Propelling India's Defence and Space Tech Revolution

PUNE DEFTECH

Insights from Pune DefSpace Tech Expo 2024

Organised by:

MSME Development and Facilitation Cell, Mumbai

In Association with:

Mahratta Chamber of Commerce, Industries and Agriculture (MCCIA)

Strategic Partners:

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Overview

CPSE Vendor Meet and DefSpace Tech 2024 Drive India's Space-Tech Ambitions

The Mahratta Chamber of Commerce, Industries, and Agriculture (MCCIA) hosted the CPSE Level Vendor Development Programme cum Exhibition of Products and Pune Def Space Tech 2024 on August 29 and and 30, 2024 at the MCCIA Trade Tower, Pune. This two-day event, organised in collaboration with MSME-DFO Mumbai and supported by key industry associations, aimed to advance self-reliance and innovation in India's defence, aerospace, and space sectors.

The CPSE Level Vendor Development Programme cum Exhibition of Products and Pune Def Space Tech 2024, jointly organised by MSME-DFO Mumbai and the Mahratta Chamber of Commerce, Industries, and Agriculture (MCCIA), concluded successfully on 29th and 30th August 2024. Supported by Strategic Research and Growth Foundation (SRGF), MCCIA Electronic Cluster Foundation (MECF), and SatCom Industry Association-India (SIA-India), the event aligned with India's Atmanirbhar Bharat initiative, promoting self-reliance and technological innovation in the defence, aerospace, and space sectors.

Day 1: CPSE Level Vendor Development Programme

The inaugural day opened with a welcome address by Mr. Prashant Girbane, Director General, MCCIA, emphasising industry-government collaboration to achieve defence self-reliance. This was followed by insightful sessions featuring prominent speakers:

- **Mr. Ajit B. Chavan,** Additional CEO, GeM, highlighted how the Government e-Marketplace facilitates MSME participation.
- **Mr. Manish Bhardwaj,** Technical Advisor to the DRDO Chairman, discussed leveraging emerging technologies in defence.
- **Mr. Milind Barapatre,** Director, MSME-DFO Mumbai, stressed the importance of industry collaboration for innovation.

The day also featured a vendor development session, where representatives from L&T Defence, Eaton Mobility Group, and others provided actionable insights on procurement strategies and maximising opportunities through platforms like GeM. Industry leaders such as Mr. Satyajit Patil, Ms. Sonali Nikam, and Mr. Bhushan Mahale discussed quality, innovation, and the need to invest in indigenous R&D.

The highlight of the day was the vendor exhibition, where 39 exhibitors showcased cutting-edge technologies. Companies like Ikran Aerospace, Manastu Space, and Vasundharaa Geo Technologies Pvt. Ltd. attracted significant attention, fostering potential collaborations.

Day 2: Pune Def Space Tech 2024

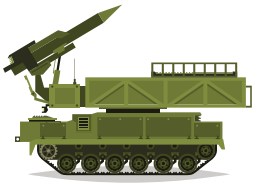
Day two commenced with opening remarks from Mr. Prashant Girbane and Mr. Mahesh Phadke, Chairman of MCCIA Defence Committee, setting the tone for discussions on defence and space convergence. Senior officials from HQ Southern Command, DRDO, and Air HQ participated, underscoring the strategic importance of merging defence and space technologies.

Notable speakers included:

- **Lt. Gen. Dr. DB Shekatkar (Retd.),** who advocated integrating space capabilities into national security frameworks.
- **Dr. Anupam Sharma,** Scientist 'H', DRDO, who highlighted startup contributions to advanced defence technologies.
- **Lt. Gen. VG Khandare (Retd.),** Principal Advisor, Ministry of Defence, and **Lt. Gen. Dr. PJS Pannu (Retd.),** Chair, Defence Space Committee, who discussed strategic policy integration.

The event featured four panel discussions on defence technologies, global collaborations in deep tech, indigenous innovation, and the startup ecosystem. Moderators like Dr. Chaitanya Giri, Mr. Harsh Gune, and Mr. Anirudh Rastogi facilitated engaging discussions, highlighting challenges and opportunities in these sectors.

The two-day event served as a dynamic platform for knowledge exchange, networking, and exploring collaborative opportunities in the defence and space industries. With a focus on self-reliance and innovation, the CPSE Level Vendor Development Programme and Pune Def Space Tech 2024 successfully showcased India's growing capabilities and set the foundation for future advancements in defence and space technology, resonating with the vision of Atmanirbhar Bharat.



Launch of the Drishti Geo Portal: Transforming Geospatial Data Accessibility

A key highlight was the launch of the Drishti Platform, a state-of-the-art surveillance and intelligence solution leveraging satellite imagery and AI analytics. Jointly inaugurated by the dignitaries, this platform is expected to significantly bolster national security.

The much-anticipated launch of the Drishti Geo Portal, an innovative open-source platform designed by Vasundhara Geo Tech, marked a significant step in revolutionising access to and analysis of geospatial data. The event featured an introduction by Advait Kulkarni, who underscored the platform's potential to simplify the complexities of geospatial data and empower users with actionable insights.

Drishti offers an all-in-one solution for remote sensing needs, enabling users to discover, access, and analyse data through a user-friendly interface. With features like automated imagery analysis, seamless 3D visualisation, and advanced vector generation capabilities, the portal eliminates the need for multiple tools. It also integrates a chatbot for enhanced usability, ensuring a smooth experience even for intricate geospatial tasks.

Highlighting the broader impact of geospatial data, the launch addressed the growing challenge of harnessing meaningful insights from the immense volumes of satellite data generated daily. Drishti's introduction promises to bridge this gap, positioning itself as a vital tool for mapping, analysis, and planning in various sectors.

With its innovative approach, Drishti Geo Portal aims to become a reliable partner for professionals navigating the complexities of an ever-evolving world. The launch was a testimony to Vasundhara Geo Tech's commitment to advancing geospatial solutions and empowering users with cutting-edge technology.

Photo Feature

Showcasing India's Defence and Space Synergy: **Highlights from Pune DefSpace Tech Expo 2024**

The Pune DefSpace Tech Expo 2024, hosted by MCCIA in collaboration with MSME-DFO Mumbai, spotlighted India's burgeoning capabilities in defence and space technologies. Over two days, industry leaders, policymakers, and innovators converged to drive self-reliance and collaboration in these critical sectors. From insightful panel discussions and product showcases to the unveiling of groundbreaking platforms like the Drishti Geo Portal, the event highlighted India's technological prowess and vision for a secure, self-reliant future.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Welcome Address

Exploring the Frontiers of Space Technology

Mr. Prashant Girbane

Director General,
The Mahratta Chamber of Commerce, Industries and Agriculture (MCCIA)

The Mahratta Chamber of Commerce, Industries and Agriculture (MCCIA) represents 3,000 member companies and operates across 18 districts in Maharashtra. Plans are in place to achieve presence in every district by the end of the year. With initiatives that engage businesses, policymakers, and international stakeholders, MCCIA drives economic growth and industrial collaboration.

In the past year, we facilitated 100 meetings with ministers and senior officials, hosted diplomats from 20 countries, and supported 2,637 companies through various initiatives. Pune, a city of immense industrial importance, ranks fifth in India for merchandise and engineering goods exports while being the largest city in the country that is not a state capital. Its position as a hub for industry and innovation continues to grow.

The space technology sector, valued at USD 88.4 billion, is set to grow fivefold over the next decade. India's share in this global market, currently 2-3%, is projected to reach 8% by 2033, with significant opportunities in satellite component manufacturing, ground systems, and space-based services.

The 2023 Indian Space Policy strengthens the foundation for collaboration across the sector, fostering partnerships between startups, large corporations, and policymakers. Over 190 startups, along with established organisations such as the Tata Group and L&T, actively contribute to shaping this ecosystem.

With the support of the Southern Command and DRDO, the discussions and collaborations in this sector highlight its immense potential and the opportunities it offers for technological advancement and economic growth.

Opening Remarks

Harnessing the Synergy of Defence and Space Technologies

Mr. Mahesh Phadke
Chairman, MCCIA
Defence Committee

The Defence Committee of MCCIA, established in 1999, serves as a platform for collaboration between the Armed Forces, DRDO, DGQA, and industry stakeholders. With the aim of aligning industrial capabilities to defence requirements, the committee continues to play a pivotal role in fostering these interactions.

The comprehensive directory of member contributions reflects the committee's dedication to strengthening ties within the sector. Initiatives such as the Brigadier SB Ghorpade Awards for MSMEs and plans for a Memorandum of Understanding with the 9 BRD of the Indian Air Force further reinforce its commitment to innovation and collaboration. Upcoming events like the Pune DefTech in November signify the growing importance of platforms that bridge the gap between industry and end users.

The convergence of defence and space technology is reshaping strategies worldwide. Space, integral to national security, spans activities such as satellite communications, Earth observation, and space exploration. India's contributions include ISRO's PSLV and GSLV launches, the Mangalyaan and Chandrayaan missions, and a growing footprint in satellite communications and Earth observation. The rise of nearly 200 startups in the space sector highlights the transformative potential of this domain.

India's space sector is supported by a robust policy framework and strategic investments. With the introduction of the new space policy and the space startup fund, the ecosystem is positioned to achieve significant advancements. Companies like L&T have been instrumental, contributing through launch vehicle structures, satellite components, and close collaborations with ISRO on various programmes.

The rapid evolution of the global space economy opens opportunities in areas such as space infrastructure, exploration, and strategic collaborations. These developments underscore the importance of fostering innovation, aligning industrial strengths, and embracing the dynamic potential of the sector.

Special Address

The Strategic Imperative of Strength and Self-Reliance

Lt. Gen. (Dr) DB Shekatkar (Retd.)
PVSM, AVSM, VSM

Pune reflects India's position as a centre of intellectual and academic growth, highlighting the interconnected nature of national, regional, and global challenges. Technological capability plays a crucial role in addressing these challenges. Looking back at the wars of 1962, 1965, and 1971, it is clear that preparedness and technological advancement are critical for national security. The 'Make in India' initiative emphasises the importance of developing indigenous solutions while remaining competitive internationally.

India is steadily moving away from its earlier reliance on defence imports, which once accounted for 70% of its requirements. Institutions such as DRDO, proactive industrial policies, and collaborative efforts are driving this change. The vision articulated by Former President of India Dr. APJ Abdul Kalam to achieve 70% domestic production is taking shape. Building strong manufacturing capabilities and integrating advanced technologies are vital steps in this process.

India's geographic diversity strengthens its defence readiness, from the islands of the Andaman and Nicobar to the rugged terrains of Ladakh. The Indian Air Force's ability to operate advanced aircraft at some of the world's highest airstrips demonstrates the skill and adaptability of its personnel. The combination of expertise and technology is a defining factor in India's defence strategy.

Space technology is now deeply integrated into defence planning worldwide. India's growing presence in this field, supported by ISRO and private ventures, signifies the importance of space-enabled systems for surveillance, communications, and strategic operations. Modern warfare increasingly depends on these advanced capabilities.

India's approach to peace is guided by strength. Operations in regions such as the Maldives and Sri Lanka reflect a commitment to protecting sovereignty without aggression. Indian peacekeepers are respected globally for their professionalism and neutrality. However, achieving and maintaining peace requires constant vigilance and capability.

