures by Dr. P K Jain, Director, PMAD, In-Space

Dr P K Jain, Director of PMAD, IN-SPACe, delivered an insightful keynote address on "Indian Space Reforms and Policies: Norms, Guidelines, and Procedures," highlighting the significant changes that have occurred in India's space sector over recent years. He began by recapping the key milestones of India's space reforms, which started in June 2020 with the government's announcement of liberalising the space sector. This was followed by the establishment of IN-SPACe through a government notification in October 2021, and the formal inauguration of its headquarters by the Prime Minister in June 2022. Since then, IN-SPACe has worked closely with the Department of Space to introduce the Indian Space Policy 2023, which clarified the roles of major stakeholders, and launched a more liberalised Foreign Direct Investment (FDI) policy designed to attract global investment into India's space industry.

Dr Jain outlined IN-SPACe's dual mandate as both a promoter and enabler of space activities, as well as an authoriser and supervisor of space operations carried out by non-government entities (NGEs). As a promoter, IN-SPACe is tasked with creating mechanisms to support the growth of space startups, encouraging international partnerships, and facilitating collaboration with academic institutions. It also enables private companies to access ISRO's infrastructure, technical support, and technology, thereby allowing them to utilise these resources for their own space projects. Additionally, IN-SPACe has established a dedicated technical centre offering end-to-end support for satellite development, including design, simulation, assembly, integration, and testing. It is also working with state governments to establish space-related manufacturing clusters and incubation centres, aimed at further advancing the sector.

IN-SPACe's supervisory role stems from India's obligations under the Outer Space Treaty, which requires the government to authorise and oversee all space activities conducted by NGEs. The Indian Space Policy 2023 plays a crucial role in this regard, clearly defining the roles and responsibilities of various entities, including private companies, ISRO, and NSIL, across all segments of the space industry—whether in transportation, satellite communications, remote sensing, or space situational awareness. The policy importantly removes restrictions on private entities, allowing them to engage in activities such as building rockets, establishing launch infrastructure, and managing Earth observation data.

Dr Jain then turned his attention to the recently published "Norms, Guidelines, and Procedures" (NGP) document, a 150-page comprehensive guide on the implementation of the Indian Space Policy. The document outlines the space activities that require authorisation, the criteria for granting authorisation, and the guidelines entities must follow once they have received authorisation. To ensure transparency, IN-SPACe has provided templates for application forms and authorisation certificates, giving applicants clarity about the information required. The guidelines also address issues such as third-party liability, the registration of space objects, and the process for non-government entities to make International Telecommunication Union (ITU) filings, facilitating the commercial use of orbital resources.

A key aspect of the NGP is its clear definition of which space activities require authorisation. These include the operation of space transportation systems, satellite communications, and

the dissemination of remote sensing data. Additionally, activities such as launching space objects, establishing ground stations, and hosting payloads on satellites also require IN-SPACe's approval. Dr Jain explained that the application process has been streamlined, with preliminary assessments conducted by IN-SPACe to verify the applicant's technical and financial capability. Depending on the complexity of the project, applications are processed within 75 to 120 days. IN-SPACe also coordinates with other government departments to ensure that applicants receive necessary licences concurrently.

Dr Jain also highlighted the impressive impact of these reforms on India's space sector. The number of space startups in India has seen a dramatic rise, from just 20 a few years ago to over 250 today. Global investment in India's space sector has also increased significantly, surpassing $100 billion in the last three years. IN-SPACe has received over 500 applications for various space activities, with 47 authorisations issued and 75 technology transfers completed. Furthermore, data dissemination for Earth observation satellites has expanded, with over 50 satellites registered and approximately 31 data disseminators already active in the sector. This growth reflects the success of the Indian government's space reforms, which have opened the sector to both startups and larger companies.

In conclusion, Dr Jain stressed the need to sustain the momentum generated by these reforms through continued collaboration among stakeholders—government, industry, and academia. While these reforms have already had a profound impact, much work remains to be done to ensure the long-term success of India's space sector. By fostering innovation, encouraging investment, and streamlining regulatory processes, India is well on its way to becoming a major global player in space exploration and commercialisation.

The Key takeaways from the keynote address were:

1. **Milestones in Indian Space Reforms**: The Government of India's space reforms began in June 2020, leading to the formation of IN-SPACe in 2021. IN-SPACe has played a critical role in implementing space reforms, enabling private sector participation, and facilitating the growth of the Indian space sector. The Indian Space Policy, released in April 2023, was a major step forward in creating a structured environment for space activities.
2. **Introduction of Norms, Guidelines, and Procedures (NGP)**: IN-SPACe introduced a comprehensive 150-page NGP document in May 2024. This document outlines the framework for authorisation, supervision, and regulation of space activities, providing clarity on how non-governmental entities can engage in space-related projects.
3. **Liberalisation of FDI in Space**: The reforms have included a liberalised foreign direct investment (FDI) policy aimed at attracting global investments. This move is part of India's broader strategy to position itself as a key player in the global space market.
4. **Dual Role of IN-SPACe**: IN-SPACe serves both as a promoter and a regulator of space activities. It provides technical support and access to ISRO's infrastructure for private players, especially start-ups, while also ensuring compliance with national and international regulations.
5. **Venture Capital Fund for Space Sector**: The Government of India announced a ₹10 billion venture capital fund dedicated to the space sector. This fund is aimed at fostering

innovation and supporting start-ups, further boosting private sector growth.

6. **Upcoming Indian Space Act**: The forthcoming Indian Space Act will formalise the legal framework for space activities, providing legal backing for the ongoing reforms and procedures.
7. **Significant Growth in Start-ups**: India's space sector has witnessed significant growth in the number of start-ups, increasing from about 20 a few years ago to over 250 today. This growth is a direct result of the government's reform initiatives and the increasing global interest in India's space potential.
8. **Global Investments and Applications**: Global investment in India's space sector has exceeded $100 billion in the past three years, and IN-SPACe has processed over 500 applications for space activities, including authorisations and technology transfers.
9. **Focus on Satellite and Data Dissemination**: IN-SPACe has facilitated the registration of more than 50 satellites and 10 constellations for Earth observation, along with 31 data disseminators. These efforts are contributing to India's leadership in satellite and data-related services.
10. **Momentum in Space Activities**: Initiatives like the PSLV Orbital Experimental Module (POEM) missions, supporting non-governmental payloads, highlight the growing momentum in the Indian space sector. Collaboration between start-ups, large corporations, and public sector undertakings (PSUs) is driving comprehensive sectoral growth.
11. **Sustained Growth and Collaboration**: The session emphasised the need for continued collaboration among all stakeholders—government, private sector, and international partners—to sustain the momentum of growth in India's space industry

C. Session on Exploring Sectoral Business Opportunities via Indian Space Industries

The discussion on exploring sectoral business opportunities in the Indian space industry provided rich insights into the sector's potential and challenges. The session emphasized the transformation within the Indian space sector, highlighting the shift from state-sponsored projects to industry-led initiatives. This evolution is driven by increasing enthusiasm among various industries to contribute to space development. The tagline for the event, "Accelerating Tomorrow: Harnessing the Potential of the Space Sector for Unified Expansion," encapsulated stakeholders' ambition to broaden the space economy, which is expected to grow at a remarkable rate of 9% per annum until 2035, outpacing global GDP growth.

Several key trends were identified throughout the discussion. The space economy is evolving from a niche market to a more ubiquitous one, impacting various non-space industries. More than 15 sectors are now reliant on space technologies, demonstrating the expansive reach of satellite data and applications. Furthermore, the socio-economic benefits of space investments were underscored, showcasing returns that extend beyond mere financial gains.

While satellite imagery is abundant, its adoption remains a challenge. There are inefficiencies in interpreting satellite data for agricultural financing, which has previously taken farmers

30-45 days to receive loans. However, advancements in leveraging satellite imagery have reduced this time dramatically to just 10 minutes. This shift illustrates the potential of satellite data, although challenges still exist in effectively communicating its utility to professionals, such as loan managers.

Innovative propulsion technologies were also discussed, particularly those reducing reliance on toxic fuels. New electric propulsion systems are enabling satellites to operate in ultra-low orbits, between 180 to 250 kilometres, which enhances sustainability and improves imaging capabilities. The launch sector was highlighted as a key area of opportunity, with projections indicating growth from a $12 billion market to an estimated $30 billion by 2030. This expansion is driven by advancements in launch technology and significant government investment in infrastructure, such as new launch pads. With a robust vendor ecosystem already in place, Indian companies are well-positioned to capture a substantial share of the small satellite launch market, especially as demand increases.

A crucial theme throughout the discussion was the need for collaboration across the industry. Stakeholders—from startups to established companies—must work together to develop integrated solutions that cater to diverse customer needs. This collaboration is essential to ensure that various segments of the space sector, including upstream, midstream, and downstream applications, function cohesively to deliver comprehensive solutions to clients.

The potential for India to establish itself as a leader in the global downstream space economy was emphasized, particularly in Earth observation, navigation, and communication sectors. With projections indicating a move from an $8.4 billion to a $44.4 billion space economy within the next decade, the downstream market is poised for significant growth. However, challenges remain, including generating demand and creating robust data aggregation platforms for Earth observation.

The session concluded with strategic recommendations for enhancing India's position in the global space market. Active efforts are needed to stimulate demand for space applications across various sectors, such as agriculture and infrastructure. Establishing platforms similar to Europe's Copernicus or the U.S.'s Landsat would facilitate better access to satellite data and drive its usage across industries. Additionally, emphasizing small satellite manufacturing can position India as a hub for both domestic and international markets. In summary, the discussion underscored the transformative potential of the Indian space sector, driven by innovation, collaboration, and strategic market positioning. As the space economy expands, stakeholders must focus on integrating technological advancements with market needs to fully leverage the opportunities available in this rapidly evolving landscape.

Key Takeaways from the Session were:

1. **Growth of the Space Sector**: The space economy is expanding from being a niche industry to one with broader applications across various sectors. According to a World Economic Forum report from April 2024, the space sector is expected to grow at an annual rate of 9%, outpacing global GDP growth. The sector's impact will extend beyond space to benefit industries such as agriculture, infrastructure, telecommunications, and finance.
2. **Collaboration and Innovation**: Success in the space sector requires collaboration between

legacy players (like ISRO) and new entrants (such as start-ups). Technological innovation and financial competitiveness will be key drivers, with an emphasis on reducing costs for accessing space and creating new commercial opportunities.

3. **Importance of Data Utilisation**: There is a wealth of satellite imagery and data available, but the challenge lies in its effective adoption. Businesses must find ways to convert raw data into usable information for specific sectors, such as agriculture, infrastructure, and energy. Companies must specialise in sectoral demands and address specific business challenges using satellite data to unlock more value.
4. **Emerging Business Opportunities in Propulsion**: The propulsion sector presents significant business opportunities, especially in developing new propulsion technologies that are cost-effective, reliable, and sustainable. Companies are focusing on creating innovative solutions such as electric propulsion systems and exploring ultra-low orbits, which could revolutionise satellite performance in imaging and communications.
5. **Launch Sector Potential**: The global launch market, though currently a small portion of the space economy (around $12 billion), is set to grow to $30 billion by 2030. India, with its established ecosystem and government support, is well-positioned to capture a significant share of the small satellite launch market, potentially accounting for 50% of launches in the small payload segment by 2030.
6. **Strategic Importance of Downstream Applications**: The downstream segment of the space sector, especially in Earth observation (EO), navigation, and communications, offers the largest growth potential. India's capabilities in IT and software development make it well-suited to take global leadership in downstream applications. However, demand generation, both from public and private sectors, will be crucial to unlocking this potential.
7. **Building a Competitive Space Ecosystem**: India's space sector can become globally competitive by developing comprehensive solutions across the value chain—from upstream (launch vehicles and satellites) to midstream (data processing and ground stations) and downstream (data applications). This requires collaboration among various stakeholders, including start-ups, established companies, and government agencies.
8. **Global Leadership in the Indian Ocean Region (IOR)**: India can leverage its geographical and technological advantages to take a leadership role in the Indian Ocean Region (IOR), including Africa, Southeast Asia, and Australia. By focusing on small satellite manufacturing and establishing a data aggregation platform similar to Europe's Copernicus or the US's Landsat, India can strengthen its global footprint in space services.
9. **Focus on Education and Research**: Space technology is a highly interdisciplinary field that brings together various branches of science and engineering. Educational institutions are increasingly recognising the need to train professionals in this field. India's academic sector is beginning to integrate space science programmes, with initiatives to develop satellites and conduct space research.
10. **Sustainability and Future Challenges**: The space industry must balance technological advancements with sustainability. Propulsion systems that can de-orbit satellites after their lifespan and focus on ultra-low orbits are being explored as potential solutions for reducing

space debris. Additionally, India's space sector needs to focus on long-term sustainability through continuous technological innovation and demand generation.

D. Keynote Presentation – Decisive Decade: Decadal Vision Roadmap for the Indian Space Economy by Air Vice Marshal D V Air Vice Marshal Khot (Retd.), Principal Consultant, IN-SPACe

Air Vice Marshal D. V. Khot (Retd.), Principal Consultant at IN-SPACe, delivered a comprehensive keynote address focusing on the strategic vision and roadmap for India's space economy over the next decade. He began by outlining the historical context of India's space programme, which was initiated in the 1960s with a core objective of societal welfare rather than military applications. This foundational principle has guided the evolution of India's space initiatives, allowing for the democratization of space and enabling broader access to its benefits.

Air Vice Marshal Khot emphasized that the current decade represents a critical opportunity for India, referring to it as a "decisive decade." He noted the challenges and competitive landscape in the global space sector, stressing the need for strategic planning and execution. Air Vice Marshal Khot introduced the vision of IN-SPACe to transform India into a dominant space power, which aims to accelerate growth through space applications while generating socio-economic benefits. The ambitious target set for the Indian space economy is $44 billion by 2033, which includes significant contributions from the private sector.

The address delved into four main areas of focus that underpin this vision:

1. **Earth Observation**: Air Vice Marshal Khot outlined the revenue potential from Earth observation, noting the importance of data generation, acquisition, and downstream applications. He highlighted the role of private sector partnerships in establishing Earth observation constellations and ground stations, which are crucial for managing data dissemination and enhancing user engagement.
2. **Satellite Communication (SATCOM)**: He described SATCOM as a matured sector with a substantial revenue stream, driven by the need for seamless connectivity across diverse terrains in India. Air Vice Marshal Khot identified areas for growth, including the expansion of satellite manufacturing, ground segment capabilities, and the adoption of consumer satellite broadband services. He projected significant growth in the SATCOM market, emphasizing that it will continue to be a key revenue generator.
3. **Satellite Navigation (SATNAV)**: Air Vice Marshal Khot pointed out that SATNAV has emerged as the second-largest revenue generator within the Indian space economy. He outlined the potential for growth in this sector, particularly through the development of integrated solutions and user devices, leveraging existing GPS technology alongside India's indigenous capabilities.
4. **Launch Services**: Air Vice Marshal Khot noted that the launch services segment is still developing in India, with significant potential for growth. He outlined the ongoing transition of launch vehicle manufacturing from government to private sectors, emphasizing the upcoming operational launch pads dedicated to small satellites. This shift aims to establish India as a global hub for small satellite launches.

Air Vice Marshal Khot stressed the importance of a collaborative ecosystem that integrates the private sector, government, and academia. He introduced the concept of a "whole-of-nation approach," wherein all stakeholders contribute to the vision and mission. A crucial element of this strategy is the establishment of a robust financial framework that supports industrial capacity building, R&D, and technology transfer.

In addition, Air Vice Marshal Khot highlighted the necessity of developing a skilled workforce capable of meeting the demands of a rapidly evolving space industry. He called for enhanced focus on talent development, proposing initiatives to nurture expertise outside the traditional ISRO ecosystem.

Air Vice Marshal Khot concluded by affirming that the future of India's space economy hinges on a collective effort. He urged all stakeholders to collaborate effectively to harness the potential of space for national and global benefit, ultimately positioning India as a significant player in the international space arena. His vision encompasses not only the expansion of India's capabilities but also the need for proactive engagement in global partnerships to seize emerging opportunities.

Key takeaways from the keynote address were:

1. **Critical Decade for Indian Space**: This decade is a crucial window of opportunity for India to position itself as a global leader in the space economy. With new policies and the active involvement of both public and private sectors, India aims to accelerate growth through space applications and socio-economic benefits.
2. **Ambitious Targets**: India's space economy, currently valued at $8.4 billion, is projected to grow to $44 billion by 2033, with $11 billion in exports. This ambitious goal requires a compounded annual growth rate (CAGR) of 16%. The plan envisions a robust ecosystem where private, public, and start-up entities collaborate effectively.
3. **Four Strategic Sectors**: The roadmap focuses on four key sectors—Earth observation, satellite communications (SATCOM), navigation, and launch services—identified as areas with the greatest revenue potential. The goal is to develop integrated solutions across these sectors, involving both upstream and downstream segments of the space industry.
4. **Growth Potential in Earth Observation**: Earth observation (EO) is expected to experience substantial growth, with market potential projected to increase by 11x over the next 10 years. India plans to build EO constellations through public-private partnerships, as well as expand ground stations and data management capabilities to capitalise on this opportunity.
5. **SATCOM Expansion**: SATCOM is already a mature sector, but it remains a key revenue generator, particularly in bridging India's digital divide. With the government's focus on Digital India, satellite communications will play a critical role in providing connectivity to remote and challenging terrains. The SATCOM market is expected to grow by 3.5x in the next decade.
6. **Navigation Systems**: The Indian Regional Navigation Satellite System (IRNSS or NavIC) is another area with high growth potential, particularly in creating user devices and integrated navigation solutions. The system has applications across a wide range of industries, from agriculture and transport to defence.

