

Conference Report

# DefSAT 2023

India's First International Defence and  
Space Conference and Expo

Organised by  
**SIA-India**

Supported By  
**NITI AAYOG, DDP, DRDO, ISRO, NSIL, NIAS, RIS**

Knowledge Partners  
**CENJOWS, CLAWS, CAPS, NMF, FROST & SULLIVAN**

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## Message from Dr Subbarao Pavuluri, CMD Ananth Technologies and President, SIA-India



Today India is marking its journey towards achieving the vision of “Atmanirbharta” by Prime Minister Shri Narendra Modi. He has also launched 75 challenges of the mission DefSpace with the mantra of Intent, Innovation, & Implementation in the defence sector, providing a unique opportunity for Indian space startups and MSMEs.

India is ushering into the commercial space and satellite communication era where the opportunities are humongous, enhancing its global digital footprint. The emergence of the commercial space sector and startups throw up some attractive possibilities for the country’s defence requirements. Leveraging space power would include utilising space to enhance defence capabilities and the protection of our national space assets.

We are glad that the Ministry of Defence recognises that progress needs to be accelerated by harnessing the country’s national capability in all its forms. SIA-India is committed to promoting the growth of the space sector in India both in the private and defence sectors and contributing to the country’s economic growth and progress towards self-reliance.

SIA-India is organising the DefSAT-23 India’s First International Defence and Space Conference and Expo on 27, 28, and 29 April 2023 at Manekshaw Centre, Delhi Cantt. The aim is to leverage space power to enhance our defence capabilities and protect our national assets.

I am confident that the DefSAT 2023 will create a synergy between the civilian and military sectors, facilitating collaborative communication, and identifying cutting-edge technologies and capabilities to meet the needs of both.

We welcome you to this event and make the most of this platform to exchange ideas, share knowledge and explore possibilities for collaboration. Let us come together and work together to achieve our common goal of a self-reliant and technologically advanced India.

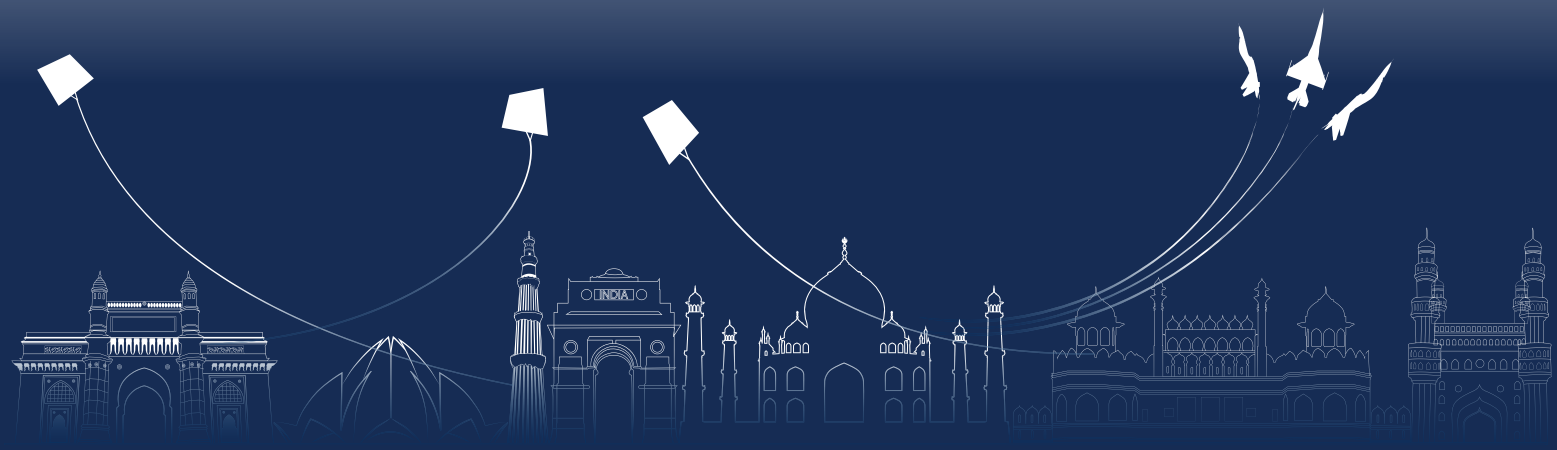
Jai Hind!



## Message from Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations)



The global race to outer space has surpassed preceding strides. Nations like India can ill afford to procrastinate or relegate this domain to lower significance. The Space sector must pursue timely prospects, through filling in gaps. Private Space players can very quickly step in and provide solutions with scales that governments cannot. Future wars and peaceful economic growth are both reliant on Space Capabilities. India must define its Space philosophy, doctrine, and strategy to enable building a tight road map for the industry. India may find it difficult to outmatch the adversaries in the short term unless we empower the private Defence and Industrial complex to take a lead in the medium to long term. DefSat 2023 is designed to offer directorial answers.







## Message from Lt Gen Sunil Srivastava, AVSM, VSM\*\* (Retd) Director, CENJOWS



DefSAT 2023 comes at a watershed moment when a resurgent and rising India has promulgated a Space Policy with a Vision to develop space capabilities with a flourishing commercial presence in space, for ensuring, inter-alia, Nation's Socio-economic development and Security. All consumers (Public and Private) of Space technology and services shall be free to directly procure them from any source, Public or Private. India's continued stellar growth story will be underpinned by the empowerment of remote and digitally deprived India through emerging affordable

capabilities in Space. However, growth is contingent on peace, stability, and security. Space technologies are very advanced, critical, and inherently dual use. Ever-increasing digitisation and network-centric multi-domain warfighting have enhanced the salience of space-based capabilities like sensing, imagery, communications, precise location, weather, and space-situational awareness for the warfighter manifold. The ongoing conflict in Ukraine has witnessed the exploitation of commercial space products for military use, being deployed at scale, and evolving on the battlefield in the face of non-kinetic threats. Indian Armed Forces got its first dedicated satellite, Rukmini, in 2013, after 65 years after independence. Now is the time for an Atmanirbhar Bharat to break out in the Space domain, enabling our defence forces in all domains — land, aerospace, maritime, and information, propelled by burgeoning, determined and exceptionally innovative space start-ups, and an enabling investment climate. The achievements showcased by our startups and SMEs during the last two years, inspire tremendous confidence. The response of Startups and MSMEs to the 75 Defence Space Challenges has been overwhelming.

CENJOWS is privileged to be a knowledge partner with SIA India for DefSAT-2023, which brings together all stakeholders- policymakers, regulators, users, Scientists, Industry, academia and startups, to brainstorm the challenges through curated thematic sessions, with domain experts' par-excellence, to find new pathways to turn these challenges into opportunities through innovative solutions.