For the younger generation, the responsibility to uphold the country's strength and unity is essential. Internal challenges often pose greater risks than external ones, requiring resilience and focus. The armed forces' efforts, combined with technological progress, highlight India's determination to achieve self-reliance and build a secure future.

Special Address

Strengthening Internal Security Through Innovation

Jayant Umranikar
Former Director General of Police, Maharashtra

The evolving concept of national security increasingly emphasises the importance of addressing internal security as part of a 'two-and-a-half front war.' While the two external fronts are well understood, the half front—internal security—requires significant attention. Key areas like police reforms, criminal justice system improvements, and basic infrastructure are foundational to national security but are often overlooked.

Infrastructure challenges highlight these gaps. For example, moving troops just two kilometres to Pune Railway Station can take hours due to traffic congestion. This underscores the need to prioritise basic infrastructure, without which even advanced technological innovations may fall short.

India's historical lag in adopting modern technology is evident. From outdated defences during Babur's invasion to police forces armed with lathis during the 26/11 attacks, the need for technological advancements in internal security is apparent. Defence innovations must also be adaptable for civil forces, offering both economies of scale and practical benefits. The combined strength of India's police and paramilitary forces surpasses that of the military, making their modernisation equally critical.

Police reforms, stalled since the 1902 Fraser Commission, remain an urgent need. Delays in providing basic equipment, like bulletproof jackets post-26/11, highlight bureaucratic and funding challenges. Intelligence gathering, a vital aspect of internal security, is undergoing transformation. Traditional methods are being replaced by advanced tools like CCTV surveillance, facial recognition, and artificial intelligence for data mining. These innovations enhance the ability to identify threats and ensure vigilance in sensitive areas.

Internal security is integral to national security and deserves equal focus. Advancements in defence and space technologies should have practical applications for law enforcement to strengthen this critical half front.

To the younger generation, I stress the importance of building a robust foundation—effective policing, reliable infrastructure, and a responsive criminal justice system. Internal threats have historically posed significant challenges, and addressing them is essential for a secure future.

Special Address

Space: The New Frontier for Military Operations

Dr Anupam Sharma
OS & DSP, DRDO

Space operations are central to modern defence strategies, with satellites in Low Earth Orbit (LEO) travelling at speeds of approximately 7.8 km/s. This velocity enables rapid intelligence gathering and real-time data transmission, which are crucial for both civilian and military operations. Space Situational Awareness (SSA) has become indispensable for monitoring satellite manoeuvres and ensuring strategic advantage.

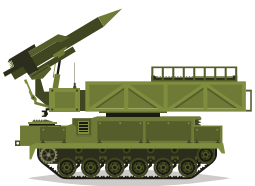
India is transitioning from single satellite launches to constellations, enabling formation flying and hybrid capabilities. These satellites can perform dual-use missions, such as monitoring vegetation while detecting ground materials for military use. Indigenous developments, including X-band radar and upcoming Ku-band synthetic aperture radars, highlight India's technological advancements.

The traditional reliance on ground-based radars and telescopes is being replaced by comprehensive space-based SSA, offering 360-degree coverage. Integrating command, control, communications, intelligence, surveillance, tracking, and reconnaissance (C2CISR) systems enhances strategic planning. Electronic Intelligence (ELINT) payloads play a critical role in mapping adversary radar locations and parameters.

The increasing complexity of space traffic requires innovations like digital twins for asset maintenance, on-demand satellite launches, and deployable satellites from mother platforms. Military countermeasures now include kinetic and non-kinetic systems, such as space-to-space lasers and particle beams. Co-orbital warfare, involving satellites manoeuvring to disrupt adversaries, represents the future of space conflict.

Emerging technologies such as artificial intelligence, quantum computing, additive manufacturing, and nanotechnology are redefining the capabilities of space systems. AI enhances onboard processing and bandwidth management, while quantum computing strengthens encryption and communications. Research into fuel efficiency, including the use of hydrogen and nitrogen in space, aims to sustain satellite operations at lower altitudes.

The integration of commercial technologies like 6G communications into military applications marks a strategic shift. Collaboration among startups, academia, and industry is essential for developing advanced sensors, energy management systems, and propulsion technologies. Neuromorphic sensors for hypersonic missile tracking, currently dominated by a single nation, underscore the need for innovation at a national level.



By 2030, the convergence of civilian, commercial, and military domains in space will reshape national security strategies. Continued partnerships between ISRO, commercial entities, and defence organisations are critical for addressing security challenges in an interconnected space environment.

Special Address

Defence and Technology: Building an Ecosystem for Self-Reliance

Lt. Gen. KS Brar
AVSM, GOC, Dakshin Bharat Area

Technology underpins every aspect of modern defence. From night sights on rifles to advanced combat systems, the Armed Forces rely heavily on innovation and industry collaboration. Achieving Rs. 3 lakh crore in defence production and Rs. 50,000 crore in exports by 2028 requires transforming policies into actionable contracts, particularly within the defence corridors of Tamil Nadu and Uttar Pradesh.

The Army's procurement model is evolving, with a shift from imports to "Make in India." However, true indigenisation goes beyond labour and services; it requires the development and integration of critical technologies. Startups play a pivotal role but need funding, guidance, and assurance of follow-up orders to thrive.

Emerging technologies must align with strategic needs. Drones, for example, excel in intelligence and reconnaissance but face limitations in high-altitude areas, where space-based assets are essential. Innovations like the Integrated Management Combat System (IMCS), which reduces heat signatures of tanks, and swarm drones demonstrate the potential of collaborative development under frameworks like Innovations for Defence Excellence (IDEX).

Balancing the maintenance of legacy equipment with the adoption of advanced systems is critical. Seventy percent of current defence assets are ageing, yet their continued utility, as seen in the Ukraine conflict, underscores the importance of sustaining these systems while pursuing future technologies. Network-centric warfare, integrating weapon systems into cohesive networks, is the next frontier.

Southern India, extending from Pune to Chennai, is emerging as a hub for defence innovation, with tank factories, research labs, and leading academic institutions like IISc contributing to advancements. Collaboration with ISRO, DRDO, and private entities is essential to build an ecosystem that fosters self-reliance.

Atmanirbhar Bharat (self-reliant India) is not merely an aspiration but a necessity. Over-reliance on foreign technology, even for civilian purposes, poses inherent risks. Progressive policies have laid the foundation, but their implementation is paramount. India's vast potential must now be fully realised to secure a self-reliant future in defence.

Keynote Address

Towards a Technologically Advanced and Self-Reliant India

Lt. Gen. VG Khandare (Retd.)
PVSM, AVSM, SM,
Principal Adviser,
Ministry of Defence

The evolving nature of threats and opportunities requires dynamic frameworks. While technology plays a crucial role in national security, its application is where the real challenge lies. India's strength lies in its knowledge-driven society, and it is imperative to harness this intellectual capacity to devise solutions rather than dwell on challenges.

Civil-military integration remains a critical area. The disconnect between academia, industry, and military needs often results in products that fail trials. Bridging these gaps through collaboration is essential to ensure innovations meet operational requirements. Pune, with its Regional Technology Node, exemplifies the potential for such integration.

The return of talent from abroad is a significant opportunity. These experts bring not only knowledge but also capital, which can transform sectors like robotics, artificial intelligence, and cybersecurity. Innovations such as robotics for artillery maintenance and geospatial data archiving demonstrate how these advancements can enhance operational efficiency.

Pune's role as an IT hub positions it to lead in defence, space, and cybersecurity. Space-based opportunities like zero-gravity manufacturing, asteroid mining, and addressing space debris are emerging areas where the city can contribute significantly. Data sovereignty is another critical issue, with secure communication and data centres being a top priority.

India's emphasis on Atmanirbhar Bharat underscores the need for indigenous capabilities. While collaborations like BrahMos showcase successful joint ventures, the focus must remain on building a robust domestic research base. By 2047, India's vision of becoming a "Viksit and Surakshit Bharat" requires investment in future technologies rather than relying on incremental progress.

Human capital is central to this vision. Initiatives like Space Kids inspire young minds across India, fostering the next generation of innovators. It is the collective responsibility of educators, scientists, industry leaders, and military personnel to nurture this potential and ensure India's rise as a global leader in technology, defence, and innovation.

Vote of Thanks

Fostering Collaboration for Defence and Space Excellence

Pune's legacy of innovation continues to position it as a critical hub for developing advanced technologies in defence and space. The city thrives on adaptability and foresight, driven by sustainable businesses and the dynamic contributions of professionals and entrepreneurs. The return of NRIs and the next generation of medium-scale enterprises underscores the confidence in Pune's ability to embrace new technologies and shape transformative changes.

The MCCIA Defence Committee plays a pivotal role in facilitating this progress. With initiatives such as the recently established Centre of Excellence, supported by the Regional Technology Node (RTN), the focus remains on addressing challenges in indigenisation and fostering innovation. This centre is a witness to Pune's capability to drive advancements in critical technologies.

Marking the first anniversary of Space Day, the vision for Pune's defence and space technology ecosystem is clear. The emphasis lies on building a collaborative framework that integrates private industries, conglomerates, and MSMEs. Long-term partnerships and robust supply chains are key to supporting this mission and enhancing Pune's standing in national security efforts.

The contributions of industry leaders, speakers, and participants showcased during the Pune DefSpace Tech Expo highlight the collective dedication to innovation and progress. These efforts are instrumental in elevating Pune as a leader in defence and space technology, reflecting its strategic importance for India's technological future.

Mr Harsh Gune

Member, Core Group,
MCCIA Defence
Committee

Panel Discussion 1

Analysis of the Current Landscape and Futuristic Perspectives in Emerging Defence Technologies

Advancing Defence Technologies Through Collaboration and Innovation

Panelists:

Dr. Chaitanya Giri
Fellow, ORF's Centre for Security, Strategy and Technology

Lt. Gen. PJS Pannu (Retd.),
PVSM, AVSM, VSM, Former DCIDS (Ops) and Governing Board Member, SRGF

Lt. Gen. KS Brar
AVSM, GOC, Dakshin Bharat Area

Rear Admiral Nelson D'Souza
NM, Commandant,
Military Institute of Technology (MILIT), Pune

Col Sunil S Fatehpur
Director, SOI, GIS&RS

Pranav R. Satyanath
Research Associate, Space Technology and Policy Programme, Council for Strategic and Defence Research (CSDR)

The panel discussion on 'Analysis of the Current Landscape and Futuristic Perspectives in Emerging Defence Technologies' highlighted the vital role of academia, industry, and operational forces in fostering defence innovation. The five panellists explored themes ranging from leveraging academic research for practical applications to adapting to emerging domains like space and cyber warfare. They emphasised indigenous solutions, seamless data integration, and AI-driven approaches as pivotal for addressing modern defence challenges. Collaboration and robust policies were underlined as critical enablers for aligning technological advancements with India's strategic objectives.

The discussion underscored the growing importance of transitioning from theoretical academic excellence to practical, tactical applications for defence. It reflected on the evolution of warfare into newer domains such as space and cyber while recognising the role of indigenous solutions in securing the future. The panellists also shared pragmatic approaches to leveraging cutting-edge technologies like AI, quantum communication, and satellite data to meet the complex demands of national security.