7. **Launch Services and Infrastructure**: India's launch capabilities are a source of pride, and there is significant potential to expand small satellite launch services. With the second spaceport expected to be operational by 2026, India aims to become a global hub for small satellite launches. The technology transfer of small satellite launch vehicles (SSLV) to private entities is underway, signalling further growth in this sector.
8. **Collaborative Approach**: The vision emphasises a "whole of nation" approach, where private industries, academia, and government work together to foster innovation and growth. Key enablers include policy frameworks, investment in research and development, talent development, and global outreach.
9. **Global Outreach and Export Focus**: India aims to position itself as a preferred global vendor for small satellite manufacturing and related services. The country plans to leverage its competitive advantage to increase exports, focusing on the Indian Ocean Region and expanding its footprint in Southeast Asia, Africa, and beyond.
10. **Funding and Investment**: The Indian government has introduced several funding initiatives, including a venture capital fund for the space sector and seed funding for start-ups. These are designed to boost industrial capacity and foster the growth of indigenous technologies.
11. **Talent Development**: As space expertise remains largely concentrated within ISRO, there is a growing need to expand skills and knowledge across the private sector. Initiatives such as academic collaborations and the National Skill Development programme are helping to train the next generation of space professionals.
12. **Demand Generation**: One of the challenges highlighted is the need for greater awareness and demand generation, both domestically and globally. The roadmap outlines customer awareness campaigns, pilot projects, and partnerships to drive demand for space-based services and solutions.

E. Session On Socio Economic Impact of Space Technologies & Applications

The session on "Socio-Economic Impact of Space Technologies & Applications" at the Bangalore Space Expo 2024 provided a detailed exploration of how space technologies can drive transformative changes across various sectors of society. The discussion began by underscoring the longstanding collaboration between India and the Netherlands, particularly in the areas of Earth observation, disaster management, and precision farming. The close cooperation between industry, academia, and government in the Netherlands was highlighted as a model for harnessing space technology to address societal challenges. This collaboration has fostered innovation in climate monitoring and disaster preparedness, where space applications play a critical role. The Netherlands' experience in using space technologies to manage climate-related risks, such as maintaining water levels in a country located below sea level, was offered as a prime example of the socio-economic benefits that can be derived from space-driven solutions.

A significant portion of the discussion focused on the role of space technology startups and their contributions to solving real-world problems. For example, innovations such as synthetic

aperture radar (SAR) combined with multispectral imaging have proved effective in monitoring natural disasters, where optical imagery is hindered by cloud cover. By using SAR, which can penetrate clouds and provide continuous monitoring, along with multispectral imaging, startups are able to offer timely and actionable data for disaster management, agriculture, and environmental monitoring. The potential for these technologies to be applied in aquaculture, where farmers can receive insights on water quality and harvest timings, was also explored. This example demonstrates how space technology can improve not only the productivity of sectors like agriculture but also the livelihoods of small-scale farmers by enabling them to access insurance schemes tailored to their specific needs.

The session also delved into the challenges related to scaling the impact of space technologies. While the supply side of space infrastructure, such as satellites and constellations, has grown rapidly, the panel identified a gap in demand creation. The global Earth observation market is projected to reach $700 billion by 2030, but realising this potential requires creating links between space technologies and industries that can benefit from them, such as insurance, agriculture, and supply chain management. Space-based data has the power to revolutionise these sectors, but the challenge remains in bridging the gap between the availability of data and its application in everyday business operations. The need for public-private partnerships and demand aggregation was emphasised as a way to make space technologies more relevant and accessible to a wider range of industries.

Another critical area discussed was the role of satellite communication in addressing socio-economic disparities, particularly in rural and underserved areas. High-speed satellite internet connectivity, especially through low-latency constellations, can bring transformative changes to rural regions, providing access to critical services such as healthcare, education, and e-commerce. The panel noted that while traditional geostationary satellites provide valuable services, emerging low-Earth orbit (LEO) and medium-Earth orbit (MEO) satellite constellations are poised to revolutionise connectivity by reducing latency and improving data transmission speeds. These improvements will make it possible for rural communities to benefit from the same digital services that urban populations enjoy, thereby reducing the digital divide and fostering socio-economic development in remote areas.

The session also explored how space technologies can play a role in addressing global challenges, such as climate change and air quality monitoring. By integrating space-based data with ground-level initiatives, governments and industries can better respond to environmental challenges. Collaboration between international space agencies, such as the European Space Agency (ESA), and national governments was seen as crucial to tackling these large-scale issues. The integration of space data into climate change mitigation strategies, air quality monitoring, and disaster preparedness efforts is increasingly viewed as essential to achieving global sustainability goals.

The indigenisation of space technology was also a major theme of the discussion. While many startups initially relied on imported components, the panel discussed the growing trend of localising production to enhance self-reliance and competitiveness. Indigenisation not only reduces dependency on foreign suppliers but also enables local companies to compete in global markets by offering high-quality, cost-effective solutions. The ability to build advanced

technologies such as synthetic aperture radar and multispectral imaging systems domestically was highlighted as a key factor in driving the growth of the Indian space sector. Startups are increasingly focusing on developing indigenous components and reducing their reliance on imports, with the goal of becoming global leaders in space technology innovation.

The session concluded by recognising the significant socio-economic impact that space technologies can have across a broad range of sectors. Whether through improving disaster management, enabling precision farming, or providing connectivity to rural areas, space technologies have the potential to address critical societal challenges. The panel underscored the importance of collaboration between governments, academia, startups, and international partners to fully harness the potential of space technologies for socio-economic development. India's robust space ecosystem was acknowledged as being well-positioned to lead these efforts, and the session called for continued innovation and cooperation to ensure that space technologies deliver tangible benefits to society at large.

Key Takeaways from the Session were:

1. **International Collaboration**: India and the Netherlands have a longstanding collaboration in space technology, especially in Earth observation and societal applications, like precision farming and disaster management. The Netherlands is a leader in integrating space technologies into governance and industries through its Innovation Network.
2. **Startups and Innovation**: Indian startups like Galaxy are leading the way in creating indigenous satellite technologies. They are focusing on multi-sensor imaging solutions that combine Synthetic Aperture Radar (SAR) and multispectral imaging to solve challenges such as disaster management, agriculture, and aquaculture. Galaxy's satellite missions are designed to provide unique, high-resolution data for strategic and commercial applications.
3. **Socio-economic Impact**: Earth observation and space applications are vital for solving real-world challenges such as natural disaster management, agriculture productivity, and water management. The data collected from satellites supports industries in these sectors, enhancing revenue and providing additional services like insurance for farmers.
4. **Challenges and Opportunities in Space Applications**: Deloitte highlighted that while space technology supply is robust, the demand side needs strengthening, especially in translating Earth observation data into actionable insights for industries like agriculture, supply chains, and insurance. They emphasised the need for intermediaries, such as insurance and large trading firms, to help connect space technologies to end users.
5. **Building Talent and Localisation**: The session touched on the importance of nurturing a talent pool in space technology. Both Indian universities and private companies are focusing on developing local capabilities in satellite technology, with an increasing emphasis on indigenisation to reduce reliance on imports while maintaining global competitiveness.
6. **Emerging Space Technologies**: The session explored the future of space technology, including SAR, optical sensors, and multi-sensor data fusion. These advancements are expected to drive further socio-economic benefits in areas such as climate monitoring, resource management, and strategic applications.

7. **Commercialisation and Global Competitiveness**: Balancing indigenous content with profitability is a challenge for startups. However, leveraging partnerships with national space agencies and using shared infrastructure can reduce costs and enable startups to focus on innovation and global market competitiveness.

F. Session On Futuristic & Emerging Technologies in Space: Commercial Prospects

The session on explored the rapid advancements in space technologies that promise to reshape the future of space exploration, satellite communication, and commercialization. The conversation began by outlining the immense shift from a government-driven space sector to one where private entities, startups, and commercial ventures play an increasingly pivotal role. This transition has been accelerated by governmental reforms, policies, and investments aimed at opening the space economy, fostering innovation, and supporting private sector participation in key areas of space technology.

One of the central themes of the session was the growing role of public-private partnerships and the rise of space startups that are contributing cutting-edge solutions across different segments of the space industry. From satellite manufacturing and launch vehicles to propulsion systems and space situational awareness, these startups are significantly shaping the future of space exploration. The speakers highlighted that the number of space-related startups has surged in recent years, with companies like Skyroot, Agnikul, Bellatrix Aerospace, and others leading innovations in both upstream and downstream space activities. These companies are now developing technologies in areas such as propulsion, satellite edge computing, and autonomous decision-making, which are critical to the future of space commercialization.

A key area of discussion was propulsion technologies, particularly the need for more efficient and sustainable propulsion systems. The limitations of traditional chemical propulsion systems, especially for deep-space exploration and missions beyond Earth's orbit, were emphasized. Current propulsion technologies face challenges related to carrying enough fuel for long-distance missions, such as those to Mars or other planets. To overcome these obstacles, advancements in electric propulsion and nuclear reactors are seen as essential for future deep-space missions. Electric propulsion offers greater efficiency, but its viability diminishes beyond Mars due to the reduced solar energy available for powering spacecraft. The session also explored the potential of green propulsion systems, which aim to replace toxic fuels like hydrazine with safer, more environmentally friendly alternatives. These green propulsion technologies will be crucial not only for reducing the environmental impact of space missions but also for ensuring the safety of human spaceflights, particularly as India advances its Gaganyaan human spaceflight programme.

The integration of Artificial Intelligence (AI) and edge computing in space technologies was another major focus. The session emphasized how AI and edge computing are transforming space systems by enabling satellites to perform autonomous decision-making and process data in real-time, closer to the source of information. This technology allows satellites to adapt their functions mid-orbit, making them more responsive to changing needs, such as switching from monitoring wildfires to tracking floods, all within a single orbit. This capability significantly

enhances the efficiency of Earth observation and disaster management applications, providing timely and actionable insights. As AI and machine learning continue to evolve, they are expected to play a critical role in supporting future space missions, from navigation systems to real-time data analysis and space situational awareness.

In addition to AI, the session discussed the increasing use of quantum communication and optical communication technologies, which are seen as vital for the future of space-based data transmission. Quantum communication, known for its high security, and optical communication, which allows for higher data transfer rates with lower latency, are expected to enable seamless communication between Earth, satellites, and deep-space missions. These technologies are particularly important for future cislunar and Martian missions, where long-distance communication poses significant challenges. Additionally, phased array systems were highlighted as a key technology for improving satellite communication, although their current high cost remains a barrier to widespread adoption. The long-term goal is to develop more affordable phased arrays that can be used by a broader range of users, including households, to enable more widespread access to satellite-based high-speed internet.

Another major topic was space traffic management (STM) and the challenges posed by the increasing number of satellites in low-Earth orbit (LEO). As the number of satellites continues to grow, managing potential collisions and space debris becomes critical. This is especially important for missions involving human spaceflight, where the risks to human life are higher. The session underscored the need for sophisticated space traffic management systems and regulatory frameworks to ensure the safe operation of satellites and space stations. Drawing parallels to the aviation industry, where stringent regulations and coordination mechanisms are in place to manage air traffic, the space sector will require similar regulations to manage the growing complexity of space activities.

The discussion also addressed sustainability in space exploration, particularly the need for innovative solutions to ensure long-term space missions are environmentally responsible. Technologies like in-situ resource utilization (ISRU), which allows resources such as water and fuel to be harvested from space environments like the Moon or Mars, were highlighted as crucial for reducing the logistical challenges of deep-space exploration. ISRU will enable astronauts to produce fuel, oxygen, and other essential materials on-site, thus reducing the need to carry all resources from Earth. This technology is seen as a stepping stone towards establishing sustainable lunar bases and eventually supporting Mars colonization.

Finally, the session touched on the importance of commercial viability in space technologies. As space becomes increasingly commercialized, technologies that can be scaled and made cost-effective will be essential for the long-term sustainability of the space industry. The development of modular nuclear reactors and other futuristic propulsion technologies was highlighted as a key area where India can contribute to the global space economy. With the recent approval of several ambitious space programmes, including the development of India's own space station and follow-up missions to the Moon and Mars, the future of India's space sector looks promising.

In conclusion, the session emphasized the immense potential of futuristic and emerging technologies in driving the next era of space exploration and commercialization. With

advancements in propulsion, AI, communication, and space traffic management, coupled with strong public-private partnerships, the space sector is set for a transformative journey. The speakers stressed that continuous innovation, coupled with sustainable and commercially viable solutions, will be critical for India to establish itself as a global leader in space exploration and the burgeoning space economy.

Key takeaways from the session were:

1. **Technological Advancements Driving Space Exploration**: The session underscored how space exploration is entering a transformative phase, with emerging technologies poised to revolutionise space missions. Advances in propulsion systems, artificial intelligence (AI), autonomous decision-making, and quantum communications are expected to enhance space exploration capabilities. New propulsion technologies, such as green propulsion and modular nuclear reactors, are seen as essential for deep-space travel, enabling missions beyond the Moon and into interplanetary space.
2. **Shift from Government to Commercial Space Activities**: Historically, space exploration was primarily driven by government-funded programs. However, the session highlighted a significant shift in recent years, with private companies and startups playing a larger role. Companies like SpaceX have demonstrated the potential for commercial manned missions, and the unlocking of space policies in countries like India has further opened the door for private sector involvement. The rise of startups focused on satellite manufacturing, launch vehicles, and space-based services reflects the growing commercialisation of the space industry.
3. **Emerging Commercial Opportunities**: The session emphasised that the future of space technology presents numerous commercial opportunities, including space tourism, planetary mining, and space-based energy generation. The development of human habitats on the Moon and other planetary bodies is seen as a long-term goal that could open up vast new markets. Additionally, autonomous spacecraft and satellite constellations could enable faster, more efficient data collection for Earth observation and other applications, offering new revenue streams for companies operating in the space sector.
4. **AI and Digital Transformation in Space**: AI and machine learning (ML) were identified as key technologies that will drive future space missions. The integration of AI in spacecraft will enable autonomous decision-making, reducing the need for human intervention in space operations. AI can also enhance the efficiency of space systems by performing real-time data analysis, aiding in tasks such as navigation, communication, and satellite management. Additionally, digital transformation through simulation and edge computing will allow for greater operational flexibility and smarter satellites, which can adapt to multiple tasks based on real-time needs.
5. **Manufacturing and Scalability Challenges**: The session also touched upon the challenges faced by the space industry, particularly in manufacturing and scaling up production. For the development of future launch vehicles and space systems, innovative manufacturing techniques such as additive manufacturing, automation, and standardisation are essential to reduce costs and production time. The importance of standardising components across different launch vehicles was highlighted as a key step in achieving scalability and lowering costs.

6. **Space Traffic Management and Sustainability**: With an increasing number of satellites and spacecraft being launched, space traffic management (STM) and space situational awareness (SSA) have become critical issues. The session noted the need for improved regulations, coordination, and safety measures to avoid collisions and mitigate the risks posed by space debris. As the number of satellites in low-Earth orbit (LEO) increases, STM will be essential for ensuring the sustainable use of space.
7. **Green Propulsion and Sustainability**: The need for green propulsion systems was emphasised as a critical element in the future of space exploration, particularly for human missions. Green propulsion technologies, which reduce toxicity and improve safety, are essential for crewed spacecraft and long-duration missions. As space activities increase, there is a growing focus on ensuring that propulsion systems are not only efficient but also environmentally friendly, helping to minimise the impact of space operations on both human health and the environment.
8. **The Role of Quantum Communication**: The session also explored the role of quantum communication in future space missions. As space activities expand beyond Earth's orbit, there will be a growing need for secure and high-speed communication systems. Quantum communication holds promise for enabling secure data transmission over long distances, particularly for missions involving human spaceflight and deep-space exploration.
9. **Public-Private Collaboration**: Collaboration between governments, space agencies, and the private sector was identified as essential for the success of future space missions. Governments are increasingly supporting space startups and fostering innovation through favourable policies and funding. Public-private partnerships will play a pivotal role in driving the commercialisation of space technologies, ensuring that new developments are both commercially viable and aligned with long-term scientific goals.
10. **Future Vision and Long-Term Goals**: Looking ahead, the session highlighted ambitious long-term goals, including the development of a lunar base, human missions to Mars, and space stations beyond Earth's orbit. The session conveyed optimism about the future of space exploration, with expectations that the coming decades will see significant advancements in human spaceflight, interplanetary travel, and space-based industries.