# Executive Summary

DefSAT 2023, India's First International Conference on Defence and Space, marked a significant milestone in recognising the convergence of these domains. The conference, organised from 27-29 April 2023 by SIA-India at the Manekshaw Centre in New Delhi, focused on the intersection of strategy and industrialisation of the space sector for national security. With 50 distinguished speakers, engaging sessions, keynote speeches from our special guests of honour **Shri S. Somanath, Secretary, Department of Space and Chairman of ISRO** and **Shri G Satheesh Reddy, Scientific Adviser to Raksha Mantri** and participation from 300 diverse stakeholders, DefSAT 2023 facilitated knowledge exchange and collaboration. Diplomatic representatives from various countries also attended the conference, highlighting its international significance.

The three-day conference was supported by esteemed organisations such as Niti Aayog, the Department of Defence Production (Ministry of Defence), the Defence Research and Development Organisation (DRDO), the Indian Space Research Organisation (ISRO), New Space India Ltd (NSIL), National Institute of Advanced Studies (NIAS), and Research and Information System for Developing Countries (RIS). The Centre for Joint Warfare Capabilities (CENJOWS), the Centre for Air Power Studies (CAPS), the Centre for Land Warfare Studies (CLAWS), and the National Maritime Foundation (NMF) served as knowledge partners, providing valuable insights into the future technology in defence and space to advance the space sector, strengthen defence capabilities, and ensure the secure and sustainable use of space assets.

This conference report highlights the significant impact and outcomes of DefSAT 2023. As we move forward, it will be of value to leverage the insights and outcomes of DefSAT 2023 to drive concrete actions and policy changes for optimising the use of national resources in the civil, commercial, and defence space programs.



## IndSpace Exercise

A highlight of the conference was the IndSpace exercise, India's first industrial space wargame. With the guidance of Lt Gen PJS Pannu, the exercise, chaired by Lt Gen Vinod G. Khandare, brought together participants from defence, government, industry, and think tanks. It showcased the industry's potential and stakeholder commitment to advancing India's space security and defence position, emphasising the private sector's role.

## Exhibition

The DefSAT 2023 exposition drew a diverse array of industry experts and enthusiasts, featuring exhibitors from esteemed organisations such as Geo Spatial World, Indian Aerospace & Defence, Comsat System Pvt Ltd, Saptang Labs, J V Micronics, Raamtel, Decibel Systems, DRDO, KaleidEO, and Ananth Technologies Ltd. Their active involvement and participation greatly enriched the event, showcasing cutting-edge advancements and innovations in the space and defence sectors.



## SPECIAL THANKS

We extend our gratitude to the members of the program committee and organizing committee for their support, with a special acknowledgment to Lt. Gen PJS Pannu, PVSM, AVSM, VSM (Retd), Former Deputy Chief of Indian Integrated Defence Staff (Operations) and Chair of the Defence Aerospace Committee, SIA-India; Lt. Gen Sunil Srivastava, AVSM, VSM\*\* (Retd), Director of CENJOWS; and Prof. Chaitanya Giri, Associate Professor at FLAME University and Consultant at RIS.



## Recommendations for Future Progress

The conference resulted in several key recommendations that aim to guide the future development and progress of defence and space industries towards addressing emerging challenges in national security. By implementing these recommendations, India will be driven towards self-sufficiency, fostering collaboration, promoting innovation, and bolstering national security and economic interests. The recommendations have been grouped under the following heads:

- **Space in the National Security Framework.**
- **Accelerating Industrialisation of Defence Space Capabilities.**
- **Defence Space Acquisition and Fulfilment.**
- **Technology Development Roadmap.**
- **Downstream application development.**
- **Enhance NAVIC capabilities.**
- **Safeguarding Space Capabilities and Cyber security.**
- **Capacity Building and Skill Development**
- **International Collaboration**

The recommendations are listed in the later part of this report.

## Conclusion

DefSAT 2023 has established a solid foundation, emphasising the strategic imperative of convergence between space and defence. India's commitment to technological advancements, industry growth, and international partnerships will enhance national security and provide opportunities for global market access and influence.







## Day 1 of the DefSAT 2023 Conference



Day 1 of the DefSAT conference commenced with the IndSpace Exercise, India's first Industrial Space Wargame. The exercise evaluated the space industry's ability to respond to contingency or crises, testing factors like resource allocation and logistics. The session saw active engagement from the civil, commercial, and defence sectors, nurturing a spirit of collaboration and fostering innovation & industrialisation.

Following this, the panel discussion on "Space Diplomacy & International Collaboration in Defence Space" explored the growing significance of space diplomacy and the need for norms and regulations governing the military use of space-based assets. The panel emphasised the importance of partnerships, joint research, shared asset utilisation, and trade in fostering trust and transparency. The discussion highlighted ISRO's collaborations with international partners and the benefits derived from such collaborations, promoting India's presence and achievements in the space sector.

The power session on "Forging Global Cooperation in Trade, Strategy, and Space Diplomacy" underscored the evolving dynamics of India's space sector, analysing strategic partnerships, the India Space Policy 2023, regional cooperation, civil-military fusion, private sector engagement, diplomatic missions, cost competitiveness, and addressing structural issues for international trade. The session highlighted the potential of the space sector to contribute to India's GDP and drive economic growth, calling for a comprehensive approach to propel India's position in the global space industry.

## IndSpace Exercise: India's First Industrial Space Wargame

The conference kicked off with the groundbreaking IndSpace Exercise, India's first Industrial Space Wargame. This simulated, scenario-based, interactive tabletop exercise was conceived and organised by Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd), Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Defence Aerospace Committee, SIA-India. The session was chaired by Lt Gen Vinod G. Khandare, PVSM, AVSM, SM (Retd.), Principal Adviser in the Ministry of Defence.

The IndSpace Exercise stimulated a comprehensive assessment of the space industry's capability to respond to contingency or crises. It tested factors such as resource allocation, logistics, sequencing of actions, and the time required for each phase of the plan. Defence practitioners and industry stakeholders collaborated to evaluate the industrialised solutions, disruptive innovations, and technological advancements in space and counter-space capabilities required to safeguard India's national security interests in these simulated scenarios.



The tabletop exercise, designed as a restricted invite session, witnessed enthusiastic participation from the civil, commercial, and defence sectors, setting a new benchmark for collaboration and innovation. Surpassing its intended capacity of 50, the event attracted an overwhelming turnout of over 90 participants. By bringing together defence practitioners, government officials, industry experts, and think tanks, it fostered collaboration and charted a roadmap for the future of the industry. Guided by the Chatham House rules, the exercise explored diverse scenarios related to space-based technology in warfare, emphasising preparedness, long-term strategies, and coordination between the government and the private sector.