With a focus on collaboration between industry, academia, and operational forces, the session illuminated pathways for addressing critical challenges, from space situational awareness to cybersecurity vulnerabilities.

Advancing Defence Innovation Through Academic Synergy

Dr. Chaitanya Giri
Fellow, ORF's Centre for Security, Strategy and Technology

Dr. Chaitanya Giri *focused on Pune's evolution into a defence innovation hub, illustrating how academic research can transition into practical military applications. He shared examples from space weather research and graphene studies that have advanced defence technologies.*

Key Takeaways

- Pune is transitioning from theoretical academic excellence to practical, tactical, and strategic applications for defence innovation.
- The U.S. Navy serves as an example of leveraging space weather research for military advancements, showcasing how academic findings integrate into defence.
- Technologies like graphene, initially explored in meteorite studies, have found applications in defence, including radiation detection in nuclear submarines.

Pune is rapidly becoming a technological hub for the Army. Historically recognised as the 'Oxford of the East' for its academic prowess, Pune has primarily been associated with theoretical advancements. However, the time has come to shift our focus towards more practical, tactical, and strategic applications.

For vendors and startups, it is crucial to recognise the emerging use cases from the armed forces. The technologies you are developing hold immense potential and are of significant interest to the research institutions across Pune. Regular interactions through forums like this play a key role in ensuring that these needs are communicated effectively and translated into impactful innovations.

I would like to share a few examples that may resonate with many entrepreneurs, especially those involved in startups. As a scientist turned think-tanker, during my PhD, I collaborated closely with solar physicists in Germany who were part of space missions like India's Aditya L1 Solar Mission, the Solar Orbiter, and other American initiatives. I observed that many of these physicists, initially engaged in academic research, were later employed by major defence contractors like Lockheed Martin and academic institutions funded by the U.S. Navy. The U.S. Navy, in fact, is one of the largest sponsors of space weather research globally, using such knowledge to enhance its carrier battle groups

> ***Cutting-edge academic research has the potential to seamlessly transition into military applications. It is imperative that we cultivate partnerships between startups, research institutions, and the military to foster impactful solutions.***
>
> – Dr Chaitanya Giri,
> Fellow, ORF's Centre for Security, Strategy and Technology

and expeditionary capabilities. This is a prime example of how cutting-edge academic research can seamlessly transition into military applications.

Another personal experience comes from my research involving the collection of comet samples to study their organic and isotopic composition. While the mission itself was a scientific milestone, a segment of that research was later adapted by BAE Systems for integration into the Astute-class SSBN nuclear submarines launched around 2015-2016. The technology was employed to detect radiation leaks within the submarine's living quarters, showcasing how scientific breakthroughs can be adapted for defence applications.

A third example relates to my work on graphene, a material of immense interest due to its potential as the next-generation semiconductor, following silicon. My research involved studying graphene present in meteorites, a project that led me to collaborate with the Smithsonian's labs. Remarkably, a significant portion of the foundational research in this field originated from the U.S. Naval Materials Lab in Washington, D.C. The expansive scope of research undertaken by a navy with global responsibilities is truly impressive. I believe that MILIT (Military Institute of Technology) is pursuing similar advanced research, and soon, academic institutions not traditionally involved in military studies will find themselves collaborating on joint ventures with MILIT.

There is a vast amount of potential for synergy—both from a top-down approach led by established institutions and from a bottom-up approach driven by startups and entrepreneurs. The opportunities for innovation are immense. The Sarvatra Centre for Research and Innovation is already spearheading several groundbreaking projects. The future is promising, and we stand on the cusp of remarkable advancements.

Integrating Space and Cyber Technologies in Defence

Lt. Gen. PJS Pannu (Retd.),
PVSM, AVSM, VSM,
Former DCIDS (Ops) and
Governing Board Member, SRGF

Lt. Gen. PJS Pannu *(Retd) highlighted the strategic role of space and cyber technologies in securing India's borders. He stressed the need for a "smart frontier" and seamless integration across military and paramilitary forces.*

Key Takeaways

- India's borders span 22,000 kilometres, requiring seamless coordination between paramilitary forces and the military.
- A 'smart frontier' integrating advanced technologies is critical for national security.
- Unified platforms across land, sea, air, space, and cyber domains are essential for modern warfare.
- Indigenous solutions in space and cyber technologies are paramount for standoff warfare.

I was commissioned into the Maratha Light Infantry, and as we gather in Pune to celebrate Space Day, it is essential to reflect on the significance of space as the ultimate vantage point. This perspective, much like the strategic foresight of Chhatrapati Shivaji Maharaj, remains timeless. His scouts stationed at elevated positions exemplified the importance of high ground in gathering critical intelligence—a lesson that applies even today.

Commanding the 14 Corps in the world's highest battlefield offered invaluable insights into our strategic challenges. On the map of India, 38,000 square kilometres of Aksai Chin and 34,000 square kilometres of Pakistan-occupied Kashmir (PoK) and Gilgit-Baltistan remain outside our control. These realities, dating back to independence, underscore the need to first reclaim the mind space before pursuing physical reclamation.

Our borders span nearly 22,000 kilometres, including 15,000 kilometres of land and 7,500 kilometres of maritime boundaries. While much of our borders are secured by paramilitary forces like the BSF, ITBP, and Coast Guard, wartime coordination with the military is vital. Seamless integration between these forces is paramount for national security.

> ***To reclaim lost territories, we must first conquer the mind space before the physical space. Technology must bind our forces into a cohesive and intelligent frontier.***

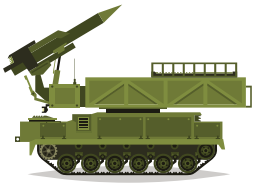
– Lt. Gen. PJS Pannu (Retd),
Former DCIDS (Ops) and Governing Board Member, SRGF

To secure our borders effectively, we must establish a "smart frontier" fully integrated with advanced technologies. Technology must serve as the binder that unites our armed forces and paramilitary entities into a cohesive defence mechanism. A unified approach is required, involving research, industry, and operational forces.

Modern warfare spans multiple domains—land, sea, air, space, and cyber. These domains must operate on unified platforms with seamless communication and intelligence sharing. Space and cyber technologies represent the fourth and fifth frontiers and demand robust, indigenous solutions. The lack of coordination during the Kargil conflict, where War Book provisions were not invoked, highlights the importance of meshed intelligence systems and unified command structures.

The future of standoff warfare lies in science and technology. Our engineers, scientists, and industry must provide indigenous solutions to reduce direct confrontation. Developing these technologies domestically is essential for sovereignty.

The National War Memorial, with the names of 27,000 soldiers who sacrificed their lives, reminds us of our duty. Today, that number has risen to nearly 28,000. Leveraging technology to prevent further loss of life is an imperative. Let us act together to address these critical issues and secure our nation's future.



Defence Space: A Futuristic Perspective

Lt. Gen. KS Brar
AVSM, GOC,
Dakshin Bharat Area

Lt. Gen. KS Brar *addressed the shift towards multi-domain operations, focusing on ISR, cybersecurity, and quantum communication. He urged indigenous development of technologies to maintain national security.*

Key Takeaways

- Warfare is shifting towards space, cyber, and the electromagnetic spectrum, alongside traditional domains.
- ISR requires a unified, multi-agency approach to be effective.
- Indigenous software development is essential to mitigate cybersecurity vulnerabilities.
- Quantum communication offers unmatched resilience against jamming or spoofing.
- Emerging technologies like drones demand indigenous components for secure operation.

We are witnessing a profound shift in warfare, driven by technological disruption. This marks the second major revolution in the history of warfighting. The first occurred when armies transitioned from traditional weapons to mechanised forces equipped with guns and rockets. Those who adapted to these new technologies dominated the battlefield, a pattern that has continued with advancements in weaponry, aircraft, and other military systems.

Today, a new era of disruption is unfolding, defined by information, data, communications, and space. Failing to adapt will leave us lagging, both as a military and as a nation. This shift introduces new domains of warfare: space, cyber, and the electromagnetic spectrum, alongside traditional domains like land, sea, and air. Additionally, cognitive warfare, which influences perception, and internal security, where technology and social media shape conflicts, are becoming increasingly relevant.

Our armed forces must adapt to multi-domain warfare. Some might argue we are not at war, but conflicts across these new domains are already producing significant results, often more impactful than conventional combat. Intelligence, Surveillance, and Reconnaissance (ISR) plays a critical role in this landscape. Effective ISR spans land, sea, space, and cyberspace, requiring data to be shared across agencies—be it the police, Army, Navy, Air Force, or

> ***If we fail to adapt, we risk falling behind, both as a military and as a nation. Tangible assets and indigenous solutions are critical for asserting control across new domains of warfare.***
>
> – Lt. Gen. KS Brar,
> GOC, Dakshin Bharat Area

others. A unified and integrated approach to ISR is essential.

Space capabilities are pivotal to asserting control in this new battlefield. Just as a navy without ships cannot dominate the seas, control of space demands tangible assets like rockets and satellites. The emergence of startups in this area is promising, and their momentum must be supported.

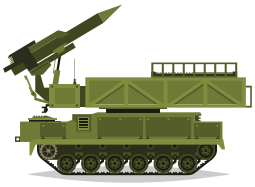
Cybersecurity is equally vital, particularly for satellites, drones, and other critical systems. Reliance on foreign software introduces vulnerabilities. The Microsoft outage caused by a technical glitch underscores how dependent we are on external systems. Developing indigenous AI, machine learning, and algorithms is essential to safeguard our security.

Quantum communication, which is resistant to jamming or spoofing, represents a critical frontier. While we are making strides in this area, collaborative efforts are necessary to fully harness its potential. Defence considerations must also be integrated into the development of emerging technologies, ensuring they address national security challenges from inception.

Energy resources are another strategic concern. China's control over much of the global lithium supply highlights the need for alternatives like new energy storage materials. These advancements are essential for environmental and strategic resilience.

Drones exemplify how technology is reshaping defence. Their ability to autonomously complete the OODA loop (Observe, Orient, Decide, Act) makes them efficient, cost-effective, and disposable. However, the use of indigenous technology in drone systems, particularly for autopilots and command links, is critical to mitigate vulnerabilities posed by foreign components.

As we navigate this evolving landscape, adopting an integrated, forward-looking approach across all domains is imperative to safeguard our national security.



Collaborating for Defence Excellence

Rear Admiral Nelson D'Souza *emphasised MILIT's initiatives to align academic expertise with industry needs, showcasing advancements in satellite imagery correlation and AI-driven solutions for defence applications.*

Rear Admiral Nelson D'Souza

NM, Commandant, Military Institute of Technology (MILIT), Pune

Key Takeaways

- MILIT connects service officers with industry partners to tackle real-world defence challenges.
- Key projects include the autocorrelation of satellite imagery and integration of SAR and electro-optical data using AI.
- MILIT collaborates with IITs and industry for advancements in Digital Elevation Models (DEM).
- The institution addresses the gap in problem clarity, providing practical, use-case-driven solutions for defence needs.

I oversee the Military Institute of Technology (MILIT) in Pune, a premier institution that brings together approximately 200 highly talented service officers from the Army, Navy, and Air Force every year. These officers, with 10 to 15 years of experience, pursue a master's degree at MILIT, engaging in rigorous academic and practical training over the course of a year.