G. Keynote Address By: Mr P Rajeeve, Hon'ble Minister Of Industries, Law & Coir, Kerala

The address delivered by the Minister focused on Kerala's vision for the future of its aerospace and defence sectors, aligning with the theme of "Accelerating Tomorrow: Harnessing the Potential of the Space Sector for Unified Expansion." The Minister began by highlighting Kerala's improvement in the ease of doing business rankings, moving from 28th to 1st position in the country. This achievement was attributed to joint efforts by the government, academia, and investors, showcasing Kerala's commitment to fostering a conducive business environment.

Kerala's aerospace and defence sector, already home to key players such as the Vikram Sarabhai Space Centre, BrahMos Aerospace, and ISRO's Liquid Propulsion Systems Centre, is rapidly evolving. The state is positioning itself as a significant contributor to India's strategic capabilities, with emerging sectors like unmanned aerial systems, missile systems, radar

systems, and homeland security solutions offering new opportunities for investment. The Minister mentioned that over 50 private companies are involved in drone technology, while government entities like ISRO are expanding their facilities in Trivandrum, reinforcing the state's growing aerospace ecosystem.

The Minister outlined the state's industrial policy, which offers a variety of incentives to attract investment, particularly in the defence and aerospace sectors. These incentives include a reimbursement of the state component of GST on capital investment, a 10% investment subsidy, and employment and quality certification benefits. Special rebates are also available for mega projects and R&D initiatives, further reflecting Kerala's strategic focus on innovation and industrial growth. The government has identified 22 priority sectors, including defence and space, and is keen to transform Kerala into a knowledge-based economy.

The Minister highlighted Kerala's *Campus-Linked Industrial Park* initiative, which aims to integrate higher education institutions with industrial development. Over 80 institutions have expressed interest in establishing industrial parks on their campuses, which will focus on the production of research outputs, faculty-led projects, and collaborations with alumni and industry. This initiative is designed to provide students with real-world industry experience, with credits and grace marks awarded for their participation in industrial activities.

Kerala's robust ecosystem for start-ups and MSMEs (Micro, Small, and Medium Enterprises) was also a key theme of the address. The state is recognised as having one of the best start-up ecosystems in the country and ranks 5th globally. In just two and a half years, Kerala has established over 290,000 MSMEs, with the Prime Minister acknowledging this as a best practice model. The Kerala Space Park, currently being developed in Trivandrum, is set to transform the city into a hub for space-related industries, focusing on satellite development, launch vehicle manufacturing, and satellite data applications.

The Minister also mentioned the *Kerala Defence Park* in Palakkad, part of the Kochi-Bengaluru industrial corridor, which is attracting companies involved in R&D, software development, and precision manufacturing for the aerospace and defence sectors. Another key development is the collaboration between Kerala Minerals and Metals Ltd. (KMML) and ISRO, which has led to the successful commissioning of a titanium sponge plant, making India one of only seven countries with this capability.

In conclusion, the Minister emphasised Kerala's strategic focus on fostering innovation and collaboration within the aerospace and defence sectors. With initiatives like the Kerala Space Park, world-class facilities, and a robust start-up ecosystem, Kerala is well-positioned to contribute significantly to India's space exploration and technology sectors. The state's comprehensive policy framework and incentives are designed to attract investment and drive industrial growth, ensuring that Kerala remains at the forefront of India's space economy.

The key takeaways from the keynote address were:

1. **Kerala's Top Ranking in Ease of Doing Business**: Kerala has made significant strides, moving from 28th to 1st place in the national rankings for ease of doing business. This success is the result of joint efforts by the government, academia, and investors, demonstrating Kerala's commitment to a business-friendly environment.

2. **Aerospace and Defence Sector Growth**: Kerala is emerging as a key player in India's aerospace and defence sectors, with several prominent institutions and companies based in the state. These include the Vikram Sarabhai Space Centre, BrahMos Aerospace, and ISRO's Liquid Propulsion Systems Centre. The state is focusing on unmanned aerial systems, missile systems, radar systems, and homeland security solutions as areas for investment and growth.
3. **Incentives for Investment**: The state's 2023 industrial policy provides numerous incentives to attract investment, particularly in defence and aerospace. These include GST reimbursements on capital investment, investment subsidies, employment incentives, and rebates for mega projects and R&D initiatives. Defence and space sectors are among Kerala's 22 priority areas for development.
4. **Campus-Linked Industrial Parks**: Kerala is launching an innovative *Campus-Linked Industrial Park* initiative, integrating higher education institutions with industrial development. This initiative allows students to work on industry projects related to their fields of study, gaining practical experience while receiving academic credit.
5. **Strong Ecosystem for Start-ups and MSMEs**: Kerala boasts a highly successful ecosystem for start-ups, ranked the best in India and 5th globally. The state has established over 290,000 MSMEs in just two and a half years, contributing significantly to economic growth and earning recognition from the Prime Minister as a best practice model.
6. **Kerala Space Park and Defence Park Developments**: The *Kerala Space Park* in Trivandrum is expected to transform the region into a hub for space-related industries, including launch vehicle manufacturing and satellite development. Additionally, the *Kerala Defence Park* in Palakkad is attracting aerospace and defence companies involved in R&D and precision manufacturing.
7. **Focus on Innovation and Knowledge-Based Economy**: Kerala's development strategy includes fostering a knowledge-based economy, with a focus on innovation and high-tech industries. The state is leveraging its strong human resources and offering wide-ranging incentives to attract companies in AI, blockchain, big data, robotics, and more.
8. **Collaboration with ISRO and DRDO**: The successful commissioning of a titanium sponge plant in collaboration with ISRO and DRDO positions Kerala as a key player in India's aerospace value chain, ensuring access to critical materials for strategic programmes.
9. **Future-Ready Education and Skilled Workforce**: Kerala is working closely with higher education institutions to align academic programmes with industry needs. This includes creating flexible courses in emerging technologies and providing real-world industry exposure to students, ensuring a skilled workforce for the future.

H. Session On Space Applications for Business Growth: Leveraging Gis Solutions for The Private Sector

The session on *Space Applications for Business Growth* was a comprehensive exploration of the critical role that space technology, particularly GIS (Geographic Information System) solutions, plays in fostering economic development across a wide range of industries. It

highlighted how space applications are integral not just for high-profile space missions but also for solving real-world problems in sectors such as agriculture, urban planning, disaster management, logistics, and renewable energy.

The session began by addressing the importance of India's space programme, which was founded with the vision of using space technology for the betterment of society. While India's space missions like Chandrayaan-3 have garnered global attention, the discussion pointed out that a major portion of the space sector's potential lies beyond these headline-grabbing projects. Space applications have far-reaching implications, particularly for the business world, where they can drive efficiencies, enable innovation, and provide data-driven solutions.

A key emphasis was placed on the distinction between upstream and downstream activities in the space sector. While upstream activities such as satellite manufacturing and launch vehicle development remain critical, they represent only about 20-30% of the total scope. The downstream activities—where satellite data is processed and applied—make up around 70-80% of the space industry's potential. These downstream applications are where businesses, especially in the private sector, can derive significant value. They include applications for Earth observation, satellite communication, and satellite navigation—all of which, when integrated, can deliver highly impactful solutions for various industries.

The discussion then focused on how the Government of India has liberalised policies to facilitate private sector involvement in the space economy. With the opening of the space sector, private companies and start-ups now have more opportunities to engage in downstream activities. The government's role is not limited to regulating space activities but also facilitating and encouraging innovation in how space technology is used in everyday business applications. This shift in policy is designed to drive the adoption of space-based solutions, particularly in areas such as agriculture, disaster management, urban planning, and supply chain logistics.

Several successful case studies were presented during the session, demonstrating how space data combined with GIS technology has already been applied to solve real-world problems. One example is the use of Earth observation data for agricultural planning and drought monitoring. GIS solutions have helped state governments assess drought conditions at a granular level, providing decision-makers with the tools to implement relief measures and manage resources effectively. In the agricultural sector, the development of an Agri Decision Support System (Agri-DSS) was highlighted, which uses space-based data to help farmers optimise crop yields and manage water resources more efficiently. The system is part of a broader initiative by the Ministry of Agriculture, with ISRO playing a key role in providing the necessary data.

The session also discussed the role of satellite-based GIS in disaster management. During natural disasters, traditional communication and navigation systems often fail, but satellite systems remain operational. Satellite communication and Earth observation play a crucial role in disaster response, providing real-time data on affected areas, which helps in coordinating rescue operations, monitoring environmental damage, and planning post-disaster recovery efforts. This is particularly relevant for India, a country prone to various natural disasters such as floods, cyclones, and droughts.

Tourism and coastal management were other areas where GIS and space applications have made a significant impact. For example, satellite data is being used to monitor coastal erosion and manage fisheries more efficiently. Fishermen are now alerted to optimal fishing zones through GIS-based applications, which not only improves their productivity but also enhances safety by providing early warnings of extreme weather events like cyclones. Coastal surveillance, which uses satellite navigation and remote sensing, is also helping in preventing illegal activities in territorial waters and safeguarding maritime security.

The session further explored the use of space data in the energy sector, particularly in the context of renewable energy. Satellite data is being used to identify suitable locations for solar farms, a key component of India's renewable energy strategy. A solar calculator application, developed using satellite data, helps businesses and policymakers determine the best locations for setting up solar panels by providing detailed information on solar potential, land slope, and proximity to transmission lines. This tool has been used not only in India but also in Africa, supporting the objectives of the International Solar Alliance.

Urban planning and infrastructure development were also key points of discussion. GIS solutions are helping municipalities and city planners map out infrastructure needs, monitor the growth of urban areas, and assess environmental impacts. For instance, satellite data has been used to create urban land-use maps at high resolutions, which support better decision-making for city planners. This technology has been integrated into the government's flagship programmes, such as the *Gati Shakti* initiative, which aims to modernise India's infrastructure and improve logistical connectivity across the country.

A significant portion of the session was dedicated to discussing the potential for public-private partnerships (PPP) in the space sector. The collaboration between the public sector (including ISRO and other governmental bodies) and private players is seen as crucial for expanding the use of space applications. Programmes like *Swamitva* and *Clean Ganga* are examples of how space technology can be integrated into national development efforts. In the *Swamitva* project, GIS technology is being used to map rural properties, thereby helping to streamline property rights and ownership issues. Similarly, the *Clean Ganga* project uses space data to monitor the health of the river ecosystem and track the progress of cleaning efforts.

One of the recurring themes of the session was the need for capacity building and skill development in the space sector. As the space industry continues to grow, there is an increasing demand for skilled professionals who can work with GIS and space data. The discussion underscored the importance of creating training programmes that align with industry needs, thereby equipping the next generation of workers with the skills required to harness the potential of space technology. Academic institutions and training centres are being encouraged to collaborate with industry to develop curricula that focus on space applications and geospatial technologies.

The session also emphasised the importance of data accessibility and sharing. While ISRO continues to provide a wealth of satellite data for public use, new platforms are being developed to make this data more accessible to businesses, researchers, and government agencies. The *Bhuvan* platform was highlighted as an example of how Earth observation data can be easily accessed by anyone, including the private sector. The platform offers a

wide range of data, including satellite imagery and geographical information, which can be used to develop innovative applications for business growth.

The session underscored the vast opportunities that space applications, particularly GIS solutions, offer to businesses across sectors. The liberalisation of space policies, combined with the growing availability of satellite data, has opened the door for private sector participation in the space economy. By leveraging space technology, businesses can enhance decision-making, improve operational efficiencies, and develop innovative products and services. As the session highlighted, space applications are not only critical for advancing business growth but also for achieving broader societal goals, such as sustainable development and disaster resilience. The future of the space industry lies in its ability to integrate with other sectors, and GIS solutions will play a pivotal role in this transformation.

Key takeaways from the session were:

1. **Significant Role of Downstream Space Applications**: While upstream activities like satellite and launch vehicle manufacturing are crucial, the majority (70-80%) of the space sector's value lies in downstream applications. These include the use of space data for agriculture, urban planning, logistics, and disaster management, among others. Space applications are essential for solving real-world problems across various industries.
2. **Government Policy Opening Opportunities**: The liberalisation of India's space sector, with policies encouraging private sector involvement, has created significant opportunities for businesses and start-ups. The government is keen to facilitate private players' entry into the space economy, particularly in downstream sectors like GIS and space-based data applications.
3. **Integration of Earth Observation, Communication, and Navigation**: The synergy between Earth observation, satellite communication, and navigation is critical for business solutions. GIS technology, combined with these three pillars, offers a range of solutions for industries like agriculture, urban infrastructure, and disaster management.
4. **Practical Applications in Agriculture and Disaster Management**: Space data is already being used to support agricultural decision-making through initiatives like the Agri Decision Support System (Agri-DSS). It helps optimise crop yields and manage resources. Similarly, in disaster management, satellite data is used to monitor natural disasters, assist in rescue operations, and plan recovery efforts.
5. **Business Opportunities in Renewable Energy**: Satellite data is being used for site selection and optimisation of solar farms. The development of tools such as the solar calculator provides precise information on solar potential, helping businesses maximise the efficiency of solar energy projects.
6. **Public-Private Partnerships and National Development Programmes**: Public-private partnerships (PPP) are essential for advancing space applications in national development initiatives. Projects like *Gati Shakti* and *Swamitva* highlight how space data and GIS solutions are being integrated into infrastructure development and rural property mapping, creating opportunities for private sector involvement.

7. **Focus on Capacity Building and Skill Development**: The need for skilled professionals in space applications and GIS is critical. There is a growing emphasis on developing training programmes to equip the workforce with the necessary skills to handle space-based data and technologies.
8. **Data Accessibility and Sharing**: Platforms like *Bhuvan* provide easy access to Earth observation data, enabling businesses, researchers, and government agencies to utilise satellite data for developing innovative applications. This open data access is essential for driving innovation and expanding the use of space technology.
9. **Expanding Scope of GIS Solutions**: GIS technology is being widely used in sectors such as urban planning, infrastructure monitoring, supply chain management, and environmental conservation. GIS-based solutions enable better decision-making, improve operational efficiency, and provide a competitive edge to businesses.
10. **Broad Scope for Start-Ups**: Start-ups have vast opportunities in leveraging GIS solutions for downstream applications. The session highlighted how the private sector can contribute significantly to space-based services by focusing on innovative applications that meet the needs of industries and governments.

I. Keynote Address / Presentation - Accelerating Indian Space Sector: Key Enabling Initiatives for Private Space Ecosystem by Dr. Rajeev Jyoti, Director Technical, INSPACe

The keynote address at the session *Accelerating Indian Space Sector: Key Enabling Initiatives for Private Space Ecosystem* provided an insightful overview of the measures taken by IN-SPACe to stimulate and support the growth of the private space ecosystem in India. The address highlighted the transformative reforms that have opened up the space sector to private entities, start-ups, and academia, allowing them to play an active role in space-related activities. The Indian Space Policy and the establishment of IN-SPACe in 2022 have created a fertile environment for private companies to engage in every aspect of space development, from ground infrastructure to space exploration.

A major point of emphasis was the rapid growth of space start-ups, with over 300 currently operational in India, thanks to the removal of restrictions on private involvement. This policy change allows companies to independently pursue opportunities across the entire spectrum of space activities, from manufacturing satellites and launch vehicles to offering satellite-based services.

IN-SPACe has introduced a range of initiatives designed to encourage innovation and reduce barriers for private companies. These include Public-Private Partnerships (PPP), seed funding for start-ups, and grants for technology development. IN-SPACe also provides financial support for technology transfers, helping companies access critical ISRO infrastructure for testing and development at affordable costs. In particular, private companies can now utilise ISRO's extensive testing and simulation facilities, which are crucial for developing space-ready hardware. Additionally, IN-SPACe has assembled a team of resident experts who offer free mentorship to companies, providing valuable technical guidance to support the development of space technologies.

To further promote private sector participation, IN-SPACe has set up a **Technical Centre** in Ahmedabad, which provides access to advanced design software, clean rooms, and testing facilities. This centre enables private companies to design, prototype, and test their technologies without incurring significant costs. The centre also offers simulators for payloads to be used in PSLV launches, allowing companies to verify and refine their technologies before they proceed to the final launch stages.

A significant portion of the address focused on the development of Earth Observation (EO) satellites through a Public-Private Partnership model. IN-SPACe is working to create a constellation of EO satellites that will be jointly funded by private companies (70%) and IN-SPACe (30%). This initiative aims to reduce India's reliance on foreign data providers and meet both domestic and international demand for high-resolution EO data. EO data has broad applications across sectors such as agriculture, disaster management, environmental monitoring, and location-based services. By enabling private companies to own and operate EO satellites, this initiative is expected to capture a significant share of the global EO data market.

The keynote also discussed **technology transfer**, with IN-SPACe having facilitated over 70 agreements with private companies, enabling them to commercialise technologies developed by ISRO. These agreements are critical for scaling up production and expanding the reach of Indian space companies in both domestic and international markets. In addition, IN-SPACe has established a venture capital fund to support early-stage companies, providing much-needed financial backing to help start-ups commercialise their innovations.

IN-SPACe is working closely with state governments to create **manufacturing hubs** for the space sector, with agreements already in place with Gujarat and Tamil Nadu. These hubs will house production and testing facilities, further supporting the expansion of space-related manufacturing in India. The development of these hubs is crucial for meeting both domestic demand and growing international opportunities.