The success of the IndSpace Exercise exemplified the industry's immense potential and the stakeholders' unwavering commitment to a shared vision.



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**Empowering space communication for defence is of utmost importance. With the participation of stakeholders from the army, air force, navy, and defence think tanks, we aim to collectively contribute to the thought process. The deliberations in the IndSpace Wargame would pave the way for a roadmap in the industry, assessing the delta, gap, and readiness. The industry not only comprehends the requirements but is also prepared to extend the necessary support, eagerly awaiting tangible orders to progress further.**

— Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd),  
Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair,  
Defence Aerospace Committee, SIA-India





## Opening Plenary

- **Dr Subba Rao Pavuluri, CMD Ananth Technologies & President, SIA-India**
- **Dr Shailesh Nayak, Director NIAS and Former Secretary MoES**
- **Dr P. K. Jain, Director PMAD, IN-SPACe**

Dr Subbarao Pavuluri welcomed the guests to DefSAT 2023 which aims to engage and motivate the audience at the conference focused on cooperation between the industry and defence sectors. The primary goal is to align space policy with defence requirements and integrate space capabilities into deliverables. He appreciated that the IndSpace Exercise highlighted a remarkable synergy between the industry and defence, paving the way for collaboration and exciting opportunities that emerged across different sectors, making it a great day for the industry. The conference offers a platform for active participation, idea exchange, and valuable insights, intending to establish a clear blueprint for cooperation.



**Progress must be accelerated by harnessing India's national capability in all its forms. We need a better fusion of civil, commercial, and defence space programs to optimise national resources and avoid duplicative research and development. Coordinated actions, clear policies, a forward-looking roadmap, and an interdisciplinary approach involving all stakeholders are essential for efficient technology spin-off."**

—Dr Subba Rao Pavuluri, President SIA-India and CMD Ananth Technologies





In his speech, Dr P K Jain spoke on advancing India's space capabilities for defence and security and highlighted key points to propel the country's abilities in this domain. He emphasised the need for a comprehensive whole-of-the-nation approach, involving stakeholders from private industry, government, space agencies, and defence. Notable advancements in institutional support, policy, and regulations were acknowledged, along with the importance of state-of-the-art technology and international collaborations. The speech called for a focus on developing the ecosystem, engaging industry, academia, and government, and strengthening international outreach and diplomacy. Adequate spectrum resources and close coordination with international efforts were also emphasised. He stressed that the conference aims to explore opportunities and establish a collaboration blueprint between the industry and the Defence Forces in space-related technologies and services.

Dr Shailesh Nayak underscored the significance of the gathering of brilliant minds where the Armed Forces demonstrate their willingness to collaborate with industries in the field of space-related technologies and services. Recognising the critical role of demand, he articulated the undeniable need for space-related technologies and services in future conflicts. He also highlighted the importance of unlocking opportunities beyond satellite launch vehicles and generating demand in unexplored applications.

Illustrating the need for navigation satellites, Dr Nayak emphasised the requirement for comprehensive coverage in the Indo-Pacific region. It calls for the development of an independent and reliable alternative system, considering the susceptibility of existing GPS systems to vulnerabilities. To drive demand and engage the industry effectively, clear communication, coordination, and standardisation of components are crucial. He concluded by expressing gratitude to participants and recommended the need for further deliberation to establish a collaboration blueprint.





## Space Diplomacy & International Collaboration in Defence Space

- **Dr Bhaskar Balakrishnan, Fmr. Ambassador & Fellow for Science Diplomacy, Research and Information System (RIS)**
- **Dr P. K. Jain, Director PMAD, IN-SPACE**
- **Dr Chaitanya Giri, Associate Professor, Flame University**
- **Cdr Subhash Ahlawat IN (Retd), Director Sales, Centum Electronics**
- **Mr Sameer Guduru, Director, Digital Economy, Aerospace & Defence, USIBC**
- **Air Cmde Terry Van Haren DSM, Retd., Managing Director, LeoLabs Australia**

Space-based assets and data play a crucial role in meeting human needs and ensuring national security. They facilitate a wide range of essential services, including communication, intelligence, navigation, weather forecasting, climate change monitoring, and disaster risk reduction. As a result, the utilisation of space resources has emerged as a new frontier in geopolitics, economic growth, and military superiority. This domain offers significant opportunities for multilateral cooperation, trade, and enhanced collaboration among nations.

The role of space in future global conflicts is expected to grow as countries increasingly rely on space-based assets. Space diplomacy is becoming increasingly important as countries seek to establish norms and regulations governing the use of space-based assets for military purposes. Collaborative efforts such as trade, joint research and development (R&D), and shared use of space-based assets can help establish mutual trust, promote transparency, and reduce the risk of misunderstandings.





During this panel discussion experts delved into the growing significance of space diplomacy and the challenges and opportunities for international cooperation in the realm of defence space. They highlighted the need to establish norms for the military use of space-based assets and underscored the role of collaborative efforts such as joint R&D, shared asset utilisation, and trade. These measures were identified as crucial for fostering mutual trust, promoting transparency, and minimising misunderstandings.

The panel emphasised the importance of strengthening partnerships with other countries to enhance India's global position in the space sector. International collaboration and partnerships were acknowledged for creating avenues in knowledge sharing, technology transfer, and market access. Initiatives like the civil joint space working group and closer collaboration with international players were acknowledged for their ability to streamline operations, boost competitiveness, and position India as an attractive global space hub.

The joint Initiative on Critical and Emerging Technology (iCET) between the United States and India, exemplified by the NASA-ISRO Synthetic Aperture Radar (NISAR) mission, served as a compelling example of the benefits derived from such collaborations. The panel also highlighted ISRO's impressive track record of signing over 275 MOUs, its commitment to nurturing young talent, and its global reach, which extends beyond India's borders and enables it to leverage the capabilities of the Indian Space sector for international customers.

Furthermore, the panel stressed that ISRO's collaborations with international partners contribute significantly to the advancement of India's space exploration endeavours. Overall, the discussion analysed the critical role of space diplomacy, international collaboration, and addressing industry challenges to propel India's presence and achievements in the space sector forward.