A key feature of their programme involves selecting a dissertation topic, which we have recently enhanced by establishing connections with industry partners. This shift allows our officers to engage in real-world, use-case-driven projects rather than focusing solely on theoretical research. Their domain expertise across space, land, sea, and underwater environments uniquely positions them to tackle complex defence challenges.

We have already formed partnerships with several companies, such as Bit Mapper, and are eager to collaborate further with other industry players. Leveraging the expertise of our officers, MILIT supports industries in addressing specific defence-related problem statements, delivering practical solutions that directly benefit the armed forces.

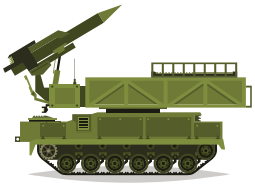
For instance, one of our ongoing projects focuses on the autocorrelation of satellite imagery. The vast amounts of satellite and drone data we gather present challenges in efficiently correlating this information in real time at high speeds.

> ***By combining the strengths of MILIT, academia, and industry, we can address complex defence challenges and deliver solutions that directly benefit the armed forces.***
>
> – Rear Admiral Nelson D'Souza,
> NM, Commandant, Military Institute of Technology (MILIT), Pune

Another initiative involves correlating ground control points (GCP) with real-time maps, streamlining the process of aligning imagery with known points on the ground. We are also exploring the integration of electro-optical and synthetic aperture radar (SAR) imagery. Since SAR lacks visual clarity for up to 12 hours, artificial intelligence is being employed to enhance the correlation between SAR data and actual ground images.

Additionally, MILIT is working on super-correlation extraction for Digital Elevation Models (DEM) in collaboration with IITs and industry partners. By combining the strengths of MILIT, academia, and industry, we aim to resolve these complex challenges together.

These projects highlight just a fraction of what we are doing. We welcome collaborations with industry players who may have defence-related challenges. Often, the difficulties faced by industry stem from a lack of clarity in problem statements. MILIT can add significant value by helping to define and refine these challenges, ensuring effective and impactful solutions.



Data Integration: The Backbone of Defence Innovations

Col Sunil S Fatehpur
Director, SOI, GIS&RS

Col Sunil S Fatehpur *discussed the role of data integration in defence innovation, advocating for interoperability and standardisation to harness the potential of AI, IoT, and geospatial technologies.*

Key Takeaways

- Data interoperability is critical for leveraging AI and quantum technologies in defence.
- GNSS-denied areas require innovative solutions for drones and communication systems.
- Defence geospatial data infrastructure is essential for sustainable and efficient data management.
- Policies like the 2021 drone rules demonstrate how regulation can drive technological advancements.
- The autonomy of AI systems must be carefully considered based on operational contexts.

At the Service Centre for Research and Innovation, our mission is to identify pressing problem statements and collaborate with industry and academia to deliver innovative solutions. The vast amount of data accessible today opens new avenues for leveraging technology, particularly in areas such as satellite imagery and drones. By using cutting-edge tools like generative AI, platforms such as Google Earth Engine, and Sentinel data, we focus on achieving self-reinforced multimodal connectivity and real-time data processing.

A recent example is the imagery provided by Black Sky satellites, which revealed critical fortifications and demonstrated the potential of advanced satellite systems. Instead of relying on external reports, we must build our own systems using available infrastructure and the creativity of young minds. However, policy remains a significant barrier to fully harnessing these technologies.

Future warfare relies on four pillars, with communication as the foundation. Space plays a critical role, yet challenges like GPS jamming and spoofing in GNSS-denied areas can disrupt drone operations. Addressing these limitations is vital. The rise of low Earth orbit satellites provides promising solutions, and MSMEs are already leveraging Hawkeye satellites for critical radio frequency

> ***Data integration, interoperability, and standardisation are the backbone of defence innovation. Collaboration between industry and technology is essential for addressing today's challenges.***
>
> – Col Sunil S Fatehpur,
> Director, SOI, GIS&RS

data across large areas. The true challenge lies in data integration. Without interoperability and standardisation across data sources, the potential of AI and quantum technologies cannot be fully realised.

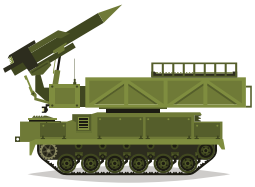
India's National Spatial Data Infrastructure, created in 2005, has undergone updates to support integration across sectors. Educating organisations on using spatial data, including geospatial, geological, and soil data, is crucial. Defence-specific geospatial data infrastructure with distributed networks is essential for sustainable data management, enabling seamless integration of vast datasets.

Sustainability and capacity building in data management are paramount. Questions about responsibility for collecting, curating, and managing data, and the use of metadata standards, are critical as we integrate emerging technologies like generative AI. The Internet of Things (IoT) further adds to the data volume, underscoring the need for robust policies.

My experience with the Survey of India's SVAMITVA project highlights how policy can drive technological advancements. Initial regulatory hurdles, such as air traffic control (ATC) clearances, delayed operations. However, the drone rules introduced in 2021 streamlined processes, showcasing how the right policies can facilitate progress.

The autonomy of AI systems is another crucial consideration. Whether human involvement is "over the loop," "in the loop," or entirely "out of the loop," depends on the context, especially in areas like battlefield decision-making or medical diagnostics.

Data integration, interoperability, and standardisation are essential for realising the full potential of emerging technologies. Defence innovation hinges on seamless collaboration between industry and technology, ensuring that the tools of tomorrow address the challenges of today.



Satellite Infrastructure and Software: Driving the Future of Space Operations

Pranav R. Satyanath

Research Associate, Space Technology and Policy Programme, Council for Strategic and Defence Research (CSDR)

Pranav R. Satyanath *explored the evolving landscape of space operations, stressing the need for distributed satellite architectures, space situational awareness, and software-driven data analysis for resilient space capabilities.*

Key Takeaways

- Distributed satellite architectures across LEO, MEO, and GEO provide redundancy and resilience.
- Space situational awareness (SSA) is critical for managing the growing number of satellites and mitigating threats like jamming and cyberattacks.
- Software is indispensable for processing and interpreting data, enabling actionable insights.
- AI-driven edge computing on satellites enhances real-time data analysis.
- International collaboration with trusted partners accelerates advancements in space technology.

Allow me to begin by addressing the critical aspect of space technology—satellites. In 2019, the prevailing view was that CubeSats, small satellites, and low Earth orbit (LEO) mega-constellations represented the future. While satellites have indeed become smaller, more intelligent, and less reliant on extensive hardware, some assumptions have been proven wrong. Mega-constellations are gradually being replaced by larger satellites equipped with powerful sensors and advanced onboard computing capabilities, enabling sophisticated operations.

The trend now favours distributed architectures across LEO, medium Earth orbit (MEO), geosynchronous orbit (GEO), and highly eccentric orbits. This approach ensures redundancy, resilience, and global, persistent coverage, often utilising previously underexplored orbital configurations.

Space debris and resident space objects have also emerged as pressing concerns. By 2021, over 2,000 satellites were being launched annually, intensifying the need for space situational awareness (SSA) and space domain awareness (SDA). Governments and private startups are investing heavily in monitoring and managing orbital activities. Anti-satellite warfare, particularly non-kinetic forms like jamming and cyberattacks, has become increasingly

> ***With the software capabilities and satellite infrastructure we currently possess, we can achieve far more than we initially anticipated, ensuring resilience and operational success.***
>
> – Pranav R. Satyanath,
> Research Associate, Space Technology and Policy Programme, Council for Strategic and Defence Research (CSDR)

pervasive, as evidenced during the Russia-Ukraine conflict. Ensuring the resilience of Indian satellites to these threats is vital.

Another underestimated factor in 2019 was the exponential growth in data generated by space assets. The sheer volume of data now requires significant resources for processing and storage. Open data, such as Earth observation imagery from Sentinel-2, offers immense potential for assessments of resident space objects when paired with analytical tools. However, the focus must extend to software, the linchpin for converting raw data into actionable insights. In India, the software sector holds considerable potential for developing platforms to visualise and interpret space activities.

Data integration is equally crucial. Space data alone has limitations and must be combined with inputs from drones, Automatic Identification Systems (AIS), and ground sensors to provide comprehensive situational awareness. Advances in artificial intelligence (AI) have further transformed space operations. AI-enabled edge computing allows satellites to process data onboard, delivering near real-time insights. It also enhances the ability to predict and analyse disparate data sources, amplifying the effectiveness of space operations.

Our technological needs must align with the armed forces' specific requirements. We need not replicate the systems developed in the United States or Europe. With existing software capabilities and satellite infrastructure, India can achieve much more than previously anticipated.

Finally, international collaboration remains indispensable. Indian space companies naturally engage with trusted collaborators in Europe and the United States, sourcing satellite data, buses, and components. These partnerships offer redundancy and resilience, bridging capability gaps and accelerating advancements that might otherwise take years to develop domestically.

Panel Discussion 2

International Perspective on Deep Tech and Space Tech Development

Future Pathways in Deep Tech and Space Tech

Panelists:

Dr. Chaitanya Giri
Fellow, ORF's Centre for Security, Strategy and Technology

Amit Mahajan
CEO and Founder, Phoenix Group, Bit Mapper Integration Technologies

Dr. Shirish Ravan
Founder, EarthSight Foundation and DevTA (Development Technologies Accelerator)

Kshitij Mall
Post-doctoral Research Associate, Centre for Integrated Systems in Aerospace, Purdue University

Anirudh Rastogi
Founder and Managing Partner, Ikigai Law

Moderator:

Dr. Chaitanya Giri
Fellow, ORF's Centre for Security, Strategy and Technology

The panel discussion explored the global dynamics of deep tech and space tech development, focusing on the critical interplay of technology, diplomacy, and regulation. It highlighted the importance of international collaborations and the need for harmonised policies to unlock the full potential of these emerging sectors. The session underscored the role of export controls, ethical frameworks, and stakeholder linkages in aligning technological advancements with national and global interests.

Discussions emphasised the balance between civilian and defence innovations, particularly in overcoming regulatory challenges and cost constraints. The transformative potential of space technology in disaster management and development was also explored, with a call for simplified, real-time systems to address pressing societal needs. Ethical considerations in artificial intelligence and the necessity for robust global partnerships were key themes, alongside the need for a unified approach to tackle challenges like debris management, militarisation, and resource-sharing in space.

The session concluded with a consensus on fostering global cooperation, robust policy frameworks, and multi-stakeholder engagement as vital elements for navigating the complexities of deep tech and space tech development, ensuring these advancements serve both national and global objectives effectively.

Dr. Chaitanya Giri
Fellow, ORF's Centre for Security, Strategy and Technology

International Linkages in Deep Tech and Space Tech Development

Dr. Chaitanya Giri *highlighted the role of international linkages and export controls, such as COMET, in facilitating collaborations that balance diplomacy and business strategy in deep tech and space tech development.*

Key Takeaways:

- Linkages between nations, industries, and stakeholders drive collaborative development in deep tech and space tech sectors.
- Export controls, including India's COMET framework, play a critical role in regulating technology transfers.
- Diplomacy intersects with business strategy, shaping international collaborations and partnerships.
- A multi-stakeholder approach is essential to align national and global interests in technology development.