Recognising the importance of internationally accepted standards, IN-SPACe is collaborating with Indian industry to develop and adopt global space standards. This effort is critical for ensuring that Indian companies remain competitive in the global space market. IN-SPACe is also encouraging the development of indigenous standards for space technologies to cater to the specific needs of Indian companies.

A significant initiative in development is the Small Satellite Launch Vehicle (SSLV) programme, where private companies are being given the opportunity to develop and launch SSLVs. A second launch complex, which will be dedicated exclusively to private sector launches, is expected to be operational by 2026. This infrastructure will support the increasing demand for smaller payload launches, which are a growing segment of the global space market.

Another innovative initiative is the **satellite bus as a service** model, where private companies can use a shared satellite bus rather than building their own. This service allows companies to focus on developing their payloads, reducing costs and accelerating the time to market for their satellite-based services.

The address also covered **skill development** initiatives, with IN-SPACe conducting regular training programmes and workshops to build a skilled workforce capable of meeting the needs of the expanding space sector. Co-working spaces at IN-SPACe facilities are designed to foster collaboration and innovation among start-ups, researchers, and companies.

In conclusion, the keynote highlighted that India's space sector is at a critical juncture, with unprecedented opportunities for private players. IN-SPACe's initiatives, including financial support, access to infrastructure, and technology transfers, are designed to nurture the growth of the private space ecosystem. With these enabling frameworks in place, India is poised to capture a larger share of the global space economy, which is expected to reach $1.8 trillion in the coming decade. The collaborative efforts between the government, private sector, and academic institutions will be key to realising this vision and positioning India as a major player in the international space arena.

Key takeaways from the keynote address were:

1. **Opening of the Space Sector for Private Participation**: The Indian space sector has undergone major reforms, fully opening up the space industry to private players. Private entities, including start-ups and academic institutions, now have unrestricted access to participate in space activities, leading to significant growth in space start-ups in India, with over 300 currently in operation.
2. **Supportive Framework by IN-SPACe**: IN-SPACe has introduced several initiatives to promote the private space ecosystem, such as:
    - **Public-Private Partnerships (PPP)** to facilitate collaboration.
    - **Seed funding, grants, and financial support** to encourage innovation and technology development.
    - **Access to ISRO facilities** for testing and simulations, crucial for the development of space-ready technologies.
    - **Mentorship programmes**, offering free technical guidance through a panel of resident experts.
3. **Focus on Earth Observation (EO) Satellites**: A Public-Private Partnership model is being developed to create a constellation of Earth Observation satellites. This initiative will allow private companies to build, own, and operate EO satellites, addressing both domestic and international demand for EO data. The project will reduce India's reliance on foreign data providers and help meet the growing need for satellite data in sectors such as agriculture, disaster management, and environmental monitoring.
4. **Technology Transfer and Commercialisation**: IN-SPACe has facilitated over 70 technology transfer agreements, allowing private companies to access and commercialise technologies developed by ISRO. These technologies are offered at subsidised rates, helping businesses develop and market their space-based products and services.
5. **Venture Capital Funding**: A dedicated venture capital fund has been established to support early-stage companies in the space sector, helping them scale their innovations and bring new technologies to market.

6. **Manufacturing Hubs**: IN-SPACe is collaborating with state governments to create manufacturing hubs for space technologies, with agreements already signed with Gujarat and Tamil Nadu. These hubs will house production facilities and testing infrastructure, supporting the growth of the space manufacturing sector in India.
7. **Development of Space Standards**: IN-SPACe is working to develop internationally accepted space standards to ensure that Indian companies can compete globally. The organisation is also encouraging the development of indigenous standards tailored to the needs of the Indian space industry.
8. **Small Satellite Launch Vehicles (SSLVs)**: Private companies are being supported in the development of Small Satellite Launch Vehicles (SSLVs). A dedicated launch complex, expected to be operational by 2026, will cater exclusively to private sector launches.
9. **Satellite Bus as a Service**: IN-SPACe is introducing a **satellite bus as a service** model, enabling private companies to focus on payload development while using shared satellite buses, reducing costs and time to market.
10. **Skill Development and Collaboration**: Regular training programmes and workshops are being conducted to build a skilled workforce in the space sector. Co-working spaces are also available to foster collaboration and innovation among start-ups and researchers.
11. **Future Roadmap for the Space Sector**: IN-SPACe has developed a decadal roadmap aimed at capturing a larger share of the global space economy, which is expected to reach USD 1.8 trillion. The roadmap focuses on creating a competitive space ecosystem, with private companies playing a key role in satellite development, launch services, and commercialising space data.

J. Session on Future of Satellite Navigation and Communications: Global Insights on Emerging Technologies and Business Models

The session on *Future of Satellite Navigation and Communications* explored the rapid advancements in satellite technology, the emerging business models in the sector, and the challenges and opportunities for both global and Indian markets. The discussion highlighted how the past five years have seen unprecedented venture capital inflows into the satellite sector, surpassing investments made in the previous two decades. This surge in funding has spurred a wave of innovation and disruption, transforming the industry. Notably, traditional Geostationary Earth Orbit (GEO) satellites are being complemented by newer, more agile solutions such as High Throughput Satellites (HTS), Medium Earth Orbit (MEO), and Low Earth Orbit (LEO) constellations. These developments are facilitating multi-orbit solutions that enable more automated and efficient communications.

Key sectors benefiting from these innovations include enterprise, energy, and defence, with automation and digitalisation leading to increased reliance on satellite communications. The growing need for data in fields like mining, energy, and defence, where real-time data transmission and automation are critical, is pushing the satellite industry to adapt and innovate. Defence applications, particularly for aerial Intelligence, Surveillance, and Reconnaissance (ISR) and high-definition video transmission from drones, are driving demand for more bandwidth and innovative satellite solutions.

The session also focused on the Indian satellite services market, which has evolved significantly over the past decade. India is one of the few nations with an independent satellite navigation system, NavIC, which is regionally focused and uniquely designed to address the challenges of the equatorial region. NavIC offers opportunities for developing new applications, particularly in high-accuracy positioning and time synchronisation, which are becoming increasingly vital in sectors such as agriculture, urban planning, and transportation. Additionally, NavIC's integration with other global navigation satellite systems enhances the potential for new services.

However, while the Indian satellite market has grown, there remain several challenges. Despite an increasing number of small enterprises and startups developing solutions based on Global Navigation Satellite System (GNSS) signals, the sector faces obstacles such as regulatory complexity and high costs. The current licensing process for satellite capacity is lengthy and cumbersome, deterring new entrants from scaling quickly. Moreover, the high cost of satellite capacity and the limited availability of affordable remote terminals continue to be barriers to broader adoption of satellite communication services in India. Nevertheless, there is optimism that with the ongoing push to reduce costs and enhance capacity, the market will see greater growth in the coming years.

The discussion also covered the underutilisation of sectors like In-Flight Mobile Communications (IFMC), where anticipated growth has not yet materialised. However, with advancements in satellite technology and better regulatory frameworks, this sector is expected to grow in the near future. The panellists also discussed the critical role of the Indian government in supporting the satellite industry through initiatives such as "Make in India" and the need for a stronger focus on research and development (R&D) to foster domestic innovation in satellite technologies, particularly in the manufacturing of terminals and other critical infrastructure.

In terms of satellite navigation, the panellists emphasised the need for resilient Positioning, Navigation, and Timing (PNT) systems that can withstand disruptions. Solutions such as signal augmentation, indoor positioning, and enhanced vertical accuracy are areas where significant value can be added, particularly in emerging fields like drone deliveries and autonomous navigation. The future of NavIC was also a focal point, with plans to introduce services such as emergency warning systems for fishermen, high-accuracy services for critical infrastructure, and message authentication to ensure data integrity. These services are expected to create new opportunities for Indian industries to contribute to the space ecosystem.

Finally, the session highlighted the importance of private sector participation in expanding the Indian satellite services market. Currently, a significant portion of satellite capacity is used by government agencies, with limited private sector involvement. The panellists advocated for simplifying the regulatory framework and fostering innovation to encourage more private companies to enter the satellite services sector. This would not only drive the adoption of satellite technology across industries but also create more jobs and boost India's global competitiveness in the space economy.

In conclusion, the discussion underscored the immense potential for growth in satellite navigation and communications, both globally and in India. By addressing regulatory challenges, encouraging private sector innovation, and capitalising on emerging technologies, the industry can unlock new business models and create a robust ecosystem that supports technological advancements and economic growth.

Key takeaways from the session were:

1. **Rapid Technological Advancements and Investment Surge**: The satellite communications industry has seen an unprecedented influx of venture capital in the last five years, surpassing investments from the previous two decades. This has driven rapid technological advancements, particularly in multi-orbit solutions incorporating GEO, MEO, and LEO satellites. High Throughput Satellites (HTS) are emerging as a key component of this transformation, offering greater agility and flexibility in communication services.
2. **Increasing Importance of Automation and Digitalisation**: Industries such as defence, energy, and mining are increasingly relying on satellite-based automation and digitalisation to improve efficiency. The demand for high-bandwidth applications, like real-time video transmission and remote data monitoring, is pushing the boundaries of what satellite communications can deliver.
3. **India's Independent Satellite Navigation System – NavIC**: India's regional navigation system, NavIC, was highlighted as a crucial player in the satellite navigation domain, particularly for addressing the unique challenges of the equatorial region. With plans to expand NavIC's coverage and services, the system is poised to offer value-added services, including emergency warnings, high-accuracy positioning, and message authentication. These advancements present opportunities for Indian industries to develop indigenous navigation-based solutions.
4. **Challenges in the Indian Satellite Services Market**: The Indian satellite services market has made significant progress, but regulatory hurdles and high capacity costs remain major barriers to growth. The complexity of the licensing process and the need for more affordable remote terminal technologies are key areas where improvement is needed. Despite these challenges, there is optimism that regulatory reforms and technological advancements will drive future growth.
5. **Underutilisation of Certain Market Segments**: Sectors such as In-Flight Mobile Communications (IFMC) have not experienced the growth expected, largely due to the high costs and regulatory issues. However, with the advent of new satellite technologies and increased capacity, this segment is expected to expand in the near future, especially as prices continue to decline.
6. **Opportunities for Startups and Indian Industry**: There is significant potential for Indian startups and industries to develop high-accuracy positioning services, particularly in areas such as real-time kinematics (RTK) and single-point positioning. Additionally, the development of indigenous chip manufacturing and software capabilities will be crucial for the growth of the domestic satellite industry. The session also highlighted the importance of "Make in India" initiatives, particularly in the manufacturing of remote terminals and other satellite infrastructure.
7. **Need for a Resilient Positioning, Navigation, and Timing (PNT) System**: With growing dependence on satellite navigation, there is a critical need to develop resilient PNT systems that can withstand potential outages. Solutions like signal augmentation, indoor positioning, and enhanced vertical accuracy will be key in sectors such as autonomous navigation, drone deliveries, and smart cities.

8. **Role of the Indian Government in Supporting Growth**: The Indian government's role is essential in fostering a favourable regulatory environment and supporting innovation in the satellite industry. Simplifying the licensing process, offering incentives for R&D, and ensuring the availability of affordable satellite capacity will be vital for boosting private sector participation and creating a robust satellite services market in India.
9. **Emerging Global Business Opportunities**: India is well-positioned geographically to serve a wider market, spanning from Africa to Southeast Asia, with satellite services. The session also pointed out the potential for Indian satellite service providers to tap into this broader market, leveraging their technological advancements and capacity to drive international growth.

K. Session On Strengthening the Space Economy – Policy & Regulation Frameworks for Space Commerce, Insurance, And Financial Services

The session highlighted the essential steps needed to advance the space sector in India, focusing on key areas such as policy reforms, regulatory frameworks, financial services, and insurance mechanisms. The space economy, characterised by high capital investment, long development timelines, and considerable risk, presents unique challenges compared to other sectors. Activities such as satellite manufacturing, launch services, and in-orbit servicing are governed by international legal frameworks and dual-use export control regimes, making investment in this area complex. The size of the global space economy is currently estimated between $440 billion and $630 billion, with projections suggesting it could grow to $1.8 trillion by 2035.

India's space reforms, particularly the 2020 reforms and the Indian Space Policy of 2023, have opened up the space sector to greater private sector participation. These reforms have introduced organisations like IN-SPACe and NewSpace India Limited (NSIL), which act as facilitators and regulators to encourage private entities to engage in end-to-end space activities. The reforms have resulted in a significant increase in the number of space startups, with over 250 startups and $100 million in annual investment now contributing to the Indian space ecosystem.

The session placed significant emphasis on the role of financial services in fostering the growth of the space economy. Initiatives such as the price support scheme for startups and MSMEs, seed funding for early-stage companies, and a 1000 crore venture capital fund dedicated to space activities were highlighted as crucial measures for encouraging innovation and scaling space-related ventures. These financial support mechanisms provide essential resources to startups, enabling them to access the necessary infrastructure and technical expertise to develop and commercialise their space technologies.

Insurance also emerged as a critical component for managing the inherent risks of the space sector. Space activities, such as satellite launches and operations, face various risks, including launch failures, satellite malfunctions, and legal liabilities. The global space insurance market, currently valued at $12.3 billion, is projected to reach $19.1 billion by 2030. In India, third-party liability insurance has been proposed as part of the regulatory framework, ensuring that

space ventures are compliant with international standards and reducing the financial risks associated with space missions.

The session also addressed the challenges faced by the Indian satellite services market, particularly in traditional sectors such as Direct-to-Home (DTH) broadcasting and VSAT terminals, which have been experiencing a decline. The growing shift towards over-the-top (OTT) services and other terrestrial technologies has impacted satellite-based services. To counter this trend, the need for innovative business models and new satellite-based services, such as real-time kinematic (RTK) positioning and flexible payload systems, was discussed. These advancements can help reinvigorate the satellite services market and create new revenue streams.

International collaboration was recognised as a key driver for accessing advanced technologies and expanding India's capabilities in space commerce. The need for government-to-government partnerships to facilitate the transfer of cutting-edge technologies and support for indigenous development was emphasised. Such collaborations would allow Indian companies to strengthen their position in the global space economy and bring international expertise into the domestic space ecosystem.

To further strengthen the space economy, the session advocated for policy initiatives such as tax holidays, Production Linked Incentive (PLI) schemes, and regulatory reforms that promote domestic manufacturing and innovation. These measures would reduce costs, enhance competitiveness, and encourage private sector investment in space activities. It was also suggested that the government could introduce an offset policy for the space sector, similar to the one used in defence procurement, to encourage foreign companies to collaborate with Indian firms and transfer critical technologies.

The session concluded by noting that a clear understanding of the demand for satellite services is essential for future planning. A more demand-driven approach, where stakeholders collaborate to identify and meet the needs of various industries, would ensure that space infrastructure is developed efficiently and that it can cater to both domestic and international markets. By leveraging international collaborations, promoting indigenous innovation, and creating a supportive regulatory and financial environment, India can significantly strengthen its space economy and position itself as a leader in global space commerce.

The key takeaways from the session were:

1. **Unique Characteristics of the Space Economy:** The space sector is characterised by high capital requirements, long development timelines, and significant risk factors. Space activities, ranging from satellite manufacturing to in-orbit services, operate under complex international legal frameworks and dual-use export control regimes, requiring robust regulatory support.
2. **India's Space Reforms and Policy Frameworks**: The 2020 space reforms and the Indian Space Policy of 2023 have opened up the space sector to greater private sector participation. These reforms, along with the establishment of organisations like IN-SPACe and NSIL, are essential in facilitating private involvement in end-to-end space activities. The policy framework also provides much-needed clarity for private investments in space commerce.

3. **Financial Support Mechanisms**: Financial services are crucial for fostering innovation and supporting the growth of the space economy. Initiatives such as price support schemes, seed funding for startups, and a 1000 crore venture capital fund for the space sector are vital for encouraging investment and enabling space startups and MSMEs to scale.
4. **Importance of Space Insurance**: Given the high risks involved in space activities—such as satellite malfunctions, launch failures, and legal liabilities—space insurance plays a pivotal role. The global space insurance market is projected to grow significantly, and India's regulatory framework has proposed third-party liability insurance to manage risks and align with international standards.
5. **Decline in Traditional Satellite Services**: Traditional satellite services, such as Direct-to-Home (DTH) broadcasting and VSAT terminals, are experiencing a decline due to competition from OTT services and terrestrial alternatives. There is a pressing need to innovate and introduce new satellite services and business models to reinvigorate the market.
6. **International Collaboration**: Global partnerships are essential for accessing advanced technologies and enhancing India's space capabilities. Leveraging government-to-government collaborations can facilitate technology transfer and create opportunities for Indian companies to expand internationally.
7. **Incentivising Space Commerce through Policy**: Tax holidays, Production Linked Incentive (PLI) schemes, and regulatory reforms are necessary to promote domestic innovation and reduce costs in the space sector. An offset policy, similar to that in the defence sector, could encourage foreign firms to collaborate with Indian companies and transfer critical technologies.
8. **Demand-Driven Space Infrastructure Development**: A clear understanding of both domestic and international demand for satellite services is essential for future planning. A demand-driven approach, supported by collaboration between stakeholders, would ensure that space infrastructure is developed efficiently and meets market needs.
9. **Encouraging Indigenous Innovation**: Promoting local manufacturing and innovation through policy and financial incentives will help strengthen India's space economy. Developing homegrown technologies and solutions is key to building a competitive space sector that can meet both national and global demands.