### The panel deliberated on the following key topics of importance for international cooperation:

- **Promoting Space Safety, Trust, and Diplomacy:** The panel stressed the importance of promoting space safety, trust, and diplomacy by emphasising the need for transparency and clear communication of activities and objectives by private players and governments. Collaboration with international partners, while ensuring the security of sensitive information, was identified to achieve goals, grow businesses, bridge technology gaps, and exchange expertise. The panel also underlined the role of diplomacy in establishing mutual trust and preventing misunderstandings in future global conflicts.
- **A Robust Framework for Information Sharing:** In an increasingly competitive landscape, potential conflicts in space are becoming a real possibility. Robust frameworks for global information sharing in the space sector are crucial for secure and efficient collaboration among private entities, government agencies, and international partners. These frameworks enable transparent communication, mitigate risks, foster innovation, and support the sustainable exploration and utilisation of space. By promoting open dialogue and transparency, they address emerging challenges in the rapidly evolving space industry.
- **Strengthening International Cooperation:** Strengthening international cooperation is crucial for India's space industry. ISRO's MoUs, with many nations, highlight its commitment to advocating for collaborating in technology co-development, particularly for other developing nations. Enhancing the effectiveness of international, multilateral, and bilateral mechanisms allows collective efforts to address challenges and explore opportunities in sector growth. Streamlining operations and empowering the private sector will boost India's competitiveness as a global space hub. By addressing pipeline gaps, investing in R&D, and strengthening cooperation, India can position itself as a prominent player in the global space arena.
- **Export Control Mechanisms and India's Space Industry:** The panel highlighted India's engagement with export control mechanisms and their positive impact. Joining the Missile Technology Control Regime (MTCR) has elevated India's global position and credibility as a responsible space-faring nation. This collaboration has opened doors for greater technological cooperation, research partnerships, and expertise exchange with other member countries. Similar positions for international space regulations enhance India's space capabilities and competitiveness, enabling access to advanced technologies for peaceful space exploration.





- **Joint Research between Entities from Different Geographies:** Such Collaborations, by bringing together diverse expertise and resources, foster innovation, knowledge sharing, and technological advancements. They enable the exploration of new frontiers in space technology, enhance capabilities, and address common challenges. Through joint research, countries can leverage each other's strengths, pool resources, and develop cutting-edge solutions that contribute to the advancement of defence capabilities and pave the way for meaningful partnerships in the space sector.
- **Shared Use of Space Assets:** The shared use of space assets fosters collaboration and cooperation in defence space. By pooling resources and expertise, nations can optimise space asset utilisation, enhance defence capabilities, and promote mutual trust and transparency. It enables cost-effective access to advanced capabilities, improves situational awareness, and encourages interoperability. This collaboration promotes stability, prevents misunderstandings, and builds a foundation for long-term partnerships.
- **Responsible Use of Space:** The panel discussion shed light on the crucial aspect of responsible space utilisation in the context of India's national security. The issue of orbital debris management and the lack of international collaboration or domestic frameworks were acknowledged as pressing concerns. Furthermore, the discussion highlighted the importance of responsible practices in satellite manufacturing and launching. Coordination and responsible utilisation of space resources were emphasised as vital elements to mitigate risks and optimise the use of space assets.
- **International Trade in the Space Sector:** Global trade in the space sector builds B2B bridges that foster space diplomacy and international collaboration in defence space. It enables nations to exchange technologies, services, and resources, enhancing defence capabilities and promoting mutual trust. Through trade partnerships, countries access advanced technologies, address challenges, and drive innovation in the space industry. This collaborative approach fuels the development of a robust and progressive global defence space sector.

The dynamics of space activities are rapidly evolving, necessitating a stronger focus on international relations, space diplomacy, and global standing to keep pace with the developments.



“Building a future of strength and progress, we must harness space technology for defence productively and strategically. Through a holistic approach encompassing policy, cutting-edge technology, ecosystem development, and international collaboration, we pave the way forward. Let academia and innovation thrive, striking the right balance of spectrum resources for all. Embrace global trends, empower startups, and seize downstream opportunities. India is primed for upstream and midstream activities. With visionary policies and the Space ACT, we unlock the potential of space technology for Space and defence, ensuring comprehensive capabilities for a safer tomorrow.”

—Dr P. K. Jain, Director PMAD, IN-SPACe

## Forging Global Cooperation in Trade, Strategy, and Space Diplomacy.

- **Amb. Rakesh Sood, Foreign Affairs, Economic Diplomacy and International Security**
- **Dr Subba Rao Pavuluri, CMD Ananth Technologies & President, SIA-India**
- **Mr Deepak Mathur, Executive Vice President, SES INC**

The DefSAT conference featured a power session titled, “Forging Global Cooperation in Trade, Strategy, and Space Diplomacy in 2023.” Chaired and moderated by Ambassador Rakesh Sood, the session included panellists Dr Subba Rao Pavuluri and Mr Deepak Mathur.

Space programs have evolved beyond mere exploration, with countries now striving to enhance their geopolitical standing and achieve economic and technological benefits. As a key contender for a leading position, India has adopted a revitalised strategy in global space affairs. Dr S Somanath, Secretary Department of Space, has set ambitious targets for India’s space sector and the upcoming space policy will enable the participation of non-governmental private entities.

The nascent commercial space sector holds significant potential and can contribute substantially to India’s GDP, potentially driving double-digit growth. Consequently, policymakers, regulators, investors, and diplomats have a strong focus on India’s space sector. By extending cooperation and opening doors to Asian, African, Latin American, and Middle Eastern countries, India can exponentially improve its trade potential in the space sector. Diplomatic efforts can complement government interventions and facilitate strategic partnerships with private players, MSMEs, and startups.





The insights provided during the power session underscored the evolving dynamics of India's space sector.

- **Promoting Strategic Partnerships:** India seeks strategic collaborations, such as the U.S.-India Civil Space Joint Working Group, to advance its space exploration and research. The upcoming NISAR mission, a joint effort between NASA and ISRO, highlights the potential of such partnerships. NISAR will employ advanced radar technology to map Earth, monitor resources, and provide vital data on ecosystems, hazards, and climate. The panel acknowledged increased interest in India's space sector, with various entities entering the field. They noted that collaboration levels in the Memorandum of Understanding (MoU) vary, reflecting different degrees of engagement with international partners.
- **Leveraging the India Space Policy 2023 for Sector Growth:** The India Space Policy 2023 serves as a crucial catalyst for the growth of the space sector through international trade. By providing a comprehensive framework and regulatory guidelines, the policy enables seamless engagement with global partners. It promotes international trade in space technologies, services, and resources, creating opportunities for knowledge sharing, technology transfer, and market access. This strategic approach not only fosters economic growth but also enhances India's capabilities in space exploration and research. Through collaborations and partnerships, the India Space Policy 2023 positions India as a prominent player in the global space industry, driving innovation, and competitiveness, and contributing to the country's overall development.
- **Regional Cooperation in the Space Sector:** India recognises the significance of regional cooperation in the space sector for enhancing its national security. Through initiatives like the CSSTEAP institution, the SAARC satellite initiative and the "Neighbourhood First" policy, India emphasises the importance of collaboration and capacity building within the region. These initiatives strengthen regional ties, enhance collective security, and contribute to India's national security objectives in the space domain.
- **Leveraging Civil-Military Fusion:** By integrating civil and military applications of space technology, India can enhance its capabilities in various sectors, including communication, intelligence, navigation, weather forecasting, disaster management, and national security. This approach allows for the efficient use of resources, promotes innovation, and creates synergies between the civil and defence sectors. Leveraging civil-military fusion not only drives economic growth but also strengthens India's strategic position in the global space industry, paving the way for a robust and sustainable space economy.