When discussing international development, the concept of linkages plays a pivotal role. These linkages—whether secure, productive, or profit-driven—are fundamental to fostering diplomatic and business relationships. They form the backbone of collaborative efforts between India and other nations, or, in the case of multilateral projects, among multiple countries.

In the realm of deep tech, space tech, and defence-tech, the dynamics extend far beyond a single company and its selling partner, joint venture partner, or subsidiary abroad. These industries operate in a highly regulated environment, where diplomacy intersects with business strategy. Export controls, in particular, shape the landscape of international trade and collaboration.

Export controls are often associated with global frameworks such as those of the United Nations or American regulations. However, India's own export control framework, known as COMET (Committee on Export Controls), is an equally important element in this discussion. COMET plays a critical role in regulating and facilitating the export of technology and products developed in India.

> ***When you talk about deep tech, space tech, and defence-tech, it all falls under the purview of export controls, with diplomacy playing a key role in shaping productive and secure international linkages.***

– Dr. Chaitanya Giri,
Fellow, ORF's Centre for Security, Strategy and Technology

Understanding these controls is vital for companies seeking to engage in the global market while aligning with India's strategic and diplomatic goals.

As we explore international perspectives on deep tech and space tech development, it becomes evident that a multi-stakeholder approach is essential. Beyond business, diplomacy becomes a key factor, ensuring that collaborations and exports align with national interests and international obligations. This session aims to address the intricate interplay between technology development, export controls, and global partnerships, highlighting the opportunities and challenges that lie ahead.

Amit Mahajan
CEO and Founder, Phoenix Group,
Bit Mapper Integration Technologies

Bridging Civilian and Defence Innovations

Amit Mahajan *emphasised the challenges of bridging civilian and defence innovations, citing regulatory barriers, cost constraints, and intellectual property protection as key considerations for advancing defence technologies.*

Key Takeaways:

- Operating across civilian and military sectors demands balancing accessibility and quality.
- Phoenix Group is one of only four global companies working on certain advanced technologies, including robotics for military equipment.
- Regulatory barriers like ITAR create challenges in accessing and affording cutting-edge technology.
- The L1 procurement model limits the ability to deliver the highest quality defence products.
- Intellectual property integrity is critical for safeguarding national and international interests.

Operating on both the civilian and military fronts brings unique challenges. These two sectors function with vastly different levels of openness. Civilian innovation is comparatively unrestricted, whereas the military side imposes stringent constraints. For example, testing military products like a 155 mm howitzer is not feasible in a standard setting. This is where our work becomes critical—developing robotics solutions to clean or examine such military equipment.

Access to equipment is crucial in this domain, but equally important is the use of the highest-grade components and materials to produce world-class products. At Phoenix Group, this philosophy is central to our operations. Globally, we are one of only four companies working on certain advanced technologies. Our clients include industry leaders like Apple and major telecommunications carriers like ATandT, underscoring our commitment to quality. We do not compromise on quality or cost. Our focus is always on delivering the best products, protected by patents to safeguard our innovations.

However, challenges such as the L1 procurement model—where the lowest bidder is chosen—often limit our ability to deliver the highest quality.

> ***Our goal is to deliver the best equipment for warfighters, but the challenges of cost, procurement models, and regulatory barriers must be addressed to realise India's full potential in defence innovation.***

– Amit Mahajan,
CEO and Founder, Phoenix Group, Bit Mapper Integration Technologies

Our goal is to provide warfighters with the best equipment, whether advanced cameras or state-of-the-art detectors. While we possess the capability to produce these, the cost barrier remains significant.

International trade regulations, such as the International Traffic in Arms Regulations (ITAR), add further complications. Certain technologies are restricted for India, and even when access is granted, the costs can be prohibitive. For instance, a world-class thermal detector costs between Rs. 1.5 and 2 crore for a single chip. When a complete system is built, the cost could reach Rs. 6–8 crore. While buyers in the U.S., Europe, and other space coalitions are willing to invest in such innovation, finding a similar buyer within India is a challenge.

Despite these hurdles, ITAR and other regulatory barriers are not insurmountable. The work we do on the civilian side enables us to explore new technologies, which can then be adapted for defence applications. This synergy is a key advantage, allowing us to innovate across both domains.

Safeguarding intellectual property is another critical consideration. Technologies developed for India's defence sector must remain within India, and products designed for U.S. or European markets should not inadvertently return to India. This compartmentalisation is essential for protecting both national and international interests.

Dr. Shirish Ravan
Founder, EarthSight Foundation and DevTA (Development Technologies Accelerator)

Space Technology in Disaster Management and Development

Dr. Shirish Ravan *shared insights on leveraging space technology for disaster management, stressing the need for automation, local stakeholder involvement, and simplified systems for real-time applications.*

Key Takeaways

- Asia's advanced space capabilities are limited to four nations, leaving many without access to critical disaster-response tools.
- The International Charter on Space and Major Disasters facilitates global collaboration during emergencies.
- Delays in processing satellite data and limited automation hinder effective disaster management.
- Space technology offers transformative potential in civilian applications, including agriculture and local development planning.
- Simplified systems are essential for grassroots adoption of space-based solutions.

I had the privilege of serving with the United Nations Office for Outer Space Affairs (UNOOSA) for 14 years, during which I worked across nearly 75 countries. My career focus has been on leveraging space technology for disaster management and development. As the global coordinator for the UN-SPIDER program (United Nations Platform for Space-based Information for Disaster Management and Emergency Response), I witnessed firsthand the challenges and opportunities in this domain.

Asia is home to only four countries with advanced space technology—India, Japan, China, and South Korea. However, disasters do not respect borders or capabilities. Among 65 Asian nations, only these four possess the necessary tools for effective disaster response. This creates significant challenges for the majority who lack access to critical space-based technologies.

The International Charter on Space and Major Disasters, established in 1999 with India's active participation, enables global cooperation during disasters. For example, during the 2015 Nepal earthquake, I activated the Charter to coordinate efforts with space agencies, including ISRO. Archived satellite images of affected areas were provided to establish pre-disaster baselines,

> ***Space technology must evolve to become as accessible as it is advanced, enabling real-time solutions for disasters and empowering local development planning.***
>
> – Dr. Shirish Ravan,
> Founder, EarthSight Foundation and DevTA
> (Development Technologies Accelerator)

and new satellite data was captured for post-disaster mapping. This initiative is a remarkable example of international collaboration, consistently activated for disasters since 2005.

Despite its successes, the process is not without limitations. Delays in processing satellite imagery remain a significant challenge, particularly in Southeast Asian nations like Myanmar, Laos, and Cambodia. Infrastructure limitations often mean maps are received days after a disaster, reducing their effectiveness. In one instance during the Nepal earthquake, it took nearly a week to create a usable map due to delays in obtaining cloud-free satellite imagery.

Automation and local involvement are critical to addressing these challenges. Many maps are prepared remotely, without engaging local stakeholders, resulting in limited real-time applicability. Automated systems that enable onboard processing of satellite data are essential for life-saving and military applications. Over the past year, I have worked with India's National Disaster Management Authority (NDMA) to address these issues. Their teams require user-friendly systems capable of quickly analysing data for actionable insights.

Beyond disaster management, space technology holds immense potential for civilian applications. For instance, geographic data can revolutionise agriculture insurance and village development planning. Ideally, each village should have a development plan informed by geology, water resources, and food security data. However, this data-driven approach remains underutilised.

The simplicity of technology plays a critical role. Just as Tesla cars use advanced systems to make driving effortless, space technology must evolve to become accessible at the grassroots level. With advancements in artificial intelligence and deep learning, we now have the tools to bridge this gap. The challenge of the past decades must be addressed now to ensure that space technology serves the broader needs of society effectively.

Kshitij Mall

Post-doctoral Research Associate, Centre for Integrated Systems in Aerospace, Purdue University

Ethics and Collaboration in the AI Era

Kshitij Mall *addressed the ethical dimensions of AI integration, advocating for global collaboration and proactive policy measures to ensure ethical, robust, and beneficial AI systems.*

Key Takeaways

- The context in which AI systems operate significantly influences outcomes, emphasising the importance of environmental awareness.
- Policy efforts must focus on both clarifying the AI landscape and prioritising ethical considerations.
- Leadership in AI development requires indispensability, fostering global collaboration rather than taking sides.
- International cooperation is critical to mitigating risks associated with rapid technological advancements.

In today's rapidly evolving technological and geopolitical landscape, we must tread carefully. The activities we undertake in technology, policy, and governance demand caution and deliberation. One factor that is often overlooked is the influence of the environment—the circumstances in which a system or individual operates. Context can shape outcomes, sometimes in ways that offer unexpected advantages. This is particularly relevant as we integrate artificial intelligence (AI) into fields where decisions carry life-and-death implications or significant consequences.

From a policy perspective, our role is twofold. First, we must clarify the AI landscape, particularly as it applies to the United States, while also considering global perspectives. Second, we must prioritise ethical considerations as we develop these technologies. The rapid pace of AI advancement necessitates a proactive approach to ensure systemic errors are not introduced into critical systems.

Leadership in this space requires more than merely setting an example. We must strive to make ourselves indispensable. This doesn't mean choosing sides but rather positioning ourselves in a way that others seek us out for collaboration. This level of indispensability is vital to navigating international dynamics effectively.

> ***"We must position ourselves to be indispensable, fostering collaboration and ensuring that AI systems are ethical, robust, and beneficial to all."***

– Kshitij Mall,
Post-doctoral Research Associate, Centre for Integrated Systems in Aerospace, Purdue University

International cooperation is essential. Without collaboration among nations, we cannot effectively mitigate the risks associated with rapid technological development. Collective efforts are crucial to creating ethical, sustainable systems that benefit all stakeholders.

The lessons and discussions shared here have reinforced my belief in the necessity of ethical AI development and robust international partnerships. These are the keys to addressing the challenges and opportunities of the AI era.

Anirudh Rastogi
Founder and Managing Partner,
Ikigai Law

Harmonising Policies for Global Space Cooperation

Anirudh Rastogi *focused on the importance of harmonising national policies with global treaties to address challenges like debris management, militarisation, and resource-sharing in space.*

Key Takeaways:

- Satellite communication (Satcom) and remote sensing are inherently global, necessitating harmonised policies.
- Fragmented regulatory frameworks limit the potential of the global space industry.
- The shift from a competitive space race to collaborative efforts is exemplified by the International Space Station.
- Global consensus is critical for addressing debris management, militarisation, and resource-sharing in space.

Space, by its very nature, is a global domain. Many of its products, especially in satellite communication (Satcom) and remote sensing, transcend national borders and serve a worldwide audience. Yet, the potential of the space industry is often constrained by the fragmented regulatory frameworks that operate in isolated silos across different jurisdictions. Aligning national policies with international treaties represents a critical opportunity to unlock this potential and foster global collaboration.

Over the decades, the narrative around space has shifted significantly. The early days of a competitive space race have given way to a more cooperative approach. A landmark example of this shift is the International Space Station, which embodies the spirit of international collaboration. The world has recognised the need for collective efforts to address complex issues that transcend borders.