L. Keynote Address / Presentation- Expanding India's Commercial Space Sector Footprint Internationally by Dr. Vinod Kumar, Director Promotion, In-Space

The keynote address on *Expanding India's Commercial Space Sector Footprint Internationally* provided a comprehensive overview of India's current capabilities in the space sector, the reforms that have accelerated its growth, and the strategic steps being taken to expand the country's presence in global space markets. The presentation highlighted India's significant achievements in space, particularly under the leadership of the Indian Space Research Organisation (ISRO), which has developed a robust infrastructure in areas such as satellite

manufacturing, launch vehicles, communication, navigation, and space exploration. Notable milestones include India's success with the Mars Orbiter Mission, Chandrayaan missions, and its recent lunar landing on the South Pole.

India's space sector reforms, initiated in 2020, have opened up the industry to private players and increased international collaborations. Since the operationalisation of the Indian National Space Promotion and Authorization Centre (IN-SPACe) in 2022, private companies have launched nine satellites, and two suborbital launches have been carried out. The number of startups in the space sector has surged to 250, along with participation from MSMEs and large corporations. IN-SPACe has emerged as a key enabler and promoter of private space activities, offering a single-window system for authorisation and support.

The address emphasised the importance of international collaboration in expanding India's commercial space footprint. Global space budgets are steadily increasing, and each nation is striving to establish a presence in the space economy. India, the world's fifth-largest economy, has developed a decadal vision and strategy to increase its share of the global space economy from the current 2% to 8-10% over the next decade. This expansion plan includes boosting internal consumption and focusing on exports, with a projected $33 billion in internal demand and $11 billion in exports.

A key component of this strategy is to focus on specific regions and sectors where India can offer expertise and services. For instance, India's experience in identifying potential fishing zones using space technology is an area where it can collaborate with other nations, especially in the Indian Ocean region. India's strategy also includes space diplomacy and cooperation with developing nations for health, agriculture, disaster mitigation, and infrastructure development. For developed economies, India seeks to collaborate on capacity building and technology sharing, leveraging its strengths in satellite launches and space applications.

The address also discussed the need to ease export-import regulations, particularly in resolving issues such as double taxation on space components. India is working to facilitate smoother international trade in the space sector and is actively collaborating with other governments and private players to resolve these challenges. Financial policies, such as the foreign direct investment (FDI) policy, have been reformed to allow 100% automatic FDI in subsystems manufacturing and 74% in satellite manufacturing, further encouraging international investment in India's space sector.

India's commercial space sector is also focused on building strong global partnerships. IN-SPACe has already engaged with over 40 countries and has established memoranda of understanding (MOUs) with key space players like Australia and the United States. India is part of global initiatives such as the India-US Civil Space Working Group and the Quad Space Commercial Group, which are aimed at enhancing commercial opportunities. The keynote also mentioned successful negotiations with the United States on the International Traffic in Arms Regulations (ITAR), aiming to make it easier for Indian companies to import and export critical space components.

The expansion of India's commercial space footprint is also supported by efforts in skilling and capacity building. IN-SPACe has launched several courses to train professionals in space technologies, with hundreds of participants across various sessions. Additionally, India has

been actively showcasing its space sector at international forums, such as the Australian Space Forum and the International Astronautical Congress (IAC), to provide global outreach opportunities for Indian companies.

In conclusion, the keynote highlighted the significant potential for India's space sector to grow globally by leveraging its expertise, strengthening international collaborations, and expanding its commercial presence in key markets. By focusing on regional opportunities, easing trade regulations, fostering public-private partnerships, and building capacity, India is positioning itself to be a major player in the global space economy in the coming decade.

The key takeaways from the session on *Expanding India's Commercial Space Sector Footprint Internationally* were as follows:

1. **Strong Domestic Capabilities:** India has developed a robust space infrastructure under ISRO, with expertise in satellite manufacturing, launch vehicles, communication, navigation, and space exploration. Recent successes, such as the Mars Orbiter Mission and Chandrayaan, have positioned India as a key player in global space activities.
2. **Space Reforms Boosting Private Participation:** The 2020 space sector reforms and the establishment of IN-SPACe in 2022 have opened up space activities to private companies, resulting in the launch of nine satellites and two suborbital launches by private players. The number of space startups has grown to over 250, indicating a vibrant and growing ecosystem.
3. **International Collaboration is Key:** Expanding India's commercial space footprint internationally requires strong global partnerships. India is actively engaging with over 40 countries and participating in forums like the India-US Civil Space Working Group and Quad Space Commercial Group. Collaborations are helping resolve regulatory issues and open up new market opportunities.
4. **Ambitious Growth Targets:** India aims to increase its share of the global space economy from the current 2% to 8-10% over the next decade. This strategy involves boosting internal consumption to USD 33 billion and generating USD 11 billion in exports. India's plan to achieve these goals includes offering space services to developing nations and collaborating with advanced spacefaring countries.
5. **FDI and Policy Reforms:** India has introduced attractive foreign direct investment (FDI) policies for the space sector, including 100% automatic FDI in subsystem manufacturing and 74% in satellite manufacturing. This is expected to draw more international investments into India's space industry.
6. **Regional Focus and Space Diplomacy:** India plans to leverage its expertise in areas such as identifying fishing zones and providing satellite launch services, particularly in the Indian Ocean region. Space diplomacy is being used to enhance cooperation with developing nations in sectors like agriculture, disaster mitigation, and health.
7. **Resolving Export-Import Challenges:** India is working to address export-import challenges, such as double taxation on space components, to facilitate smoother international trade in the space sector. Collaborating with other governments, India aims to ease these regulatory bottlenecks and improve the ease of doing business for space-related exports.

8. **Focus on Skilling and Capacity Building:** IN-SPACe is actively engaged in skilling and capacity-building initiatives, having successfully conducted multiple training sessions for professionals. This is key to ensuring a skilled workforce that can support the expansion of India's space sector.
9. **Showcasing Indian Companies Globally:** India is providing platforms for its private companies to showcase their expertise at international forums like the International Astronautical Congress (IAC) and the Australian Space Forum, helping them build global partnerships and expand their market reach.

M. Session On the Quest for Capacity – Accelerating R&D, Manufacturing Capacity and Human Expertise

The session offered a comprehensive examination of the critical areas necessary for advancing India's space sector, particularly in research and development (R&D), manufacturing capabilities, and human capital. It was acknowledged that while the 2020 space reforms have opened up tremendous opportunities for private sector participation, there remains a significant gap in terms of the capacity required to meet the growing demands of the space industry. The session brought together academic, industry, and government representatives to discuss how India can address these challenges and build a sustainable space ecosystem.

One of the focal points of the session was the essential role of academic institutions in driving innovation and developing human capital. ISRO has been instrumental in establishing partnerships with universities and research institutions through its *Respond* programme, which fosters collaboration between academia and the space sector. This initiative funds research projects that address specific needs in space technology, providing academic institutions with the resources to conduct cutting-edge research. Furthermore, ISRO has been supporting the establishment of Space Technology Cells, Incubation Centres, and Regional Academic Centres across India. These centres are designed to bridge the gap between theoretical knowledge and practical application, giving students and researchers the tools to develop innovative solutions for the space industry.

The Indian Institute of Space Science and Technology (IIST) was highlighted as a leading institution in training the next generation of space professionals. IIST, the first Space University in Asia, has implemented a hands-on approach to education, where students are involved in real-time research and development projects from the very beginning of their academic journey. Examples include small satellite projects, electric propulsion systems, and quantum technologies. The students not only gain theoretical knowledge but also work directly on the design, integration, and testing of space systems, making them industry-ready by the time they graduate. The involvement of students in these advanced projects has already led to the successful development and launch of multiple satellites and has also enabled them to gain placements at top space agencies and companies globally. Additionally, IIST supports student startups, with several emerging from the institution's innovation labs, thus contributing to the development of a robust space-tech startup ecosystem in India.

A significant portion of the session was dedicated to the importance of developing manufacturing capabilities to support the growing space sector. With the increasing involvement of private

companies and startups, there is a pressing need to scale up the production of space technologies, such as satellites, launch vehicles, and communication systems. The panellists discussed how the collaboration between public institutions like ISRO and private players could accelerate the development of this manufacturing capacity. Initiatives like IN-SPACe's pre-incubation programmes offer financial and technical support to students and entrepreneurs to develop proof-of-concept projects. These efforts aim to nurture early-stage innovations and transform them into commercially viable solutions, ensuring that India's space manufacturing sector grows in tandem with the global market.

The session also touched upon the growing number of space startups in India and how they are contributing to the capacity-building efforts in the sector. Since the space reforms were enacted, the number of space startups has increased dramatically, and several of these companies have developed solutions for satellite communications, space exploration, and advanced propulsion systems. ISRO and IN-SPACe have been instrumental in supporting these startups by providing funding, access to infrastructure, and mentorship through incubators and accelerators. The session highlighted the importance of these startups not only in creating new technologies but also in contributing to the overall employment and economic growth of the space sector.

In terms of skilling and human expertise, the panellists emphasised the need for continuous skill development programmes to meet the industry's evolving requirements. Short-term courses and certifications focused on specific areas like satellite avionics, propulsion, and satellite communication are being offered by various institutions, including ISRO and IIST. These courses are designed to provide both students and industry professionals with the latest technical knowledge and hands-on experience in space technology. This capacity-building effort is crucial, given the growing demand for highly skilled professionals in both public and private space companies.

The session also introduced innovative initiatives such as the *Space Tutor* programme, which aims to build awareness of space science among schoolchildren and engage them in early-stage learning about space technologies. *Space on Wheels*, another outreach programme, brings mobile space exhibitions to rural and remote areas, creating a broader base of students interested in pursuing careers in space science. The idea is to cultivate interest at a young age, ensuring a steady pipeline of future space professionals. The engagement of younger generations is considered critical for sustaining the long-term growth of India's space sector.

Additionally, the panellists discussed how academic institutions like IIST are encouraging entrepreneurship among their students. Programmes aimed at fostering innovation and entrepreneurship have led to the development of several successful space startups, which have become key players in the Indian space ecosystem. These startups are leveraging their technical expertise to create new solutions for the global space market, with support from academic incubators, industry mentors, and government programmes. The collaboration between academia, industry, and government agencies is seen as a vital component of creating a self-sustaining space ecosystem that can scale quickly to meet global demands.

The session also recognised the need for further collaboration between India's space sector and international space agencies. By fostering global partnerships, Indian companies and

academic institutions can gain access to the latest technologies and best practices, further accelerating the country's capacity for innovation. Several panellists highlighted the importance of continuing to send Indian startups and researchers to international space forums, where they can showcase their work and establish global networks.

In conclusion, the session underscored the importance of accelerating R&D, enhancing manufacturing capacity, and building human expertise to meet the growing demands of India's space sector. By fostering closer collaboration between academic institutions, industry, and government, India can create a robust ecosystem that supports innovation and commercialisation. Additionally, through initiatives that engage students and encourage entrepreneurship, the country is ensuring that it has the skilled workforce and technological capabilities required to remain competitive in the global space market. The integration of these elements will be crucial for India's continued leadership in the space economy and its ability to capture a larger share of the global market in the coming decades.

The key takeaways from the session were as follows:

1. Collaboration Between Academia and Industry:

- Collaboration between academic institutions and the space industry is critical for driving innovation. ISRO's *Respond* programme fosters partnerships between universities, IITs, and other academic institutions, providing them with funding and resources to conduct research relevant to space technology.
- Academic institutions are playing an essential role in preparing industry-ready graduates by offering hands-on experience in real-world space projects.

2. Building Human Capital:

- Developing skilled human resources is a priority for the space sector. Institutions like the Indian Institute of Space Science and Technology (IIST) are actively training the next generation of space professionals by involving students in cutting-edge research projects, including satellite design, electric propulsion, and quantum technology.
- Various skill development programmes, such as short-term courses and workshops, are being conducted to train both students and industry professionals, addressing the specific technical skills required in the space sector.

3. Promoting Space Startups and Entrepreneurship:

- The number of space startups has significantly increased since the space reforms of 2020. These startups are creating innovative solutions in areas such as satellite communications and propulsion systems.
- Government initiatives like IN-SPACe's pre-incubation and entrepreneurship development programmes are helping students and startups transition from concept to market-ready solutions by offering financial support, mentorship, and infrastructure access.

4. Expanding Manufacturing Capacity:

- To keep pace with the global space sector, India needs to expand its manufacturing capacity. Collaboration between public institutions and private companies is essential to accelerate the production of satellites, launch vehicles, and communication systems.
- Programmes supporting startups and entrepreneurs play a crucial role in developing new manufacturing technologies and capabilities for the Indian space sector.

5. Engaging Younger Generations:

- Initiatives like the *Space Tutor* programme and *Space on Wheels* are vital for building interest in space science among school students, especially in rural areas. These outreach efforts aim to engage younger generations in space technologies at an early age, ensuring a steady talent pipeline for the future.

6. Developing an Innovation Ecosystem:

- Public-private partnerships and strong industry-academia collaborations are crucial for creating a self-sustaining innovation ecosystem. By supporting the commercialisation of space technologies, India can scale its space sector more quickly and capture a larger share of the global space market.
- Academic institutions are increasingly focused on fostering entrepreneurship and innovation, with many space startups emerging from academic incubators and innovation labs.

7. Global Collaborations:

- International collaborations and exposure to global best practices are essential for accelerating the development of India's space industry. By participating in global forums and space-related events, Indian companies and academic institutions can build networks and gain access to advanced technologies.

N. Highlight Talk: Human Space Flight Programme by Dr Dk Singh, Director, HSFC

The highlight talked on the *Human Space Flight Programme* provided a comprehensive overview of India's efforts to send humans into space, detailing the technical aspects, progress, and future roadmap for the mission. Officially announced in 2018, the programme represents a significant undertaking, with a focus on five critical areas: safe access to space, ensuring a habitable environment in orbit, a secure re-entry to Earth, a robust recovery system, and post-mission care for astronauts.

The programme's technical foundation is built around three core engineering systems. The first is the Orbital Vehicle, consisting of two modules: the Crew Module, where the astronauts reside, and the Service Module, which contains support systems such as propulsion. The second is a specially designed Human Rated Launch Vehicle (HRLV), distinct from traditional rockets. This vehicle is designed to safely transport humans, ensuring that physiological

factors such as acceleration remain within acceptable limits during launch and re-entry. The third major system is the Crew Escape System, which ensures astronaut safety in case of a launch anomaly. This system is designed to pull the crew module away from the rocket in emergencies, either on the launch pad or during the early phase of ascent.

The mission profile begins with a launch from Sriharikota, followed by the spacecraft's journey to a 400-kilometre low Earth orbit, where astronauts will remain for the mission duration. The most critical phases of the mission are the return to Earth and re-entry through the atmosphere, where temperatures can reach several thousand degrees Celsius. The Crew Module is equipped with a Thermal Protection System (TPS) to withstand this intense heat. Upon re-entry, large parachutes will deploy to decelerate the vehicle for a splashdown in the ocean, with recovery efforts coordinated by agencies such as the Indian Navy and Coast Guard.

A critical innovation within the programme is the Environmental Control and Life Support System (ECLSS), which will maintain a habitable atmosphere for the astronauts. The system controls temperature, humidity, and oxygen levels within the Crew Module, while also managing waste, fire detection, and fire suppression. Other technologies in development include a space suit that acts as a self-contained life support system in case of cabin depressurisation, and systems for in-orbit food, water, and waste management.

Safety remains paramount, with significant focus on systems such as fire detection and suppression, emergency survival kits, and health monitoring. The recovery process after splashdown involves coordination between multiple national agencies to ensure astronauts are retrieved within 48 hours, regardless of where the module lands.

The programme's broader vision includes several international collaborations with agencies such as Roscosmos, the European Space Agency (ESA), and NASA. These partnerships provide India with access to advanced technologies and expertise. Furthermore, the programme envisions the development of a long-term presence in space. Prime Minister Narendra Modi's announcement of a crewed mission to the Moon by 2040 and the establishment of an Indian space station by 2028 reflects the long-term strategic ambitions of the Human Space Flight Programme.

ISRO's approach to human spaceflight is incremental, with a series of unmanned test flights planned to validate all technologies. One such test, the TV-D1 mission, successfully demonstrated the Crew Escape System by simulating an emergency at Mach 1.2. This test validated the parachute deployment and recovery system. Ongoing propulsion system qualifications for solid, liquid, and cryogenic engines are being conducted to ensure redundancy and safety.

The programme offers extensive opportunities for collaboration with industries and academia. With 75% of the project budget expected to be spent through industry partnerships, there are substantial opportunities in developing flight systems, flight suits, and space station infrastructure. The upcoming Bhartiya Space Station will provide a platform for scientific research, including microgravity experiments that will benefit sectors such as pharmaceuticals.

In conclusion, India's Human Space Flight Programme is not only a technological endeavour but also a national mission involving a range of stakeholders. It aims to establish a sustained

human presence in space, with the potential to open up vast opportunities for industries, academia, and international collaborations. The programme is poised to be a major milestone in India's space exploration journey, contributing to global space research and innovation.