- **Private Sector Engagement:** Recognising the vital role of the private sector in India's space industry, the panel emphasised the need to foster collaboration between private companies, government agencies, and international partners. To support and encourage private players, favourable policies, funding opportunities, and world-class infrastructure should be implemented. Additionally, investing in skill development and education programs will cultivate a qualified workforce and drive innovation, positioning India as a global leader in the space sector.
- **Leveraging Diplomatic Missions:** Diplomatic attaches require the skills and knowledge to navigate the evolving technological landscape and advocate for India's space industry. They play a crucial role in representing India's interests and promoting collaborations internationally. By staying informed about emerging technologies, policies, and industry dynamics, they can effectively engage with other nations, foster understanding, and advance India's strategic objectives in space. Investing in their training and empowerment strengthens India's diplomatic presence and ensures the continued growth of its space industry.
- **Leveraging India's Cost Competitiveness:** The country's ability to offer cost-effective solutions and services has positioned it as an attractive destination for space-related collaborations and partnerships. By leveraging its cost competitiveness, India can enhance its international trade in the space sector, attracting foreign investments, encouraging technology transfers, and promoting collaborations with global players. This not only expands India's market reach but also contributes to the growth and development of the global space industry through mutually beneficial trade relationships.
- **Addressing Structural Issues for International Trade:** The panel emphasised the vital role of industry ecosystems in meeting the needs of other countries. The suggestion put forward was to conduct a comprehensive evaluation of existing systems and implement concerted efforts to optimise and integrate them. This would include aligning the government's impetus for scouting opportunities globally and financing those opportunities. This approach would maximise resource efficiency and enhance overall space capabilities.

India's space industry stands at a critical juncture, poised for further growth and success. By addressing gaps in the industry pipeline, investing in R&D, strengthening international cooperation, and empowering the private sector, India can position itself as a prominent player in the global space arena.



“Indian Space Research Organisation (ISRO) was once the only space organisation in India, this is no longer the case. Today, many private players are entering the space industry, which is leading to a more diversified and competitive space sector in the country. There is a growing importance of the space sector in India, and the need for greater collaboration and coordination among all stakeholders to ensure the country’s continued success in this vital area.”

—Amb. Rakesh Sood, Foreign Affairs, Economic Diplomacy and International Security





# Day 2 of the DefSAT 2023 Conference

Day 2 of the DefSAT 2023 Conference emphasised collaboration, innovation, and investment in the defence and space sectors. Key discussions revolved around integrating space-based assets into India's military capabilities, strengthening Positioning, Navigation, and Timing (PNT) systems, and ensuring space security. Speakers highlighted the importance of disruptive technology in warfare, economic development through space assets, and responsible decision-making. The significance of accurate information, robust intelligence capabilities, and partnerships with industry and international allies were also emphasised. Overall, the day focused on strengthening India's space capabilities for national security and development through collaboration, indigenisation, and cutting-edge technology.

## Opening Plenary

- **Shri S. Somanath, Secretary Department of Space and Chairman, ISRO (Chief Guest)**
- **Air Marshal Surat Singh AVSM, VSM, VM, Director General Air (Operations), (Special Guest of Honour)**
- **Lt Gen Tarun Kumar Aich, AVSM, Deputy Chief of Army Staff (Strategy), (Special Guest of Honour)**
- **Dr Subbarao Pavuluri, President SIA-India and Chairman, Ananth Technologies Limited**
- **Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Defence Aerospace Committee at SIA-India**
- **Lt Gen Sunil Srivastava, AVSM, VSM\*\* (Retd) Director, CENJOWS**

The opening plenary, featuring esteemed speakers from various domains, shed light on key aspects of the defence and space sectors.



**Dr Subba Rao Pavuluri** commenced the discussion by highlighting DefSAT-23 as a significant gathering of industry experts, government policymakers, and thought leaders. The objective of this congregation was to deliberate on strategic measures and chart a course of action for the defence and space sectors. Dr Pavuluri stressed the need for coordinated efforts, clear policy direction, long-term planning, and an interdisciplinary approach involving all stakeholders. Such endeavours would lead to efficient progress in technological advancements that address the needs of the sectors while fostering economic growth, employment opportunities, and disruptive innovations.





**Lt Gen PJS Pannu** drew attention to the criticality of being the best to secure victories in battles. He emphasised that in warfare, the margin between winning and losing is often very narrow. The side that possesses superior skills, better equipment, and comprehensive training is more likely to emerge victorious. This holds even more significance in modern warfare, which involves complex systems and technologies that require extensive training and expertise. He also underscored the importance of accuracy in military systems, as being inaccurate can lead to wasted resources, missed targets, and potentially disastrous outcomes. Therefore, military forces must invest in accurate systems that are reliable and effective. Lt Gen Pannu further highlighted that disruptive technology in modern warfare acts as both a deterrent and an offensive capability. Technological advancements provide militaries with new ways to project power and defend against threats. Effectively using and controlling these technologies often determine the outcome of battles.

While expressing concerns about the existing capability of the domestic sector to meet the demands of contemporary combat, Lt Gen Pannu emphasised the significance of self-reliance in the defence sector. The term “domestic sector” refers to a country’s own industry’s ability to produce and supply advanced military equipment and systems at regular intervals. A robust domestic industry allows nations to reduce their reliance on foreign suppliers, mitigating concerns of dependency, vulnerability, and potential avenues for unauthorised technology access.





**Air Marshal Surat Singh** shed light on the increasing importance of space in military operations. He highlighted that the role of space has undergone a significant transformation in recent years and is now recognised as being of paramount importance in the modern military environment. Air Marshal Singh emphasised the need for discussions on how to stay ahead of the curve and leverage India's thriving space ecosystem, particularly in the private sector. He underscored the government's Space Policy, which aims to develop both government and private space capabilities. This development will enable India to effectively utilise space as a continuation of air warfare. He also underscored that air defence naturally transitions into aerospace defence, and modern technology has made this transition seamless.