Today's pressing challenges in space demand global consensus. Debris management, for instance, has become a critical issue as the number of satellites in orbit continues to grow. The militarisation of space raises concerns about security and sustainability, while sharing space-derived resources

> ***The alignment of national policies with global treaties is essential to unlocking the full potential of the space industry and fostering meaningful international collaboration."***

– Anirudh Rastogi,
Founder and Managing Partner, Ikigai Law

brings up questions about equity and governance. These are challenges that no single nation can address alone.

By aligning national policies with global treaties, we can create a unified framework to address these challenges. Such an approach not only benefits individual nations but also strengthens the global space industry, enabling it to thrive in a cooperative environment.

The evolution of space from a competitive frontier to a collaborative domain is a proof to humanity's ability to work together for the greater good. The future of space technology and exploration depends on our ability to build upon this spirit of cooperation, ensuring that space remains a shared resource for all.

Panel Discussion 3

Industry Outlook on Development of Defence Space Technologies

Accelerating India's Leadership in Defence Space Technologies

Panelists:

Harsh Gune
Member, Core Group,
MCCIA Defence Committee

Anil Prakash
Director General, Satcom
Industry Association (SIA), India

Vivek Mokashi
Senior Deputy General Manager,
Business Development and
Marketing, Larsen & Toubro

Moderator:

Harsh Gune
Member, Core Group,
MCCIA Defence Committee

The panel discussion titled Industry Outlook on Development of Defence Space Technologies brought together key stakeholders to explore the dynamic interplay between technology, policy, and collaboration within India's space and defence sectors. The session underscored the growing global importance of the space industry and India's potential to emerge as a leading player in this field.

Discussions revolved around optimising supply chain dynamics, fostering public-private partnerships, and leveraging India's geographic and technical advantages. Panellists stressed the need for strong collaboration among industry giants, MSMEs, startups, and academia to create a robust ecosystem. Challenges such as regulatory barriers, funding constraints, and talent development were examined, with solutions proposed to address these issues through innovation and policy reform.

The session also explored the significance of integrating the space sector into defence strategies, scaling up for mass production, and developing globally competitive solutions. Panellists highlighted the need to streamline procurement processes, ensure system integration expertise, and create a skilled workforce to meet ambitious national goals. With the global space economy expected to reach USD 1.8 trillion by 2035, the discussion reaffirmed the importance of collective efforts in positioning India as a major player in this burgeoning market.

Supply Chain Dynamics and Geographic Strategy in Space Launch Development

Harsh Gune
Member, Core Group,
MCCIA Defence Committee

Harsh Gune *highlighted the importance of supply chain efficiency and geographic strategy in satellite launches, emphasising equatorial locations for optimal performance in high-thrust vehicle development.*

Key Takeaways

- L&T supports over 4,000 MSMEs, showcasing the private sector's role in sustainable supply chains.
- Geographical proximity to the equator provides a rotational advantage, making launches more efficient and cost-effective.
- High-thrust vehicles like GSLV and PSLV benefit significantly from equatorial launch sites.
- Globally, major spaceports are strategically located near the equator for optimal performance.
- Pune was once considered for space vehicle development but lost to more geographically favourable southern locations.

The private industry in India has consistently demonstrated its ability to deliver sustainable and profitable supply chains. A prime example is L&T, which supports over 4,000 MSMEs, fostering a robust ecosystem for innovation and manufacturing. This capability has been instrumental in driving India's progress in space and defence technology.

Years ago, after India successfully developed the technology to send payloads into space, there was significant discussion about building launch vehicles like the GSLV and PSLV. Pune was considered as a potential site for hosting or developing these launch vehicles, and the idea gained traction in the media. However, nothing materialised, and the development of launch vehicles and satellites shifted to southern India, where ISRO conducts its launches.

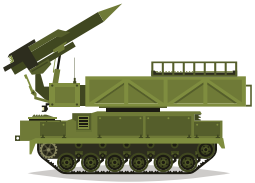
The reasoning behind this geographic preference is rooted in efficiency. Locations closer to the equator provide an undeniable advantage for satellite launches due to the Earth's rotational velocity. This natural phenomenon enhances the efficiency of launches, especially for high-thrust vehicles like the

> ***Geographical strategy plays a critical role in the efficiency and success of satellite launches, making equatorial sites indispensable for high-thrust, large-payload vehicles.***
>
> – Harsh Gune,
> Member, Core Group, MCCIA Defence Committee

GSLV and PSLV, which are designed for heavier payloads. Launching closer to the equator reduces fuel requirements and makes the process more cost-effective.

Globally, this principle is well recognised. Most major launch sites, such as Cape Canaveral in the United States or Kourou in French Guiana, are situated near the equator. For smaller payloads, launches can be conducted from other locations, but for high-thrust vehicles carrying significant payloads, equatorial sites remain optimal. This is why India's space vehicle development and launch activities have primarily been centred in the southern region.

While the prospect of Pune hosting a spaceport was promising, the practical advantages of southern sites ultimately determined the course of action. This strategic choice reflects the importance of aligning geographic and economic factors to maximise the success of India's space programme.



➔ **Panel Discussion 3**

Subject: Industry Outlook on Development of Defence Space Technologies

India's Space Sector: Challenges and Collaborative Solutions

Anil Prakash
Director General, Satcom Industry Association (SIA), India

Anil Prakash *stressed India's comprehensive space capabilities and the need for startups to advance through technology readiness levels. Called for better knowledge-sharing networks, streamlined procurement processes, and integration into defence offset obligations.*

Key Takeaways

- India is one of seven nations with comprehensive space launch capabilities, supported by 500 industries and 200 startups.
- Startups need support to transition through technology readiness levels (TRLs) and develop space-worthy solutions.
- A searchable database is being developed to enhance knowledge sharing and networking across the space sector.
- Defence procurement processes require streamlining to facilitate timely delivery of solutions.
- Integrating the space sector into defence offset obligations could unlock significant growth opportunities.

India stands proudly among the select group of nations with deep space exploration and space launch capabilities. Our position as one of only seven nations with space launch capabilities reflects our unique, comprehensive 360-degree expertise—something most countries lack. This ecosystem includes approximately 500 industries, led by nearly 200 startups, 300 MSMEs, and 50 large enterprises. It is this collective strength that has propelled India to the forefront of global space capabilities.

The success of the Chandrayaan mission has redefined India's global standing in space. Nations that once sought our services for their space assets now view us as co-developers and partners. Countries without space programmes are increasingly looking to India for support in building their own.

I have personally engaged with over 60 heads of state, ministers, ambassadors, and defence attachés. During the India Space Congress last June, we hosted 850 delegates from 36 countries, including six space agencies and two of their leaders. These milestones highlight India's strides in the space sector.

In this context, I would like to focus on three key areas:

> ***Collaboration is the cornerstone of success in the space sector. By aligning with global partners, we bring unique value propositions and drive our capabilities forward.***
>
> – Anil Prakash,
> Director General, Satcom Industry Association (SIA), India

Startups and Innovation

India boasts the largest pool of space startups in the Asia-Pacific region. These startups represent a wellspring of innovation but require substantial support to thrive. Transitioning from TRL 1 (basic principles) to TRL 9 (fully operational systems) is a significant challenge. Collaboration with MSMEs and large industries is critical in providing the necessary handholding and resources. Without structured support, only a small fraction of startups will succeed. Providing investments and opportunities for these innovators is essential for creating space-worthy products and services.

Knowledge Sharing and Networking

One of the major gaps in our space ecosystem is the lack of awareness about what stakeholders are working on. Bridging this gap requires enhanced interaction and the sharing of information. To address this, we are developing a comprehensive, searchable database of industries and individuals active in the sector. Our association is currently mapping around 500 industries and has launched a survey to gather further insights. I encourage companies to participate in this effort to connect investors, collaborators, and technology providers, fostering a more cohesive ecosystem.

Streamlining Procurement Processes

The procurement process, particularly in the defence sector, remains lengthy and frustrating. Delays in delivering solutions often discourage companies. Many, after years of navigating these challenges, have given up. To address this, we are creating platforms like defence space events and industrial war game exercises, facilitating dialogue between users and the industry. These initiatives aim to identify challenges and generate actionable recommendations, streamlining the procurement pipeline.

Finally, I would like to draw attention to defence offset obligations. Out of a total of USD 12 billion, USD 7 billion remains unfulfilled. Integrating the space sector into these offset obligations presents a significant opportunity. Partnering with global giants like Dassault, Thales, and Airbus, which are already active in the space industry, can strengthen India's capabilities and create new avenues for growth.

While challenges persist, solutions are within reach. Collaboration, both domestic and international, is the key to addressing these challenges. By working with other nations, we bring unique value propositions to the table—capabilities and perspectives that others may lack. This spirit of partnership will be instrumental in driving India's space sector forward.

Building a Collaborative Space Ecosystem

Vivek Mokashi
Senior Deputy General Manager, Business Development and Marketing, Larsen & Toubro

Vivek Mokashi *addressed the need for early academic initiatives to build a skilled workforce, while emphasising collaboration across ISRO, industry, MSMEs, and academia. Discussed material dependencies, funding gaps, and system integration as key challenges.*

Key Takeaways

- India aims to capture USD 1 trillion of the global space economy by 2030, increasing its GDP share from 2% to 9–12%.
- Academic initiatives must start early to develop a skilled space sector workforce.
- Collaboration across ISRO, industry, startups, MSMEs, and academia is vital for success.
- Addressing material dependencies and enhancing system integration expertise are critical for self-reliance.
- Funding, insurance, and space qualification of systems are key challenges for startups.

Space is indeed the next frontier, and the global space economy is projected to reach USD 1.8 trillion by 2035. India has set an ambitious goal of capturing USD 1 trillion of this market by 2030. While the space sector currently contributes about 2% to India's GDP, we aim to grow this share to 9–12%. Supportive government policies are paving the way toward these objectives, though challenges remain.

One key challenge is developing a skilled workforce for the space sector. Building this talent pool requires long-term planning. Space-oriented academic programs must be introduced as early as the 7th grade, incorporating space-related chapters in school curricula. Without a steady inflow of space-qualified manpower, achieving our ambitious growth targets will remain a struggle.

India is uniquely positioned to capitalize on global opportunities in the space sector. We have the potential to become a manufacturing hub for specific payloads, a satellite integrator, and a global launch provider. ISRO has laid the foundation, and we now have the technology and expertise. Collaboration between industry, startups, and other stakeholders is essential to leveraging these assets for the global market.

> ***The success of India's space sector depends on collaboration among stakeholders, from MSMEs to academia, to build a sustainable and globally competitive ecosystem.***
>
> – Vivek Mokashi,
> Senior Deputy General Manager,
> Business Development and Marketing, Larsen & Toubro

An excellent example of collaboration is the industrialization of the PSLV, where Larsen & Toubro partnered with HAL. Our journey with ISRO over the decades highlights the importance of partnerships. The success of India's space sector depends on the combined efforts of the Government of India, ISRO, large industries, MSMEs, startups, and academia. MSMEs, in particular, bring agility and the ability to learn quickly, making them indispensable to the ecosystem.