The key takeaways from the highlight talk on the *Human Space Flight Programme* were as follows:

1. **Comprehensive Human Spaceflight Mission:** The Human Space Flight Programme is focused on five critical areas: safe access to space, maintaining a habitable environment in orbit, ensuring a secure re-entry, developing robust recovery systems, and post-mission care for astronauts. Each phase requires unique technological innovations to ensure the safety and success of the mission.
2. **Core Engineering Systems:** The mission involves three major engineering systems: the Orbital Vehicle (Crew Module and Service Module), a specially designed Human Rated Launch Vehicle (HRLV), and the Crew Escape System. The HRLV is designed to safely carry astronauts, ensuring that human physiological limits are not exceeded during the launch and re-entry phases. The Crew Escape System provides an emergency exit for astronauts if any anomaly occurs during launch.
3. **Critical Safety Measures:** Extensive safety mechanisms are in place, including a Thermal Protection System (TPS) to withstand re-entry heat, a parachute system for deceleration, and an Environmental Control and Life Support System (ECLSS) to maintain a habitable atmosphere. The space suits are designed to ensure astronaut safety in the event of cabin depressurisation.
4. **Recovery Operations:** Recovery operations are a multi-agency effort involving the Indian Navy, Coast Guard, and Air Force to ensure that astronauts are safely retrieved from the ocean within 48 hours of splashdown, even in adverse conditions. International partnerships and advanced planning are crucial to this phase.
5. **Focus on Collaboration and Industry Involvement:** Collaboration is a cornerstone of the programme. Numerous Indian agencies, industries, and international space organisations, including Roscosmos, NASA, and ESA, are contributing to the mission. With 75% of the programme's budget allocated to industry partnerships, there are significant opportunities for collaboration, particularly in manufacturing and testing systems like flight suits, propulsion, and in-orbit technologies.
6. **Incremental Approach to Human Spaceflight:** ISRO is following an incremental approach to human spaceflight, ensuring that all technologies are thoroughly tested before the final manned mission. Unmanned test flights, including the successful TV-D1 mission, have validated the Crew Escape System and parachute deployment, demonstrating the readiness of critical technologies.
7. **Future Ambitions and Long-Term Vision:** Beyond the initial manned mission, India has set ambitious long-term goals. These include establishing a Bhartiya Space Station by 2028 and conducting a crewed lunar mission by 2040. The space station will serve as an orbital laboratory, offering opportunities for research and industry-driven innovations, including in microgravity research and manufacturing.

8. **Opportunities for Academia and Industry:** The programme offers extensive opportunities for Indian academia and industry. Research and development in areas such as in-orbit manufacturing, microgravity experiments, and the development of astronaut training facilities are key growth areas. The mission will boost space-related R&D and innovation across various sectors, including pharmaceuticals and materials science.
9. **Emphasis on Crew Training:** Astronaut training is a critical component of the programme, ensuring that astronauts are physically and mentally prepared for space conditions. This involves rigorous training in handling non-nominal scenarios and familiarisation with the spacecraft's technical systems. The first set of astronauts, selected from the Indian Air Force, have already undergone significant training.
10. **India's Commitment to Space Exploration:** The programme represents a national mission that aligns with India's broader vision for space exploration. The government's approval of a ₹20,000 crore investment underscores its commitment to advancing human spaceflight capabilities, and the programme is expected to solidify India's position as a significant player in global space exploration.

O. Session on a Global Destiny: International Collaborations in Space Sector

The session on *A Global Destiny: International Collaborations in the Space Sector* delved deeply into the critical role that international partnerships play in advancing space exploration, technology development, and commercial opportunities. The discussion opened by tracing the evolution of global cooperation in space, beginning with early milestones such as the launch of Sputnik in 1957, the Apollo missions, and the first human spaceflight by Yuri Gagarin. Over time, international collaborations became more structured, with notable initiatives like the International Space Station (ISS) and joint Mars exploration missions. The panellists emphasised how space has evolved into a highly competitive and complex domain, one that requires substantial investment and expertise, making international cooperation more essential than ever before.

A key theme of the session was the transformation of the space sector from a government-led initiative to a more collaborative and commercialised arena. In recent years, private players have emerged as significant contributors to space activities, driving innovation in areas like reusable launch vehicles, material sciences, and space data utilisation. The reduction in launch costs, coupled with advancements in 3D printing and other technologies, has made space more accessible to a broader range of countries and industries. This commercialisation has led to the rise of new business models, enabling industries to achieve faster returns on investment, which was a significant focus of the discussion.

The panel acknowledged that international collaborations in space are now a vital necessity, offering numerous advantages. By pooling resources, sharing risks, and drawing on a diverse range of expertise, countries and companies can achieve technological breakthroughs more efficiently. The panellists noted that such partnerships not only reduce financial burdens but also minimise the risks associated with space missions, which are inherently expensive and prone to technical

challenges. Furthermore, by collaborating, countries can optimise their research and development efforts, eliminating the need to reinvent the wheel and accelerating the pace of innovation.

Several successful examples of international collaboration were highlighted during the session, including the ISS, which stands as a testament to the power of global cooperation in space. The ISS, involving the United States, Russia, Europe, Japan, and Canada, has not only advanced scientific research but also paved the way for future collaborative projects. The Square Kilometre Array (SKA) telescope project was also discussed as an example of joint efforts in astronomical research, aiming to achieve breakthroughs in understanding the universe. Additionally, the Mars exploration initiatives have become iconic for international partnerships, demonstrating the potential of shared expertise in tackling complex space challenges.

The European Space Agency (ESA) was repeatedly cited as a model of how multiple countries can collaborate effectively. ESA's ability to integrate the capabilities of different European nations has led to significant achievements in space exploration and satellite technology. This cooperative model was presented as an example that other regions of the world, including Asia and Africa, could follow to boost their space ambitions through collaboration.

One of the session's critical discussions was the legal and regulatory challenges that often impede international collaboration. Space technology, being a dual-use technology, involves significant security concerns, making it subject to stringent export controls and regulations. The panellists discussed frameworks such as the Missile Technology Control Regime (MTCR) and the Wassenaar Arrangement, which aim to facilitate collaboration while addressing security concerns. These frameworks have helped manage the complexities of technology transfers and collaborations, especially between nations with sensitive geopolitical relationships. However, there remains a need for continuous refinement of these regulations to keep up with the evolving space sector.

In the context of India, the session explored the country's long history of international partnerships, starting from its early collaborations with countries like the United States and France. India's space programme has been built on a foundation of international cooperation, with missions like Chandrayaan and the Mars Orbiter Mission (Mangalyaan) benefiting from partnerships with various spacefaring nations. The NISAR (NASA-ISRO Synthetic Aperture Radar) mission, in collaboration with NASA, was cited as an example of how joint efforts are leading to cutting-edge advancements in space technology.

India's role in international forums like the G20 and BRICS was also discussed, particularly in the context of space diplomacy. The panellists highlighted India's efforts to help emerging spacefaring nations develop their own space programmes, particularly through capacity-building initiatives. India's willingness to share satellite data and provide training to countries like Bhutan, Mauritius, and several African nations is part of a broader strategy to use space as a tool for international cooperation and development. Initiatives such as the G20 satellite, which aims to share space assets and data with other nations, were highlighted as key examples of India's leadership in global space diplomacy.

One of the important future aspects discussed was the growing role of private industry in international collaborations. Traditionally, space collaborations were government-to-government;

however, private companies are now at the forefront of new partnerships. As private players like SpaceX and Blue Origin lead the charge in space exploration, countries are increasingly looking to partner with these companies to enhance their own space capabilities. The panel noted that in the coming years, space stations, lunar bases, and even Mars missions will likely be driven by private sector involvement, with governments playing a supporting role. This shift has already started, as private companies are actively involved in developing the next generation of space stations to replace the ISS.

The session concluded with a focus on the need for trust and diplomacy in fostering successful international collaborations. Trust is a key element when it comes to sharing sensitive technologies and data, especially in a competitive environment like space. Diplomacy plays a crucial role in ensuring that space remains a domain of peaceful cooperation, rather than conflict. The panellists stressed that, as space exploration moves beyond Earth's orbit, countries will need to come together to address common challenges, such as space debris, space traffic management, and the sustainability of space activities.

In summary, the session underscored that the future of space exploration and technology development will be increasingly defined by international cooperation. Whether it's reducing costs, sharing expertise, or minimising risks, global partnerships are essential for overcoming the technical, financial, and geopolitical challenges of space. As space becomes more commercialised and competitive, international collaborations, including those led by private industry, will be key to unlocking the full potential of space exploration, ensuring that space remains a domain of innovation, discovery, and shared benefits for humanity.

The key takeaways from the session were as follows:

1. **Shift from National to Global Collaborative Efforts:** The space sector has evolved from being predominantly government-driven to a more collaborative, global effort involving both national space agencies and private companies. International partnerships have become essential for accelerating technological advancements and sharing the costs and risks of space exploration.
2. **Role of Private Industry in Space Collaboration:** The rise of private companies in the space sector has significantly transformed the landscape. Private industry now plays a major role in driving innovation, reducing costs through reusable launch vehicles, and leading new space initiatives. Future space missions, including space stations and lunar exploration, are expected to be driven by private sector involvement alongside governments.
3. **Optimisation of Resources and Expertise:** International collaboration enables countries and companies to pool resources, share expertise, and distribute risks. This allows for more efficient research and development, faster technological breakthroughs, and the ability to undertake larger and more complex missions than any single entity could achieve alone.
4. **Success Stories of Global Collaboration:** Major international collaborations such as the International Space Station (ISS), Mars exploration, and the Square Kilometre Array (SKA) telescope were highlighted as successful examples of how global partnerships can achieve significant scientific and technological advancements. These projects demonstrate the power of shared goals in driving space exploration forward.

5. **Regulatory Challenges and Technology Transfers:** Export controls, technology transfer regulations, and national security concerns often hinder smooth international collaboration in space. Frameworks like the Missile Technology Control Regime (MTCR) and the Wassenaar Arrangement are essential in managing the complexities of international partnerships while ensuring security concerns are addressed.
6. **India's Long History of International Collaboration:** India has a strong tradition of international cooperation in space, with successful collaborations on missions such as Chandrayaan, Mangalyaan, and the upcoming NISAR mission with NASA. These partnerships have been vital for India's development of space capabilities, and the country is now positioning itself as a leader in space diplomacy through initiatives like capacity building and satellite data sharing.
7. **Space Diplomacy and Capacity Building:** India is playing a key role in supporting emerging spacefaring nations, especially through capacity building and technology transfer initiatives. India's efforts to share satellite data and train other countries in space technology are part of its broader space diplomacy strategy, particularly in forums like the G20 and BRICS.
8. **Future of Space Collaboration Driven by Private Companies:** The role of private companies in space collaborations is expected to increase, with partnerships between governments and private enterprises becoming the new norm. Private players are likely to lead the development of space stations, lunar missions, and Mars exploration, with governments playing a supportive role.
9. **Trust and Diplomacy in International Cooperation:** Trust is essential for successful international collaboration in space. Diplomatic efforts are key to ensuring that space remains a domain of peaceful cooperation, with shared benefits for all participating nations. This is particularly important as space becomes more congested and competitive.
10. **Addressing Global Challenges in Space:** International collaboration is crucial for addressing global challenges in space, such as space debris management, space traffic control, and ensuring the sustainability of space activities. These issues require coordinated global efforts to maintain space as a viable and safe environment for exploration and commercial activities.

3. STARTUP INVESTOR MEET

The Startup Investor Meet focused on the immense potential of India's burgeoning space industry and the key role it plays in global innovation. A wide range of topics were covered, including the importance of venture capital, corporate strategic investments, and government support in driving the growth of the space sector. Participants acknowledged that while the Indian market is still developing, it has great potential to attract overseas investment, particularly in deep technology and space. Several challenges were highlighted, including the relatively small amount of investment being directed to Indian startups compared to more developed markets like the US, EU, and Japan. This is largely because many Indian companies are still in their early stages, yet to fully industrialise and scale.

The meet also underlined the role of venture capital in nurturing startups from inception to IPO, with additional support from venture debt and equity funding at mid-stages. Government-backed initiatives like the Fund of Funds for Startups, managed by SIDBI, have been instrumental in providing equity investments, and a focus on deep tech and national priorities has helped channel much-needed funds to the space sector. SIDBI's venture debt schemes were highlighted as a critical support mechanism for startups unable to secure traditional loans due to a lack of profitability or collateral. The agency has also developed seed fund partnerships with leading incubators, providing early-stage companies with the first institutional check to help them catalyse private investment.

In terms of corporate participation, Qualcomm's investment philosophy was discussed, emphasising their focus on deep tech areas like AI, IoT, and AR, and their interest in investing in the space sector in India. Qualcomm illustrated its role as a strategic investor by assisting startups not just with funding but also by providing access to its cutting-edge technology, expertise, and global markets. For example, Qualcomm's collaboration with IdeaForge, a drone startup, highlighted how corporate partnerships could help startups commercialise their innovations by leveraging advanced technology and global market access.

The panel also discussed the Space Activities Bill, which will provide a legal framework for both public and private sector activities in India's space domain and establish InSpace as a regulatory body. The bill aims to ensure that India adheres to international obligations while creating a structured and legally sound ecosystem for space activities. The legal framework is expected to promote private sector participation in space ventures, which has long been dominated by government agencies like ISRO.

Foreign investors expressed optimism about India's space startups, noting the need to streamline bureaucratic processes to speed up innovation. They suggested that faster access to government testing facilities and reduced administrative hurdles would help young companies grow more quickly. It was also noted that the government could play a more proactive role by ensuring demand certainty for space products and services, similar to how other global governments promote their local champions.

A key theme was the balance between technological development and market readiness. Investors noted that startups need to demonstrate value to the market by aligning leadership and innovation with market needs. Companies that manage this balance are more likely to

succeed. Moreover, foreign investors were keen to see faster growth trajectories for Indian space companies, advocating for policies that reduce paperwork and promote quicker access to necessary resources.

The discussion also touched upon the global competition for talent, particularly in deep tech fields, and how the space sector's long gestation periods and capital-intensive nature make it crucial to secure long-term investments. The investors highlighted that while space startups often require substantial funding for technology development and scaling, the ability to deliver value and establish a reputation for reliability is critical for long-term success.

In summary, the Startup Investor Meet showcased the tremendous potential of India's space sector, underscored by government initiatives, corporate investments, and international partnerships. However, it also brought attention to the need for a supportive regulatory environment, easier access to resources, and a focus on market-driven innovation to accelerate growth and position India as a global leader in space technology.

The key takeaways from the Startup Investor Meet session were as follows:

1. **India's Space Sector Potential**: India's space industry is seen as having immense potential, with both domestic and international investors recognising the opportunities for growth. However, the industry is still in its early stages compared to global counterparts like the US, EU, and Japan, and needs further industrialisation and investment.
2. **Role of Venture Capital and Government Support**: Venture capital plays a critical role in nurturing startups, particularly during the early and mid-stages of growth. The government's Fund of Funds for Startups, managed by SIDBI, has significantly contributed to early-stage funding, with a focus on sectors like deep tech. Venture debt schemes and seed funding partnerships with incubators are filling a crucial gap for startups that need non-dilutive capital but lack traditional financial backing.
3. **Corporate Investments and Strategic Partnerships**: Large corporations like Qualcomm emphasised the importance of strategic partnerships with startups, beyond just funding. These partnerships offer startups access to advanced technologies and global markets. For instance, Qualcomm's collaboration with the drone company IdeaForge highlighted how technology transfer and expertise can significantly enhance a startup's product offerings.
4. **Legal and Regulatory Framework**: The upcoming Space Activities Bill is expected to provide a much-needed legal framework for space-related activities in India, including private sector participation. This legislation will regulate public and private space ventures and is seen as crucial for India's long-term leadership in the space industry.
5. **Cross-border Collaboration and International Investment**: Foreign investors acknowledged India's strong innovation potential but called for a reduction in bureaucratic processes that slow down startup growth. They highlighted the need for faster access to government resources, such as testing facilities, and fewer administrative hurdles to help startups move more quickly towards commercialisation.
6. **Balancing Market Needs with Technological Innovation**: A recurring theme was the need for startups to balance technological advancements with market demand. Startups need to demonstrate market value, strong leadership, and the ability to deliver solutions

that meet customer needs in order to succeed. Investors are more likely to support companies that can achieve this balance.

7. **Challenges in Deep Tech and Space Investment**: The session pointed out that while deep tech and space startups are attracting attention, they face unique challenges such as long gestation periods and high capital requirements. Investors called for a more structured approach to risk management, particularly in sectors like space, where technological risks and market readiness can be difficult to gauge.
8. **Foreign Investor Concerns**: While foreign investors are keen to invest in India's space startups, they mentioned that regulatory hurdles and slow processes remain significant challenges. They suggested that India could boost growth by simplifying these processes and providing better access to infrastructure and resources.
9. **Talent and Skills Gap**: There is a growing demand for skilled professionals not only in technical fields like engineering but also in areas like sales, government affairs, and legal strategy. The space sector will require a broad set of skills to develop into a fully functioning ecosystem and addressing this talent gap is crucial for future growth.
10. **Importance of Public and Private Partnerships**: Successful collaboration between public and private entities will be essential for the continued growth of the space sector in India. Government initiatives need to be aligned with private sector capabilities and requirements to create an ecosystem conducive to long-term success.