To optimise the utilisation of the space medium, the modern Air Force needs to transform itself into a capable aerospace force. He further highlighted the evolving aerospace power landscape due to new technologies, including advances in satellite communications (SATCOM) and the utilisation of space for offensive operations. Air Marshal Singh emphasised the interconnectedness of space and air operations, stating that they cannot be conducted in isolation. He stressed that India heavily relies on space assets for target acquisition and highlighted the need to continue investing in and developing its space capabilities to remain a relevant player in the increasingly complex aerospace power landscape.



**The recently released space policy marks a significant milestone for the Indian space industry, providing a strong impetus for its growth and development. The transformation of the Indian Air Force into an Indian airspace force, utilising space for ISR, navigation, targeting, SSA, and meteorological operations, is of utmost importance. We must prioritise the development of offensive and defensive technologies integrated with space capabilities to bolster our readiness. It is essential to maintain a high state of preparedness and proactively address challenges to effectively counter China and mitigate battlespace vulnerabilities.”**

—Air Marshal Surat Singh AVSM VM VSM, Director General Air (Operations)



**Dr G Satheesh Reddy** drew attention to the importance of evaluating and enhancing India's anti-satellite (ASAT) capabilities. He highlighted the need to consider both hard-kill and soft-kill capabilities to effectively address space-based threats while minimising the creation of space debris. Dr Reddy stressed that India should focus on developing and deploying technology that can neutralise the impact of hostile satellites and counter other space-based threats. Additionally, he dwelled on the importance of quantum technology for secure communications, as traditional encryption methods are becoming vulnerable to sophisticated attacks. Dr Reddy urged that the country needs to invest in R&D in quantum technology to stay competitive and protect national security interests.



**Space technology for defence purposes has witnessed a significant surge globally, including advancements in image intelligence, electronic intelligence, signal intelligence, and communication intelligence. For India's defence, Synthetic Aperture Radar (SAR) and Hyperspectral technology are critical, especially in border regions. Developing space-based electronic warfare capabilities, both from and within space, is imperative. In addition, our focus should be on miniaturisation and amplification of high-power laser and High-Power Microwave (HPM) technology."**

—Shri G Satheesh Reddy, Scientific Adviser to Raksha Mantri (Ministry of Defence)



**Lieutenant General T K Aich** highlighted the increasing importance of space assets in economic development and military capacities. He emphasised that space technology plays a crucial role in various areas, such as missile launch capabilities, command and control systems, imaging capabilities, mapping, and surveillance. Lt Gen Aich stressed the need for effective regulation and governance to address the growing importance of space in modern warfare. He stressed the importance of space situational awareness to monitor and mitigate potential threats to space assets. Lt Gen Aich also highlighted the need for international cooperation and collaboration in space activities to ensure the safe and sustainable use of outer space.

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**Since the Gulf War, the military use of space has increased significantly, with satellite-based communication, reconnaissance, and GPS technology playing crucial roles. To catch up with China and meet battlespace requirements, India must prioritise preparedness, address vulnerabilities, and establish a robust space policy ensuring national control. Key military applications such as satellite-based surveillance, precise positioning, and quantum communication are essential. Leveraging IRNSS, empowering DSA (Def Space Agency India), adopting a joint services approach, and providing comprehensive training are imperative. Maintaining control over the battlefield is crucial for staying ahead in a changing geopolitical landscape. Balancing societal and national security is vital.”**

—Lt Gen Tarun Kumar Aich, AVSM, Deputy Chief of Army Staff (Strategy)





**Dr S Somanath** discussed India's capabilities in manufacturing space assets and conducting cost-effective space missions. He emphasised the need to scale up the space sector to meet the growing demand and create a sustainable space industry. Dr Somanath highlighted the importance of creating demand for space-based services and applications and addressing the capital-intensive nature of the space industry. He affirmed the need for public-private partnerships to foster innovation, investment, and job creation in the space sector. Dr Somanath also stressed the significance of reusable systems for space launches, as they can significantly reduce costs and improve the efficiency of space missions. Furthermore, he pointed out the significance of downstream applications of satellite data, which have the potential to drive economic growth and development in various sectors.



**Space's strategic potential was not fully recognised earlier as it was primarily utilised for public and civilian purposes. However, it is now evident that space capabilities are crucial for national security, and collaboration is necessary to enhance power and scale-up capabilities. India can launch reasonably, but further scaling up and building up demand is essential as space investment is capital-intensive. To bring down the cost of access to space and augment the demand for application creation, India must provide the necessary impetus for the growth of the industry.”**

—Shri S. Somanath, Secretary, Department of Space and Chairman, ISRO



In conclusion, the eminent guests provided valuable insights into the defence and space sectors. The speakers maintained the importance of collaboration, self-reliance, accuracy, innovation, and the need to stay ahead in the evolving aerospace power landscape. They highlighted the critical role of space technology in military operations and economic development, urging India to invest in research, development, and commercialisation of space technologies while ensuring regulatory guidance and support for a thriving space industry.

### **Environmental Scan by Lt Gen Sunil Srivastava, AVSM, VSM\*\* (Retd) Director, CENJOWS**

Lt Gen Sunil Srivastava delivered an insightful talk on the changing dynamics of the space sector, focusing on national security, commerce, and growth. During the talk, Lt Gen Sunil Srivastava pointed out the growing interdependence between economics and space activities for nations. He highlighted the growing importance of space in military capabilities and security issues, pointing out how Ukraine reacted to initiatives such as SpaceX's Starlink and the subsequent responses from Russia and NATO. The speaker noted that space, once a realm of growth and exploration, has become congested and contested.

Lt Gen Srivastava provided an approximation of the space economy. He further broke down the allocation of funds into categories, indicating that the commercial component is the largest, followed by the defence and government sectors, indicating the significant portions dedicated to services, applications, manufacturing, and launch.