Addressing domestic requirements is vital for achieving self-reliance. However, scaling up for mass production poses challenges, especially regarding material availability. Despite advancements in 3D printing and composites, we still rely on suppliers from Europe, the U.S., and Russia. Resolving these dependencies is fundamental to achieving true self-sufficiency.

The capital-intensive nature of the space sector adds to its complexity. Long gestation periods often strain startups, forcing many to exit the market prematurely. Larger companies and industry forums must work together to provide support, shorten gestation periods, or find ways to help startups sustain themselves during this critical phase.

System integration knowledge is another area requiring attention. Enhancing capabilities in integrating large-scale technologies, such as those used in space and defence systems, is essential. While talent is returning to India, retaining this talent and strengthening system integration expertise is crucial, especially during scale-ups.

Funding and insurance are additional challenges for space startups. Competing globally also requires subsystems to be space-qualified, a process demanding significant infrastructure, time, and investment. Awareness among financial institutions about the immense business potential of the space sector must be raised to unlock more funding opportunities.

Lastly, ensuring the safety and security of assets developed by Indian companies and startups is crucial for sustained growth in the space economy. By addressing these challenges collectively, we can solidify India's position as a global leader in the space sector.

Panel Discussion 4

Journey of Space Tech Startups: Opportunities, Challenges and the Way Forward

Driving Growth and Innovation in India's Space Tech Ecosystem

Panelists:

Anirudh Rastogi
Founder and Managing Partner, Ikigai Law

Advait Kulkarni
Director, Vasundharaa Geo Technologies

Tushar Jadhav
Co-founder and CEO, Manastu Space

Soumya Misra
Co-founder and CEO, SISIR Radar

Siddhesh Naik
CEO, Ulook Technologies

Atharva Barbudhe
CEO and CTO, KosmosOne

Moderator:

Anirudh Rastogi
Founder and Managing Partner,
Ikigai Law

The panel discussion on Journey of Space Tech Startups: Opportunities, Challenges and the Way Forward offered valuable insights into the rapidly evolving landscape of India's space startup ecosystem. As the sector matures, stakeholders highlighted the transformative role of policy reforms, regional synergies, and financial strategies in shaping the industry's growth trajectory.

The dialogue underscored the significant evolution of the investment landscape, shifting from passion-driven backing to a focus on profitability and tangible outcomes. Panellists stressed the need for operationalising policies and fostering user-centric solutions that integrate diverse datasets to address real-world challenges. The importance of streamlining regulatory frameworks, creating testing infrastructure, and building a skilled workforce emerged as key enablers for startups to thrive.

Regional ecosystems like Maharashtra were recognised for their potential to serve as hubs for space and defence innovation, with a focus on leveraging legacy strengths, financial expertise, and manufacturing capabilities. Panellists also explored opportunities in emerging niches such as in-space manufacturing and pharmaceutical production, which could redefine the upstream and downstream dynamics of India's space sector.

The discussion concluded with a consensus on the importance of collaboration, targeted interventions, and regulatory reforms to unlock the full potential of India's space startups, ensuring their competitive edge in a global marketplace.

Anirudh Rastogi
Founder and Managing Partner,
Ikigai Law

Evolving Investment Landscape in the Space Sector

Anirudh Rastogi *highlighted the evolving investment landscape in the space sector, stressing the need to bridge the funding gap between Series A and Series C stages and communicate the sector's potential to investors.*

Key Takeaways

- Early investors in the space sector were passion-driven; today, the focus has shifted to profitability and viability.
- Startups face challenges with investor expectations, such as unrealistic demands for balance sheets at the seed stage.
- Experienced investors recognise defence as the primary customer, while commercial applications are still emerging.
- A critical funding gap between Series A and Series C stages threatens long-term investor confidence.
- Policy measures like relaxed FDI rules aim to unlock capital pools and support funding transitions.

The investment landscape in the space sector has seen a significant transformation over the years. Early investors were often driven by passion, captivated by the allure of supporting ambitious, groundbreaking ideas, even with uncertain outcomes. Today, however, the investment climate is more pragmatic. Investors are increasingly focused on profitability and long-term viability, asking pointed questions such as, "Is this ever going to pay off?"

India's evolving investment ecosystem presents unique challenges for the space sector. New investors entering the domain often bring expectations that are out of sync with the industry's reality. For example, some demand balance sheets at the seed stage, a phase where the focus should primarily be on the idea, the founding team, and the founder's vision. While many startups prefer to rely on paying customers rather than raising external funds, educating investors about the nuances of the space sector remains a significant need.

Venture capitalists today are adopting approaches similar to private equity firms, demanding detailed projections that are often infeasible for early-stage companies in the space sector. Additionally, superficial research by analysts limits meaningful engagement with startups.

> ***The space sector must actively communicate its potential to investors, bridging gaps in understanding while delivering tangible outcomes to sustain interest and investment."***

– Anirudh Rastogi,
Founder and Managing Partner, Ikigai Law

Experienced investors, particularly those familiar with space and defence, understand that the defence sector remains the primary customer, with civil and commercial applications still in their early stages. They often question whether the defence sector has made upstream commitments—something not yet visible in public forums. On the other hand, newer investors, buoyed by policy reforms and optimism around the ecosystem, are showing greater enthusiasm.

To build investor confidence, suborbital launches, smaller satellite deployments, and technology demonstrators are essential. While investors are entitled to metrics, the ecosystem must actively communicate the sector's potential returns, demand projections driven by defence, and satellite capacities.

Compared to a decade ago, the investment climate in space and defence has vastly improved. Early pioneers endured years of effort driven by passion with little external support. Today, the ecosystem is evolving, and partnerships between legacy players and startups are growing, creating new opportunities for investment. However, venture capitalists remain focused on high-probability exits within 4–5 years, a timeline that poses challenges for the space sector, which often has longer gestation periods.

A critical funding gap exists between Series A and Series C stages, and if not addressed, it may lead to early-stage investor disillusionment, discouraging further investments. Measures like relaxed FDI rules are steps in the right direction, aiming to unlock larger capital pools and bridge this gap.

Ultimately, as the saying goes, "the proof is in the pudding." The true impact of these efforts will only be evident when startups achieve their milestones and deliver tangible outcomes. A mature ecosystem with successful IPOs, cash-flow-positive companies, and acquisitions by larger players will alleviate investor concerns over time.

Advait Kulkarni
Director,
Vasundharaa Geo Technologies

Bridging Policy and Practicality in Geospatial Solutions

Advait Kulkarni *emphasised operationalising policies over drafting them and the importance of integrating diverse datasets to create user-centric, actionable geospatial solutions.*

Key Takeaways

- Operationalising policies is more impactful than drafting them, especially in space and drone technologies.
- User-centric solutions require the integration of multiple datasets, not just raw satellite imagery.
- Centralised and regulated repositories of government-managed datasets are critical for enabling startups to develop Proofs of Concept.
- Real-world challenges, like forest fire prevention, demand fused datasets combining satellite imagery with local sensor networks.
- Regulatory frameworks must prioritise data accessibility and integration to create actionable, practical solutions.

Several states have introduced promising initiatives like drone corridors and testing areas. While these offer immediate potential, progress in the space industry often takes longer to materialise. Even within the drone sector, much of the progress remains conceptual, with initiatives like sophisticated drone corridors yet to be fully operational. This underscores a critical reality: implementing policies is far more impactful than simply drafting them.

Pune's established automotive ecosystem and testing facilities offer a strong model for operationalising industry frameworks. However, as we move from state-level initiatives to central regulatory frameworks, space startups in India continue to face significant challenges, even in this post-policy era.

For downstream companies, the challenge lies in developing user-centric solutions. End users are less concerned with the technical clarity or detail of satellite imagery and more focused on whether it solves their specific problems. Practical solutions require more than just raw data—they demand the integration of multiple datasets to provide actionable insights.

> ***Practical solutions go beyond satellite imagery—they integrate diverse datasets to deliver actionable insights, addressing real-world challenges effectively.***

– Advait Kulkarni,
Director, Vasundharaa Geo Technologies

In the geospatial domain, large-scale datasets are often managed by government agencies. For startups to create impactful solutions, it is essential to make these datasets accessible through a centralised, well-regulated repository. Such a system would enable startups to develop Proofs of Concept (PoCs) and foster actionable, user-focused solutions.

At GeoSmart 2023, 60 sarpanches were introduced to advanced geospatial technology for the first time. Their insights revealed critical gaps in current solutions. For example, they highlighted the urgent issue of forest fires. While seeking predictive and preventative solutions using satellite technology, they approached a leading technology company. The response, however, was limited to post-event patch analysis, which failed to meet their immediate needs. The real question remained: How can we prevent fires from spreading to farms and causing significant damage?

Addressing such challenges requires more than satellite imagery. A practical, comprehensive solution would integrate sensor-based data, local camera networks, and sensor arrays with satellite imagery to provide real-time, actionable insights. This fusion of datasets can enable predictive measures and efficient crisis management systems.

The future of geospatial solutions depends on the establishment of robust regulatory frameworks that prioritise data accessibility and integration. By building a centralised infrastructure to facilitate the fusion of diverse datasets, we can develop practical, user-centric solutions that address real-world challenges effectively.

Tushar Jadhav
Co-founder and CEO, Manastu Space

Strengthening Regional Synergies in Space Sector Growth

Tushar Jadhav *discussed regional synergies in space sector growth, highlighting states like Maharashtra's potential as a hub for space and defence innovation through targeted infrastructure development.*

Key Takeaways

- States like Telangana, Tamil Nadu, Karnataka, and Gujarat are leading space sector initiatives, often aligned with defence.
- Many states are offering land incentives, with discounts of up to 90%, to support space startups.
- Skill development programs, such as those in Uttar Pradesh, are addressing workforce challenges in the sector.
- Pune and Navi Mumbai have the potential to become a major hub for space and defence manufacturing and research.
- Streamlining complex approval processes is essential to fostering innovation and ease of doing business.

The space ecosystem in India is witnessing remarkable progress, with several states taking proactive steps to advance the industry. Telangana (Hyderabad), Tamil Nadu (Tiruchirapalli), Karnataka (Bangalore), and Gujarat (Ahmedabad) have been at the forefront of driving development, often in alignment with defence initiatives.

One of the most significant advantages for the industry has been the availability of incentives, particularly in terms of land acquisition. As startups evolve and scale, establishing manufacturing and testing facilities becomes a priority. However, land costs can pose a challenge. Many states are addressing this issue by offering substantial discounts, with some providing up to 90% concessions on land for startups. Moreover, the establishment of space parks near ISRO's new spaceport is creating an integrated ecosystem where satellites can be manufactured, tested, and efficiently transported to the launch site.

Hyderabad, with its well-established IT ecosystem, excels in supporting downstream applications and fostering innovation. Simultaneously, Gujarat has collaborated with ISRO and DRDO to develop state-of-the-art testing facilities, reflecting its commitment to advancing infrastructure for the space sector.

> ***By integrating talent, manufacturing expertise, and targeted infrastructure, we can transform regions like Maharashtra into leading centres for space and defence innovation.***
>
> – Tushar Jadhav,
> Co-founder and CEO, Manastu Space

Skill development has emerged as another crucial area of focus. Uttar Pradesh, for example, has launched a robust skill development program in partnership with IIT Kanpur and other universities. These initiatives aim to address workforce challenges and ensure the availability of skilled professionals essential for the space sector's growth.