4. COUNTRY SESSIONS

A. European Space Agency Session

The Europe Session focused on the collaboration between the European Space Agency (ESA) and various stakeholders, including the Indian space industry. The session highlighted ESA's role as an intergovernmental organisation working with 22 member states and several associate members, including countries outside the European Union, such as the UK and Norway. ESA clarified that it is independent of the European Commission but works closely with it on major programs like Galileo and Copernicus.

ESA's space programs cover a wide range of activities, including human and robotic exploration, satellite launches, Earth observation, navigation, climate change monitoring, and secure communications. The agency's collaboration with India was notably discussed, with a strong emphasis on joint space missions and the mutual benefits of partnerships between ESA and ISRO, such as cooperation on satellite launches, scientific research, and Earth observation.

ESA's budget for 2024 was outlined, with 7.8 billion euros allocated across various programs, with Earth observation being the largest focus. The agency is involved in major global scientific initiatives, including space weather and planetary defense, and is committed to the development of cutting-edge technologies and the promotion of space industry innovation in Europe.

One of the key topics was the role of the space industry in fostering international collaboration, particularly between Europe and India. ESA emphasised that India, as one of the world's largest democracies and a major player in space exploration, is a natural partner for Europe. The session underscored the importance of strategic collaboration between Indian and European industries in advancing space technology and commercialisation efforts.

ESA also provided an overview of its initiatives to support startups and SMEs through its business incubation centres, which have been operational for 20 years. These centres help early-stage companies access ESA branding, technical expertise, business development support, and networking opportunities. Over 1,750 startups have benefitted from this program, which is expanding to include new networks like ESA Filabs, aimed at bridging the gap between R&D and commercialisation.

The session concluded with a focus on ESA's efforts to foster future-proof partnerships, particularly in space commercialisation, and the need to integrate public and private capital to fund future space systems. ESA is committed to building mutually beneficial relationships with international partners, with a specific interest in working closely with Indian companies and space agencies to drive innovation and commercial opportunities in the global space sector.

The presentations from European startups in the session further emphasised the growing opportunities in space commercialisation, with projects ranging from IoT satellite constellations to innovative solutions in water management, highlighting the broad applicability of space technology in addressing global challenges.

The key takeaways from the Europe Session were as follows:

1. Strong Collaboration between ESA and ISRO:

- The European Space Agency (ESA) and the Indian Space Research Organisation (ISRO) have a long-standing partnership, which is poised to grow further. There is an emphasis on joint space missions, such as Chandrayaan-3, and future cooperation in areas like space science, human spaceflight, and planetary defence.
- The two agencies are also working together on technologies like Earth observation, space navigation systems (Galileo), and satellite-based communications.

2. Growing Role of ESA in Commercialisation:

- ESA is increasingly focused on commercialising space technologies. Through initiatives like the Scale-Up program and business incubation centres (ESA BICs), ESA is supporting startups and SMEs in developing commercial space solutions.
- ESA has been building commercial ecosystems for over 20 years and is helping startups bridge the gap between R&D and commercialisation.

3. Public-Private Partnerships are Key to Space Industry Growth:

- ESA is keen on fostering partnerships between governments, private companies, and SMEs to build future space capabilities. The involvement of new players in the space industry, driven by both public policies and private investment, is reshaping the space ecosystem.

- ESA is working closely with international partners and financial institutions like the European Investment Bank to facilitate funding for space-related startups and commercial projects.

4. Focus on Emerging Space Markets:

- ESA is actively supporting the growth of space startups across Europe, with a particular focus on high-potential areas like quantum computing, artificial intelligence, and propulsion systems.
- The session highlighted the role of new space markets in countries like India, where a growing number of space startups are emerging, driven by government policy changes and international collaboration.

5. Importance of Technological and Programmatic Synergy:

- The synergy between different space programs, such as Earth observation (Copernicus), space science (James Webb Telescope), and planetary defense, was underlined as a key focus of ESA's ongoing strategy.
- These efforts are crucial in tackling global challenges like climate change, natural disasters, and space debris, and ESA is positioning itself as a key player in this effort through collaborations with other space agencies and international organisations.

6. Opportunities for Indian Space Industry:

- The session opened doors for potential collaboration between European and Indian space industries, especially for startups. European startups are keen on entering the Indian market and collaborating with Indian companies, particularly in areas like IoT satellite constellations, spaceports, and data analytics.
- Indian space companies can leverage European expertise and investment, particularly through ESA's existing networks and upcoming business matchmaking events, to expand their technological capabilities and access to global markets.

7. Technology Transfer and Innovation Support:

- ESA's technology transfer programs and business incubation centres are critical in facilitating innovation and helping companies commercialise their products. Startups benefit from access to ESA's branding, technical support, and networks, which helps them scale faster.
- ESA is also working to bring together companies from different countries to create stronger innovation ecosystems across Europe and beyond, with India being a key market for collaboration.

8. Addressing Climate and Environmental Challenges through Space Technologies:

- There was a significant focus on using space technologies, such as satellite-based water management and Earth observation, to address pressing global issues like climate change, flooding, and natural disaster mitigation.

- European startups presented innovative solutions using advanced sensors and IoT devices, providing real-time data to improve decision-making in sectors like hydropower, agriculture, and water conservation.

9. Focus on Space Debris and Planetary Defence:

1. ESA is actively involved in planetary defence and space debris management, which are critical for maintaining the safety and sustainability of space operations. ESA's cooperation with international partners, including ISRO and NASA, is vital for missions like asteroid deflection and monitoring.
2. The collaboration between Europe and India in planetary defence is seen as a growing area of mutual interest, given the increasing global focus on space safety.

10. Spaceports and Launch Infrastructure:

- European startups are also focusing on improving space launch infrastructure by developing modular and interoperable spaceports, which aim to reduce the cost and time of access to space. This was identified as a key competitive factor for the future of space exploration and commercial satellite deployment.

B. Australia Session

The Australia session at the Bengaluru Space Expo 2024 provided a comprehensive overview of the growing collaboration between Australia and India in the space sector, underscoring the mutual benefits of partnerships, investment opportunities, and technological innovation. Australia, recognised as a key player in the global space industry, is on an ambitious mission to triple the size of its space sector by 2030, with a current annual growth rate of over 7%. The country's strategic geographic advantages, including proximity to the equator, dark skies, and ground station infrastructure, make it an ideal partner for space-related collaborations, particularly with India.

The Australian Space Agency highlighted its focus on international partnerships, with India being a central partner in its space agenda. Australia is actively contributing to India's space ambitions, notably through joint projects under the International Space Investment (ISI) India Grants program, which has allocated $18 million to foster collaboration between Australian and Indian companies. These projects are designed to support both countries in areas such as satellite launches, space exploration, and advanced remote operations. Furthermore, Australia is playing a supportive role in India's Gaganyaan human spaceflight program, with ongoing cooperation in space science and technology aimed at helping India achieve significant milestones in space exploration.

Australia's rapidly expanding commercial space ecosystem was another focal point of the session. The country's expertise in fields such as robotics, remote operations, optical and quantum communications, and Earth observation was showcased as areas where Australia can support India's ambitious space goals. With over 640 space organisations and more than 17,000 people employed in the sector, Australia is positioned to offer advanced capabilities and foster innovation. The country's clear skies, low noise, and light pollution, along with

streamlined regulatory frameworks, were presented as significant advantages for Indian companies seeking partnerships and joint ventures in the space domain.

The session featured presentations from several Australian states, each offering unique strengths in the space industry. South Australia, often referred to as the "space capital of the Southern Hemisphere," is home to the Australian Space Agency and over 100 space organisations. The state boasts a collaborative and inclusive ecosystem that facilitates innovation across various sectors. New South Wales, which hosts the largest number of space entities in Australia, highlighted its focus on satellite manufacturing, space systems engineering, and its robust research infrastructure. The state is also home to some of Australia's leading universities, providing a highly skilled workforce for space-related activities. Western Australia, known for its significant mining sector, is using space technologies to drive automation and remote operations in mining, while also expanding its space education and research capabilities.

The session also emphasised the importance of public-private partnerships and the role of venture capital in driving the space industry forward. Several upcoming opportunities for collaboration were presented, including the International Astronautical Congress (IAC) in Sydney in 2025 and Space Week in Western Australia. These events will provide platforms for Indian companies to engage with Australian firms, explore joint ventures, and access funding opportunities through programs such as the South Australian Space Collaboration Innovation Fund and the Perth Landing Pad initiative.

In conclusion, the session highlighted the deepening ties between Australia and India in the space sector, with both countries committed to fostering long-term partnerships that leverage their respective strengths in technology, innovation, and investment. Australia's focus on creating a strong Indo-Pacific region, combined with India's rapidly growing space sector, presents numerous opportunities for collaboration, particularly in areas like satellite launches, Earth observation, and space exploration. The session reinforced the message that Australia is not only a committed partner but also a leader in space technology and innovation, offering significant opportunities for Indian companies and institutions to collaborate and grow in this dynamic field.

The key takeaways from the Australia session at the Bengaluru Space Expo 2024 were as follows:

1. **Australia's Rapidly Growing Space Sector:** Australia's space sector is growing at a rate of more than 7% annually, with a target to triple in size by 2030. The country's strategic location, with proximity to the equator, dark skies, and ground station infrastructure, makes it an attractive partner for space collaborations, especially with India.
2. **Strong Collaboration Between Australia and India:** Australia considers India a key economic and strategic partner in space. The collaboration is bolstered by initiatives like the **International Space Investment (ISI) India Grants**, which have allocated $18 million to joint projects between Indian and Australian companies. These partnerships are designed to foster innovation and growth in space exploration, satellite technology, and remote operations.

3. **Support for India's Space Ambitions:** Australia is actively supporting India's space missions, including the **Gaganyaan human spaceflight program**. This collaboration aims to enhance India's capabilities, and Australia is committed to helping India become one of the leading spacefaring nations.
4. **Australia's Commercial Space Ecosystem:** Australia has over 640 space organisations and employs more than 17,000 people in the sector. The country is known for its expertise in **robotics, remote operations, quantum communications, satellite tracking, and Earth observation**. These capabilities present opportunities for Indian companies to collaborate with Australian firms to achieve mutual growth in the space industry.
5. **State-Level Contributions to the Space Sector:** Australian states like **South Australia**, **New South Wales**, and **Western Australia** play significant roles in the space industry:
    - **South Australia** is referred to as the "space capital of the Southern Hemisphere" and is home to the Australian Space Agency and over 100 space organisations.
    - **New South Wales** has a large concentration of space-related entities and offers a skilled workforce and infrastructure for satellite technology and advanced manufacturing.
    - **Western Australia** leverages its vast landmass and expertise in mining to integrate space technologies, particularly in automation and remote operations.
6. **Public-Private Partnerships and Funding Opportunities:** Australia encourages public-private partnerships to support the development of space technologies. **Venture capital funds**, such as the **South Australian Space Collaboration Innovation Fund** and **Perth Landing Pad**, offer Indian companies opportunities to collaborate and secure funding for space projects.
7. **Focus on Innovation and Research:** Australia is heavily invested in **space research and innovation** through partnerships with leading universities, research centres, and companies. The country's research infrastructure and emphasis on **space systems engineering** make it an attractive destination for Indian companies and researchers looking for innovation-driven collaborations.
8. **Future Collaboration Opportunities:** The session highlighted several upcoming events, such as **Space Week** and the **International Astronautical Congress (IAC)** in Sydney in 2025, as key platforms for Indian and Australian companies to explore new partnerships and collaboration opportunities.
9. **Strategic Indo-Pacific Cooperation:** Australia's commitment to a strong **Indo-Pacific** region is a central theme of its space strategy. The country views its collaboration with India as a vital part of maintaining regional stability and driving innovation in space exploration and commercial space applications.
10. **Bureaucratic Ease and Infrastructure:** Australia offers a **streamlined regulatory framework** and **state-of-the-art infrastructure** that provides clear advantages for Indian companies looking to establish partnerships. The country's well-developed ecosystem, including **low-light and low-noise environments**, is conducive to satellite operations and space research.

C. UK Session

The UK session at the Bengaluru Space Expo 2024 offered an in-depth look at the capabilities of several UK-based companies in the space sector, focusing on their advanced technologies and how these could foster partnerships with Indian companies. The session illustrated the UK's strong emphasis on innovation, particularly in space manufacturing, digital intelligence, and software solutions for satellites, highlighting the potential for collaborative efforts between the two nations.

One of the key presentations was delivered by **Cambridge Vacuum Engineering (CVE)**, a specialist in electron beam (EB) and laser welding technologies. CVE's expertise lies in creating highly precise and efficient welding processes, which are particularly well-suited for aerospace and space applications. Their welding techniques are not only 90% efficient in converting electricity into heat energy but also minimise the heat-affected zones, ensuring precision without compromising nearby components. The technology can weld metals as thin as 50 microns and as thick as 250 millimetres in a single pass, making it ideal for complex geometries in space applications. Importantly, CVE has a long-standing presence in India, with a machine in use at the Liquid Propulsion Systems Centre (LPSC) for over 30 years, a testament to the durability and quality of UK engineering. The company's focus on custom solutions and long-lasting machinery highlighted their commitment to meeting the specific needs of space and aerospace sectors in India.

BAE Systems, a world leader in aerospace and defence, showcased its evolving role in the space industry, particularly through its integration of digital, data, and cyber technologies. BAE Systems discussed their acquisition of In-Space Missions, a UK-based small satellite manufacturer, which now operates as a fully owned subsidiary. This acquisition has allowed BAE to enhance its space solutions, focusing on satellite manufacturing, battle space integration, and digital intelligence. One of the standout projects discussed was the **Titania mission**, a 130-kilogram satellite equipped with advanced radio frequency (RF) sensors. This mission demonstrated BAE's capability to use satellites for RF mapping, enabling real-time intelligence by geolocating terrestrial emitters and providing highly accurate data. BAE's focus on edge computing in space was also highlighted, which enables satellites to process data on-board and deliver actionable intelligence quickly, reducing the reliance on ground-based processing. BAE Systems is also actively exploring opportunities for ride-share missions, particularly in the Asia-Pacific region, offering payload hosting services for civil applications at ultra-low cost, further opening the door for Indian companies to collaborate.

The session also featured **Bright Ascension**, a Scottish software provider specialising in flight software for satellites. The company's experience spans more than 12 years, having provided software solutions for over 50 satellites globally. Their **Helix software platform** was a key focus, showcasing a family of nine software kits and applications designed to provide end-to-end solutions for satellite missions. This includes tools for mission control, simulation, and data visualisation, ensuring operators have the software needed to manage every aspect of their satellite missions. Bright Ascension's software is designed to be vendor-agnostic, allowing operators to adapt the system to their specific needs while maintaining interoperability across different hardware and data systems. Their emphasis on providing flexible, scalable solutions is particularly valuable for satellite constellations, enabling rapid

deployment and reduced costs for future satellite launches. Bright Ascension's technology is already gaining interest from Indian satellite operators, particularly for its capability to deliver real-time, actionable data for Earth observation and other space-based applications.

LDRA, a UK-based company with over 50 years of experience in embedded software testing and standards compliance, presented its expertise in safety, security, and certification for critical systems in aerospace and defence. LDRA's role in developing global standards for embedded software was emphasised, particularly in sectors that require stringent compliance, such as aerospace, nuclear, and automotive. The company has successfully built a strong presence in India since 2010, commanding a 75% market share in embedded software testing. LDRA's approach to the Indian market, which involved customising communication strategies and building trust-based relationships, was highlighted as a key factor in their success. The company's leadership in driving compliance with international standards in India's defence and aerospace sectors underscores the potential for further collaboration in ensuring that Indian space technology meets global safety and security benchmarks.

The session concluded with discussions on the broader UK-India partnership in space technology. Both nations share strong democratic values and have a long history of collaboration, making them natural partners in space exploration and technological advancements. The UK government's support for companies looking to establish a presence in the UK was also a key focus, with grants, accelerators, and a range of financial assistance programs available to help businesses grow. This support extends to space-focused companies, with opportunities for Indian firms to collaborate on satellite missions, software development, and manufacturing innovations.

The overarching theme of the session was the mutual benefit of UK-India partnerships in the space sector. The UK's advanced capabilities in manufacturing, software, and space solutions offer Indian companies access to cutting-edge technologies, while India's rapidly growing space industry presents significant opportunities for UK firms to expand their reach in one of the world's most dynamic markets. By leveraging these synergies, both countries stand to gain from enhanced collaboration in space exploration, satellite technology, and beyond.

The key takeaways from the UK session were:

1. **Advanced Welding Technologies for Space Applications: Cambridge Vacuum Engineering (CVE)** showcased their electron beam (EB) and laser welding technologies, which offer high precision and efficiency. These techniques are particularly valuable for space applications due to their ability to weld complex geometries and minimise heat-affected zones, making them ideal for sensitive components like those used in satellites and aerospace projects.
2. **UK-India Collaboration in Space Technology:** UK companies, such as CVE and **BAE Systems**, have a strong presence in India, with long-standing partnerships, such as CVE's 30-year collaboration with the Indian space sector. The UK sees significant potential in expanding these collaborations, especially in areas like satellite technology, digital intelligence, and space exploration.