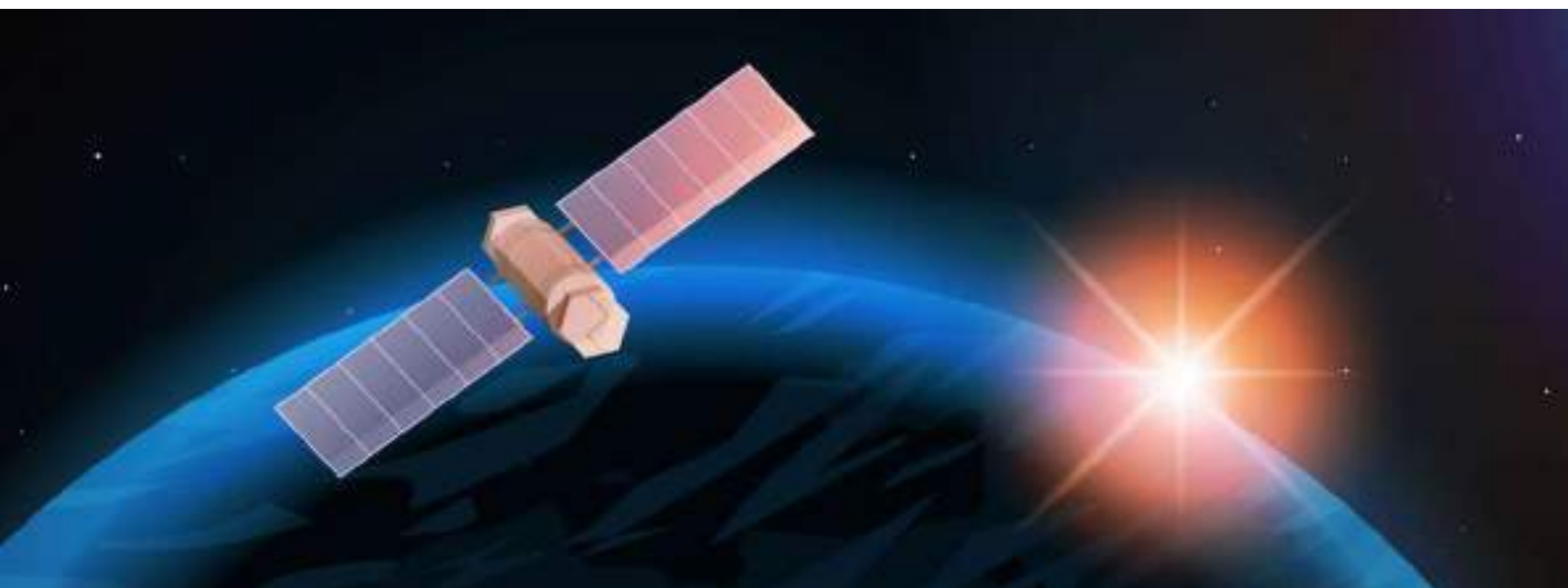


Referring to India's Defence vision, He highlighted the relatively small share India currently holds in the space economy, with the United States leading at 40% while India stands at only 2%. However, he pointed out projections indicating India's potential growth. Lt Gen Srivastava underscored that in recent times, governments are not the primary drivers of this growth, with the United States private sector currently investing significantly more in space compared to India. He highlighted China and the United States as the key players in this competitive landscape, although China's growth rate may be affected by demographic limitations and other factors.

There are several implications arising from the ongoing competition in space. These include the polarization of countries and the efforts of major players like the United States and China to secure their influence. Power diffusion, technological confrontation, fragmented supply chains, and competing worldviews were identified as some of the manifestations of this contestation. The talk stressed the significance of establishing norms and order in outer space, focusing on resolving disputes regarding laws, non-proliferation, arms control, space traffic, and other essential domains.

Lt Gen Srivastava discussed the significance of securing critical supply chains, particularly rare earth minerals. The speaker also accentuated the cost reduction driving the increasing interest in space, pointing to examples of decreasing costs in heavy launches, communication satellites, and Earth observation imagery.

In conclusion, Lt Gen Sunil Srivastava's talk shed light on the evolving space landscape, focussing on the interconnectedness of space, national security, commerce, and growth. The deliberations underscore the importance of sustained discussions on establishing norms and regulations in space, resolving conflicts, and harnessing the diverse applications of space technology for the betterment of humanity.





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Space, once an exploration playground, has evolved into a congested and contested domain, where national security, commerce, and national growth converge. Space assets have become indispensable for all nations, enabling the expansion of capabilities across various domains. India's ambition to grow its market share from 2% to 9% by 2030 reflects the increasing importance of space. With private players and corporations taking the lead, the trillion-dollar space economy outshines government contributions. In the 21st century, technology, networks, and information-based power drive development, with space-based assets at the forefront. The transformation of space signifies a new era of possibilities and challenges.”

—Lt. Gen Sunil Srivastava, AVSM, VSM\*\* (Retd) Director, CENJOWS



## Dialogue on Defence Space Realm and Required Capabilities

- **Air Vice Marshal DV Khot, AVSM, VM, Director General Defence Space Agency**
- **AVM Rajiva Ranjan VM, ACAS OPS Space**
- **Col ADS Herr, Col Strategic Planning (Space)**
- **Captain Chandra Kant Kothari, Captain (NSO) Space**

The panel discussion on the Defence Space Realm and Required Capabilities was chaired by AVM DV Khot and covered various aspects of integrating space-based assets into India's military capabilities. The panel deliberated on the significance of partnering with industry stakeholders and international allies, as well as promoting self-sufficiency in the space sector to strengthen India's defence space readiness. The specific requirements and capabilities of the Indian Army, Indian Air Force, and Indian Navy were discussed, highlighting the need for higher resolution sensors, multi-sensor layered architectures, synthetic aperture radar (SAR) technology, electronic intelligence (ELINT) satellite constellations, and positioning, navigation, and timing (PNT) tools.

The panel recognised space as a military domain and traced its historical military applications. They emphasised that integrating space-based assets with ground-based assets is crucial for enhancing military capabilities in modern warfare. The involvement of private players in the space sector was acknowledged as a significant driver of progress in both commercial and military aspects of space.





The panel emphasised the requirement for adaptive target recognition, weather-resistant intelligence, surveillance, and reconnaissance (ISR) ability as well as communication networks and enhanced space situational awareness for augmenting land warfare capabilities. They assessed the significance of collaborating with industry partners to explore novel technologies and capabilities. The panel also stressed the significance of higher resolution sensors, a multi-sensor layered architecture, geostationary data relay satellites, SAR technology, and PNT with sub-metric accuracy for the Indian Army's requirements.

They reaffirmed the importance of adopting a multi-domain strategy that integrates air and space capabilities, utilising all accessible resources for air superiority and informed decision-making. Advanced technologies including re-launchable vehicles, human flight, nuclear and plasma propulsion, kinetic kill vehicles, co-orbital platforms, satellite jamming, near-space capabilities, space robotics, and ground lasers were identified as necessary for fulfilling the requirements of the Indian defence and national security.

The panel highlighted the critical need for persistent surveillance and monitoring in the Indian Ocean Region (IOR). They highlighted the importance of space assets, including constellations of satellites, geostationary imaging satellites, SAR with wide swath imagery, and the integration of artificial intelligence (AI) for data analysis. These capabilities would enhance situational awareness and contribute to effective military operations in the maritime domain.