Ease of doing business remains critical for startups operating in this highly specialized domain. The space industry often requires approvals for fuel handling, chemicals, fire safety, and environmental clearances, among others. Securing the necessary 15–20 approvals is a time-consuming process that can stifle innovation. Streamlining these procedures through proactive measures is essential for fostering growth.

Maharashtra presents a significant opportunity for development in the space sector. Pune, with its manufacturing expertise and talent pool, along with the rapid growth of Navi Mumbai, is uniquely positioned to serve as a hub for space and defence manufacturing and research. Strategically located between Mumbai and Pune, this region could become a central node for space and defence activities, leveraging its existing strengths.

The synergy of talent, manufacturing capabilities, financial focus, and dedicated infrastructure provides the foundation for Maharashtra to emerge as a leader in space and defence innovation. A targeted approach to infrastructure development, focusing on sustained growth rather than relying solely on corridor-based strategies, will be key to achieving this potential.

Soumya Misra
Co-founder and CEO, SISIR Radar

Strategic Investments and Infrastructure for Space Sector Growth

Soumya Misra *addressed the need for strategic investments in labs, infrastructure, and regulatory reforms to boost innovation and data accessibility, particularly for upstream and downstream integration.*

Key Takeaways

- 70–80% of space investments in India are defence-driven, forming the foundation for further sector growth.
- Dedicated labs for robotics, AI, and machine learning are essential for next-generation innovation.
- Limited access to existing facilities like biosafety level (BSL) labs hampers new product development.
- Incentivising downstream companies to utilise Indian startups' data strengthens the space ecosystem.
- Regulatory reforms in ITU bandwidth allocations can position India as a leader in radar imaging technologies.

Data, when paired with actionable insights and access for the right stakeholders, is pivotal to driving meaningful progress in the space sector. Currently, 70–80% of space investments in India are defence-driven. For India to establish robust space assets, government-led investment—primarily from the defence sector—is essential. Once this foundation is laid, supporting elements like facilities, skills, and hardware will follow gradually.

Collaboration between the central and Maharashtra governments highlights significant gaps in testing infrastructure. For instance, advanced fields like robotics and edge computing lack dedicated laboratories for next-generation technologies. Instead of focusing solely on incentives like free land or subsidies, state governments could invest in creating specialised labs for robotics, AI, machine learning, and related emerging technologies. Such facilities would provide critical infrastructure for developing Proofs of Concept (PoCs), enabling companies to prototype, scale production, and gain a competitive edge.

Consider the example of protein crystal manufacturing, which requires biosafety level (BSL) 3 and 4 labs. Pune, with six such labs, has the capacity to

> ***Strategic investments in infrastructure and regulatory reforms are key to unlocking India's potential as a global leader in space and radar imaging innovation.***
>
> – Soumya Misra,,
> Co-founder and CEO, SISIR Radar

support such innovation, but limited access hinders progress. Government programs aimed at easing access to existing facilities could unlock significant potential for innovation and product development.

Strategic clarity is equally important. Different platforms—such as satellites, drones, and others—serve distinct purposes and require tailored approaches. Similarly, upstream and downstream sectors function as separate entities with unique challenges. From an upstream perspective, the lack of government orders, particularly in defence and intelligence (DNI), is a critical bottleneck. While entrepreneurs can address infrastructure gaps like labs and testing facilities, only government intervention can ensure sustained demand. Globally, defence contracts form the backbone of revenue for many space companies. For example, Planet, a publicly listed company, generates a significant portion of its revenue from DNI contracts. A similar approach in India could unlock immense potential for the sector.

Two strategic ideas could address these challenges. First, incentivising downstream companies—the primary consumers of upstream data—to prioritise services and data from Indian startups would strengthen the ecosystem without overburdening the government. This would optimise the dynamics between upstream and downstream players, fostering sector-wide growth.

Second, regulatory reforms around ITU (International Telecommunication Union) bandwidth allocations for space applications could give India a strategic edge. For instance, radar satellites equipped with RF sensors or synthetic aperture radar (SAR) depend on ITU regulations. Current restrictions on P-band and L-band allocations limit resolution to 15 metres. Expanding these allocations to achieve resolutions of 3–5 metres would enable capabilities like foliage and ground penetration, positioning India as a global leader in radar imaging. Since these signals do not interfere with communication systems, such advancements could address India's unique use cases while driving innovation.

Strategic investment, streamlined infrastructure access, and regulatory reforms will be instrumental in enabling India's space sector to achieve its full potential.

Siddhesh Naik
CEO, Ulook Technologies

Bridging Ecosystem Gaps for Space and Defence Startups

Siddhesh Naik *focused on bridging ecosystem gaps for space and defence startups, calling for tailored funding solutions and enhanced support during the early stages of startup development.*

Key Takeaways:

- Satellite frequency allocation is improving but requires further clarity for commercial operations.
- National labs in southern and eastern states have fostered ecosystems supporting startups.
- Defence and space startups need tailored funding solutions, such as collateral-free loans and innovative debt instruments.
- The gap in supporting startups during the 0-to-1 phase remains a critical challenge.
- Maharashtra has the opportunity to carve its own path through targeted interventions and collaborative frameworks.

The regulatory landscape in India has undergone a substantial transformation. When we first entered the Indian space ecosystem, there was virtually no regulatory framework in place. Today, while a foundational framework has emerged, providing much-needed clarity, significant gaps remain. For example, satellite frequency allocation, previously restricted to amateur or scientific purposes, is now opening up for commercial operations. However, the journey is far from complete, particularly in areas such as infrastructure development, incentives, and tailored schemes for startups.

A thriving ecosystem requires more than just funding and infrastructure. Talent naturally gravitates toward regions that offer complementary factors, such as proximity to national laboratories and established vendor networks. Southern and eastern states have strategically benefited from the presence of national labs, which have, over two decades, fostered ecosystems comprising secondary and tertiary vendors. These robust networks provide startups with a strong foundation to build upon.

Maharashtra, while performing reasonably well in fostering startups, still has ample scope for improvement, particularly in catering to defence and space startups. One critical area is funding access during the early stages of a

> ***By fostering collaboration and creating targeted interventions, Maharashtra can position itself as a leader in the space and defence sectors, driving innovation and growth.***
>
> – Siddhesh Naik,
> CEO, Ulook Technologies

startup's journey, such as achieving a product-market fit (PMF) or reaching the minimum viable product (MVP) stage. Unlike traditional businesses, such as e-commerce, the funding requirements in the defence and space sectors are significantly higher, and the associated risks are greater. Currently, startups in these sectors rely heavily on venture capital and private equity. State governments could provide meaningful support by introducing innovative mechanisms like collateral-free loans or tailored debt instruments to bridge this gap.

While several cities and states are effectively fostering startup ecosystems, large-scale funding rounds often gravitate toward financial hubs. The primary challenge lies in supporting startups during the critical 0-to-1 phase, as the 1-to-N phase tends to receive better support. In the drone industry, for example, where I am actively engaged, shaping policies has revealed critical gaps. An analysis of state-level drone policies highlighted a disparity: states with high levels of activity in the sector often lack formal policies. This disconnect underscores that ecosystem readiness and stakeholder engagement frequently outweigh the quality of policies in driving investment and activity.

For Maharashtra, the central question is whether to replicate the strategies of successful states or carve its own distinct path. By focusing on targeted interventions, creating an enabling environment for early-stage startups, and fostering collaboration among talent, industry, and policymakers, Maharashtra has the potential to establish itself as a leader in the space and defence sectors. A distinct approach tailored to its unique strengths could position the state at the forefront of innovation and growth in these industries.

Atharva Barbudhe
CEO and CTO, KosmosOne

Leveraging Maharashtra's Legacy for Space Sector Growth

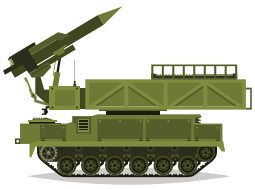
Atharva Barbudhe *stressed leveraging Maharashtra's space heritage, financial resources, and niche opportunities like in-space manufacturing to establish a competitive role in the national and global space ecosystem.*

Key Takeaways:

- Maharashtra's space heritage, rooted in BARC, positions it uniquely as the "grandmother" of India's space ecosystem.
- Access to financial resources could make Maharashtra a financial hub for space startups, particularly in the upstream sector.
- Niche areas like in-space manufacturing, especially pharmaceutical production in low Earth orbit, present significant opportunities.
- Pune is well-positioned to lead downstream activities such as data analytics and IT solutions.
- A balanced strategy integrating upstream and downstream activities, combined with tailored incentives, can unlock Maharashtra's full potential.

States like Tamil Nadu, Gujarat, Karnataka, and Telangana have made significant strides in the space sector, building on decades of space heritage supported by ISRO centres and well-established subsystem supply chains. Maharashtra, however, holds a unique position in the history of India's space ecosystem. As the "grandmother" of the space sector, with its roots in BARC, the state has a storied legacy. The challenge now lies in effectively leveraging this heritage to drive future growth and innovation.

Maharashtra has an unparalleled advantage in access to financial resources, which could serve as a critical differentiator for upstream space startups. These startups often face challenges in securing funding, grants, and financial mechanisms. By positioning itself as the financial hub for the space sector, Maharashtra could attract and support companies with tailored incentives and funding opportunities, strengthening its role in the ecosystem.



Focusing on emerging technologies and niche areas within the upstream space sector offers another promising avenue. In-space manufacturing, particularly pharmaceutical production in low Earth orbit for terrestrial applications, presents significant opportunities. With a strong pharmaceutical industry centred in Pune, Mumbai, and the Goa region, Maharashtra is well-

> ***By leveraging its legacy, financial resources, and focus on niche opportunities like in-space manufacturing, Maharashtra can carve out a distinctive and competitive role in the space ecosystem.***
>
> – Atharva Barbudhe,
> CEO and CTO, KosmosOne

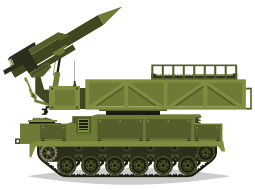
placed to capitalise on this niche. Policies aimed at attracting companies like Serum Institute to invest in space-related ventures could create a new growth area for the state.

Currently, Maharashtra lags behind other states in implementing comprehensive policies or structured incentives for the space sector. Rather than replicating the models of Tamil Nadu and Telangana, which focus on launch vehicles and spaceports, Maharashtra could chart a unique course. By prioritising upstream activities such as in-space manufacturing and leveraging its financial capital status, the state can establish a distinct role within the national space ecosystem.

A balanced approach integrating upstream and downstream activities would further enhance Maharashtra's competitiveness. Pune's robust ecosystem positions it as an ideal hub for downstream activities, such as data analytics and IT solutions. A comprehensive policy combining financial incentives, infrastructure development, and a clear focus on specific niches would offer Maharashtra a significant competitive edge.

Understanding the specific incentives sought by the downstream industry is also crucial. These could include tax benefits, subsidised infrastructure, or streamlined regulatory approvals for operations. By addressing these needs holistically, Maharashtra could emerge as a leader in both upstream and downstream space industries, unlocking its full potential in the rapidly evolving space ecosystem.

Media Coverage



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