3. **BAE Systems' Digital Intelligence and Space Integration:** BAE Systems presented their advanced capabilities in space through their **Digital Intelligence** division, which integrates satellite technologies with digital, data, and cyber capabilities. Their acquisition of **In-Space Missions** has enhanced their ability to deliver cutting-edge solutions, such as RF mapping for real-time intelligence and **synthetic aperture radar (SAR)** satellites for advanced space applications.
4. **Growing Role of Small Satellites and Ride-Share Missions:** BAE Systems highlighted opportunities in small satellite development and ride-share missions, including the **Faraday Dragon mission** for hosting technology payloads in the Asia-Pacific region. These initiatives offer Indian companies cost-effective ways to access space for civil and commercial applications.
5. **Bright Ascension's Software Solutions for Satellite Missions: Bright Ascension** introduced their **Helix software platform**, offering end-to-end solutions for satellite missions. The software is designed to manage the entire satellite lifecycle, from mission control to data visualisation, and provides vendor-agnostic, scalable solutions, which are particularly attractive for satellite constellations and Earth observation missions.
6. **Standards and Compliance in Embedded Systems: LDRA**, a leader in safety, security, and standards compliance, emphasised the importance of adhering to global standards in aerospace and space technology. Their success in India highlights the growing need for compliance in the embedded software used in critical space and defence systems.
7. **Opportunities for Indian Startups to Collaborate with UK Firms:** The session highlighted significant opportunities for Indian space startups to collaborate with UK companies in areas like satellite manufacturing, software development, and space exploration. The UK government's support through grants and accelerators was noted as a key factor in facilitating these partnerships.
8. **UK's Focus on Supporting Space Innovation:** The UK's space sector, represented by a range of companies, is committed to fostering innovation through digital intelligence, space integration, and satellite technologies. This offers Indian companies the opportunity to tap into the UK's expertise and advanced technologies, fostering a mutually beneficial collaboration.
9. **Shared Strategic Interests and Values:** The session reinforced the shared values and strategic interests between the UK and India, particularly in leveraging space technologies for global good. Both countries are committed to building long-term partnerships to drive innovation and growth in the space sector.

D. Italy Session

The Italy session at the Bengaluru Space Expo 2024 provided a detailed exploration of Italy's historical and contemporary role in the global space industry, and its potential for future collaboration with India. Italy's extensive six-decade experience in space began in 1964, when it became the third country in the world, after the US and Russia, to launch a satellite, marking its entry as a pioneering nation in space exploration. This legacy has continued,

positioning Italy as a major player in satellite development, space mission management, and innovative research, making it a natural partner for India in the space sector.

The session highlighted the long-standing partnership between Italy and India, particularly between the Italian Space Agency (ASI) and the Indian Space Research Organisation (ISRO). This collaboration, formalised in 2005 through a framework agreement, has grown steadily over the past two decades, resulting in significant advancements and shared achievements in space missions. The session reflected on the recent Italy-India Space and Industry Day, which brought together companies from both nations to explore potential collaboration, leading to the signing of Memorandums of Understanding (MoUs) aimed at expanding joint space efforts.

Italy's contribution to the European Space Agency (ESA), as its third-largest financial supporter, further reinforces its role as a leader in space research and technology. The Italian space industry spans a wide range of domains, including telecommunications, satellite navigation, Earth observation, and deep space exploration. Italian companies like Leonardo, ELT Group, Davi Promo, and Officina Stellare were presented as key examples of Italy's capabilities, offering cutting-edge solutions in aerospace and space systems. These companies focus on various advanced technologies such as opto-mechanical instrumentation, space propulsion systems, and satellite manufacturing, showcasing Italy's industrial strength in the space sector.

Italy's space economy, comprising over 250 companies and institutions, employs more than 7,000 people and generates approximately €1.9 billion annually. The Italian space sector is built upon a robust industrial and research ecosystem, with its companies involved in both upstream and downstream activities. The country also maintains a well-structured supply chain in space technology, supported by world-class research and innovation across various sectors. This supply chain, coupled with competitive labour costs and strong R&D capabilities, makes Italy an attractive partner for Indian companies looking to expand their space initiatives globally.

The session particularly emphasised Italy's commitment to addressing global challenges through space technology. Two significant contributions were noted: COSMO-SkyMed, a constellation of radar satellites, and PRISMA, a hyperspectral satellite. These systems are instrumental in providing real-time data for environmental monitoring, disaster management, and resource management. Italy's expertise in this area offers significant opportunities for collaboration with Indian counterparts, especially in using satellite data to tackle critical issues such as climate change, natural resource management, and food security.

In terms of future collaboration, Italy is keen to expand its partnership with India in satellite manufacturing, data processing, space propulsion systems, and space exploration technologies. This focus aligns with the strategic partnership agreement signed between Prime Ministers Narendra Modi and Giorgia Meloni, which highlighted space as a key area for bilateral cooperation. The session also outlined key upcoming opportunities, such as the International Astronautical Congress (IAC) in Milan in October 2024 and a planned trade mission of Italian space companies to India in 2025, which will serve as important platforms for advancing joint initiatives.

The Italian Trade Agency (ITA) played a pivotal role in facilitating Italy's engagement at the Bengaluru Space Expo. The ITA highlighted Italy's integrated aerospace value chain, which spans design, manufacturing, and downstream applications, supported by a strong network of SMEs and large integrators. Italy's focus on advanced manufacturing, research, and competitive costs further reinforces its appeal as a global hub for space technology, offering Indian companies and institutions a valuable partner for innovation and development in the space sector.

In summary, the Italy session at the Bengaluru Space Expo 2024 reinforced the deepening ties between Italy and India in the space sector, with both countries sharing a commitment to technological advancement, innovation, and addressing global challenges through space collaboration. The session underscored Italy's significant contributions to global space exploration and its readiness to collaborate with India in shaping the future of the space industry. Both nations are poised to strengthen their partnership, leveraging their respective strengths in technology, research, and industrial capacity, to drive joint achievements in space exploration and beyond.

The key takeaways from the Italy session were as follows:

1. **Italy's Longstanding Legacy in Space:** Italy has a six-decade history in space exploration, beginning in 1964 when it became the third country to launch a satellite, after the US and Russia. This positions Italy as a pioneer in space, with expertise spanning satellite manufacturing, space mission management, and cutting-edge research.
2. **Strong Italy-India Space Collaboration:** Italy and India have maintained a long-standing partnership in the space sector. Since the signing of the 2005 framework agreement between the Italian Space Agency (ASI) and ISRO, this collaboration has grown significantly. Italy and India are exploring new avenues for deeper cooperation, including satellite development, space propulsion, and space exploration technologies.
3. **Italy's Leadership in the European Space Industry:** Italy is the third-largest contributor to the European Space Agency (ESA) and plays a crucial role in Europe's space advancements. Italian companies such as Leonardo, ELT Group, Davi Promo, and Officina Stellare showcased their expertise in aerospace, defence, and space systems, further reinforcing Italy's leadership in the global space sector.
4. **Italy's Advanced Space Technology:** Italy's space industry has made significant advancements in areas such as telecommunications, Earth observation, and deep space exploration. The COSMO-SkyMed radar satellite constellation and the PRISMA hyperspectral satellite are examples of Italy's contributions to global environmental monitoring, disaster management, and resource management.
5. **Opportunities for Italy-India Collaboration in Satellite Manufacturing:** Both countries see significant potential for joint ventures in satellite manufacturing, data processing, and space propulsion systems. Italian companies and institutions are keen to collaborate with Indian counterparts to enhance technological capabilities and develop joint space initiatives.
6. **Strategic Focus on Addressing Global Challenges:** Italy's space industry is focused on using satellite technology to address pressing global challenges, including climate

change, food security, and natural resource management. Collaboration with Indian entities in these areas offers mutual benefits, particularly in leveraging satellite data for environmental and resource management.

7. **Upcoming Opportunities for Engagement:** Key events such as the International Astronautical Congress (IAC) in Milan in October 2024 and a trade mission by Italian space companies to India in 2025 were highlighted as major opportunities to strengthen collaboration between the two countries.
8. **Italy's Comprehensive Space Ecosystem:** Italy's space ecosystem consists of over 250 companies and institutions, employing more than 7,000 people and generating €1.9 billion annually. The sector is supported by a strong industrial base, with companies involved in both upstream and downstream activities, offering a wide range of expertise for collaboration.
9. **Italy's Commitment to Bilateral Cooperation:** Italy's commitment to furthering its collaboration with India in space was underscored by the strategic partnership agreement signed between Prime Ministers Narendra Modi and Giorgia Meloni. Space remains a high priority in the bilateral relationship, with both nations committed to leveraging each other's strengths to advance global space exploration.

E. Indo-Danish Collaboration in Space

The Indo-Danish collaboration session at the Bengaluru Space Expo 2024 provided a detailed overview of the growing partnership between Denmark and India in the space sector, highlighting Denmark's strategic ambitions and its alignment with India's space goals. Denmark, despite being a relatively small country, has placed a significant emphasis on expanding its space industry through innovation and international collaboration. This ambition is reflected in Denmark's evolving national space strategy, which is increasingly focused on global partnerships, with India being a key partner, particularly in the areas of sustainable solutions and the green transition.

The Danish Innovation Centre in India, based in Bangalore, plays a central role in facilitating collaboration between the two countries. The centre works with Danish and Indian universities, research institutions, and businesses to foster innovation in space technologies. Denmark has already been leveraging ISRO's capabilities, particularly for launching CubeSats, and there is a growing interest in expanding this cooperation. Danish companies see significant opportunities in collaborating with Indian counterparts to develop advanced space technologies that can contribute to sustainability and environmental management.

One of the main themes of the session was the use of space technologies to address global challenges, such as climate change, pollution management, and sustainable agriculture. Denmark's national space strategy places a strong emphasis on the green transition, with much of its research funding dedicated to sustainable solutions. Danish companies are increasingly using satellite services to support industries such as agriculture, maritime transport, and pollution control, and they are keen to collaborate with Indian companies to enhance these efforts. The session highlighted how the use of satellite data can significantly improve operational efficiency and environmental sustainability across various sectors.

Denmark's space industry, though small, is rapidly growing, with plans to significantly increase the number of space companies in the coming years. There is a strong focus on innovation in areas such as CubeSat technology, onboard processing, and quantum security, and Denmark is working closely with ESA to develop new space capabilities. Danish universities are also playing a critical role in advancing research in these areas, and there are significant opportunities for collaboration with Indian academic institutions through joint research projects and initiatives.

Another important aspect of the session was Denmark's effort to encourage non-space companies to adopt space services, particularly through the use of satellite data. Danish companies in sectors such as agriculture, transport, and environmental management are increasingly integrating space technology into their operations, and there is a clear interest in working with Indian companies to further develop these capabilities. The session also touched upon Denmark's support for startups and small businesses in the space sector, with initiatives in place to help them scale up and tap into the growing global space market.

In conclusion, the Indo-Danish collaboration in space is poised for significant growth, with both countries sharing a strong commitment to using space technology for sustainability and innovation. Denmark's focus on the green transition aligns closely with India's objectives, and there is substantial potential for joint ventures, technology transfer, and industrial partnerships. The session underscored the importance of deepening ties between Denmark and India in the space sector, particularly in areas such as CubeSat development, satellite services, and the application of space technologies to address global environmental challenges. This growing partnership holds promise for both nations, contributing to their respective space industries and the global space ecosystem at large.

The key takeaways from the Indo-Danish collaboration session at the Bengaluru Space Expo 2024 were:

1. **Strengthening Indo-Danish Space Collaboration:** The partnership between Denmark and India in the space sector is growing, driven by shared goals in sustainability and innovation. Denmark has been using ISRO's launch capabilities, particularly for CubeSats, and is keen to deepen this collaboration by exploring more space-related opportunities.
2. **Danish Innovation Centre in India:** The Danish Innovation Centre in Bangalore plays a pivotal role in fostering collaboration between the two countries. The centre facilitates connections between universities, businesses, and research institutions to promote innovation in space technology, with a strong focus on sustainable solutions.
3. **Focus on the Green Transition:** Denmark's national space strategy prioritises the green transition, aligning with India's goals for sustainability. The Danish government is heavily invested in space technologies that can address global challenges like climate change, pollution control, and sustainable agriculture. This creates significant opportunities for joint initiatives between the two nations.
4. **Use of Space Technology for Global Challenges:** Danish companies are leveraging satellite services to support industries such as agriculture, maritime transportation, and pollution management. There is a clear interest in working with Indian counterparts to

expand the use of satellite data for improving operational efficiency and environmental sustainability in these sectors.

5. **Increasing Number of Danish Space Companies:** Denmark's space sector, though relatively small, is rapidly growing. The government aims to increase the number of Danish space companies, particularly in areas like CubeSats, onboard processing, and quantum technologies. The session highlighted opportunities for Indian and Danish companies to collaborate in these emerging fields.
6. **Encouraging Non-Space Companies to Adopt Space Services:** Denmark is actively encouraging non-space companies to adopt space-based services, especially satellite data, to enhance their operations. There is an opportunity for Indian and Danish companies to jointly develop solutions that apply space technology to non-space sectors, improving efficiency and contributing to the green transition.
7. **Potential for Research Collaboration:** Danish universities are playing a significant role in advancing space research, with a focus on CubeSats and satellite image analysis. There are substantial opportunities for research collaborations between Danish and Indian academic institutions, particularly in areas that align with both nations' space and sustainability priorities.
8. **Opportunities for Joint Ventures and Technology Transfer:** The session highlighted the potential for joint ventures and technology transfer between Denmark and India. Danish companies are interested in working with Indian companies to co-develop space technologies, benefiting from each other's strengths in research, development, and commercialisation.
9. **Danish Commitment to Expanding Space Investments:** Denmark is committed to expanding its investments in the space sector, with plans to triple the funding allocated to space initiatives over the next decade. This creates a fertile environment for Indo-Danish collaboration, providing financial support and resources for joint projects.
10. **Denmark's Strategic Focus on Expanding International Collaborations:** Denmark is not only focused on partnerships within Europe but is actively seeking international collaborations, particularly with India, to develop space solutions that can address both global and local challenges. This strategic approach will create more opportunities for collaboration across various sectors, including space technology, sustainability, and research.

4. CONCLUSION

BSX 2024 underscored the immense potential of India's space sector to drive global innovation and economic growth. The event emphasised the need for continued collaboration between government, industry, academia, and international partners to harness the full potential of the space industry. India's progress in space exploration, combined with the increasing participation of the private sector, positions the country to play a leading role in the global space economy.

The event also highlighted Karnataka's critical role as a hub for space innovation and manufacturing, supported by the state's government and its robust ecosystem of academic institutions and private enterprises. International partnerships were a recurring theme, with countries like France, Italy, the UK, and Australia committed to collaborating with India in space exploration, satellite technology, and addressing global challenges such as climate change.

BSX 2024 served as a vital platform for fostering partnerships, sharing knowledge, and promoting innovation in the space sector. As India continues to expand its capabilities, the space industry is poised to contribute significantly to the country's economic growth, technological advancements, and global leadership in space exploration.

GLIMPSES OF THE EVENT

(L-R): Mr Rabindra Srikantan, Vice Chairman, CII Karnataka State Council, Shri D Radhakrishnan Chairman and Managing Director, NSIL and Co – Chairman, CII National Committee on Space, Mr Enrico Palermo, Head, Australian Space Agency, Dr. Pawan K Goenka, Chairman, IN-SPACe, Shri Priyank Kharge, Minister for Rural Development & Panchayat Raj, and IT & BT, Government of Karnataka, H.E. Mr. Alfonso Tagliaferri Consul General of Italy, Mr Apparao Mallavarapu, Chairman, CII National Committee on Space and CMD, Centum Electronics Ltd., Mr. Harshbir Sangha MBE FRSA Director Missions and Capabilities UK Space Agency.

Shri Priyank Kharge
Minister for Rural Development & Panchayat Raj, and IT & BT, Government of Karnataka.

Dr. Pawan K Goenka
Chairman, IN-SPACe

Inauguration of Exhibition at BSX 2024

Shri S Somanath, Secretary, DoS and Chairman, ISRO at BSX 2024

Confederation of Indian Industry

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

CII is a non-government, not-for-profit, industry-led and industry-managed organization, with around 9,000 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 365,000 enterprises from 294 national and regional sectoral industry bodies.

For more than 125 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. CII charts change by working closely with Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness, and business opportunities for industry through a range of specialized services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Through its dedicated Centres of Excellence and Industry competitiveness initiatives, promotion of innovation and technology adoption, and partnerships for sustainability, CII plays a transformative part in shaping the future of the nation. Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes across diverse domains including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

For 2024-25, CII has identified **"Globally Competitive India: Partnerships for Sustainable and Inclusive Growth"** as its Theme, prioritizing 5 key pillars. During the year, it would align its initiatives and activities to facilitate strategic actions for driving India's global competitiveness and growth through a robust and resilient Indian industry.

With 70 offices, including 12 Centres of Excellence, in India, and 8 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with about 300 counterpart organizations in almost 100 countries, CII serves as a reference point for Indian industry and the international business community.

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