The panel stressed the importance of the indigenisation of the space industry in these domains. The panel engaged in discussions regarding the valuable collaboration with foreign investments and emphasised the advantages of forming partnerships and exchanging knowledge with friendly nations globally including the allied countries within the Quad Alliance. Collaboration with these countries would provide India with access to advanced technologies and expertise in areas such as satellite imaging, artificial intelligence, and machine learning, thereby enhancing the Indian military's capabilities. The panel emphasised the significance of investing in state-of-the-art technology and R&D initiatives to bolster India's defence capabilities and decrease dependence on external sources.

Overall, the panel discussion highlighted the need for integration, collaboration, and innovation to enhance India's defence capabilities in the space realm. By leveraging space assets, collaborating with industry partners and international allies, and investing in cutting-edge technology, India can strengthen its military capabilities and maintain its position as a regional power.



**Space has transitioned from a purely military domain to a commercial one, blurring the lines of conduct of war. The synergy between the commercial and military wings of space is highlighted by the opening of the space sector to private players and the establishment of the Defence Space Agency in India.”**

—Air Vice Marshal DV Khot, AVSM, VM, Director General Defence Space Agency

### **Tech Brief – HawkEye 360**

Dr Rao Ramayanam provided an overview of HawkEye 360, a US company specialising in radio frequency monitoring. Established in 2015, the company operates 21 satellites in orbit that are designed to detect signals from various sources such as satellite phones, push-to-talk phones, UHF, VHF, and radar systems.

The satellites are organised into clusters, with three satellites in each cluster currently and a plan to increase the total to 60 satellites in orbit by 2025. The revisit capability of the satellites varies based on latitude, with higher latitudes receiving more frequent revisits.

HawkEye 360 specialises in identifying and collecting signals of interest, including navigation radars, GPS interference, and other relevant signals for intelligence purposes. They offer geolocation information through their RF analytics product, RFGeo, which provides location data and metadata such as latitude, longitude, received frequency, pulse length, and PRI for radar signals. Additionally, their Raw I/Q product records digital energy during signal collection for deeper analysis.

The capabilities of HawkEye 360 support various applications such as border monitoring, intelligence gathering, data fusion, and maintaining awareness of exclusive economic zones. They can assist in geolocating emitters, detecting anomalies, and monitoring military radars.



The company has successfully demonstrated their capabilities in regions including Syria, Azerbaijan, Iran, Yemen, India-China borders, and the South China Sea. They have been able to pick up signals, provide satellite imagery evidence, and support intelligence analysis. They also have expertise in identifying GPS interference signals, monitoring maritime activities, and detecting dark vessels, offering a comprehensive global spectrum awareness across land, sea, and air domains.

In conclusion, Hawkeye 360's RF monitoring technology serves as a valuable tool for intelligence gathering. While integration with other intelligence sources is important, the company's unique capabilities in signal detection and analysis make them a significant player in the field. Dr Ramayanam provided a comprehensive overview of Hawkeye 360's offerings and their commitment to supporting intelligence operations.

### **Intelligence Preparation of Battlefield – Sensors, Data, Information, Intelligence, and Everything in Between**

- **Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Defence Space Committee at SIA-India**
- **Brig Anshuman Narang, Author and ISR Domain Expert**
- **Mr Arpan Sahoo, Co-Founder, KaleidEO, a Satsure Company**
- **Dr Rao Ramayanam, HawkEye 360**
- **Lt Col Amandeep Singh, Spatial Domain Expert and Author**
- **Gp Capt Arvind Pandey (Retd), Sr. Fellow, Geospatial Intelligence in Military Operations, CAPS**
- **Mr Toby Simon, Founder & President, Synergia Foundation**

The session "Intelligence Preparation of Battlefield –Sensors, Data, Information, Intelligence, and Everything in Between" was chaired and moderated by Lt Gen PJS Pannu, who accentuated the significance of accurate information and decision-making in warfare. He highlighted the importance of having a clear understanding of the necessary information and taking precise actions accordingly, rather than relying on trial-and-error methods. The economy of a nation cannot afford speculation in warfare, making precision fighting crucial.

The session commenced with the keynote address titled, "Space Enablement – Intelligised IPB for Multi Domain Battlefront," delivered by Brigadier Anshuman Narang, an esteemed author and ISR Domain Expert. The address provided insights into the role of ISR (Intelligence, Surveillance, and Reconnaissance) in intelligence preparation for the battlefield.





## **“Space Enablement – Intelligised IPB for Multi Domain Battlefield” Keynote Address by Brig Anshuman Narang**

Brigadier Narang discussed the critical role of space-based technologies in modern warfare, highlighting the shift from “Tactics Determines Technology” to “Technology Determines Tactics.” Key points covered included the fusion of civil and military resources, indigenous talent and software, geospatial intelligence, multi-domain operational structure, and space asset utilisation in overcoming military challenges.

Emphasis was placed on indigenous talent and software for adapting tactics to align with current technology. Space-based intelligence, surveillance, and reconnaissance (ISR) were deemed pivotal, with a focus on joint intelligence preparation of the battlespace (IPB) and shorter observation, orientation, decision, and action (OODA) loops. Geospatial intelligence, integrating AI in target acquisition, and persistent space-based imaging were highlighted. A multi-domain operational structure, real-time intelligence analysis, and consideration of sub-surface and meta-domains were recommended for situational awareness.

Space asset utilisation for joint operational plans, surveillance, and decision-making was stressed, along with collaboration between civilian and government sectors. High-perspective images, interoperable systems, near real-time data, predictive analytics, and a multidomain battlespace operating system were underscored. Accurate IPB and a comprehensive common operating picture were deemed vital, with a focus on archive calibrated data, joint IPB, synchronisation, and convergent mapping. Brig Narang emphasised the utilisation of space capabilities to overcome limitations associated with conventional weapons, extend military reach, and acquire valuable battlefield intelligence.

In conclusion, continuous advancements in space-based technologies were dwelled upon to strengthen national defence capabilities. Developing accurate terrain models and aligning them with short-term, mid-term, and long-term requirements were seen as crucial for national security in a complex operational environment.





## The Panel Discussion

During the panel discussion on “Intelligence Preparation of Battlefield – Sensors, Data, Information, Intelligence and everything in between”, Lt Gen Pannu kickstarted the conversation by highlighting the importance of analysing adversary’s intentions and capabilities. The key points addressed in the discussion were as follows:

- **Upstream, Midstream, and Downstream Capabilities:** The discussion stressed the importance of developing and strengthening upstream capabilities, including constellations, and multi-sensory aircraft payloads. The need for secure and reliable midstream capabilities for data transmission was also argued. Downstream capabilities, such as software and technology development, data fusion, and AI prediction were identified as areas where India needs to catch up.
- **Progress and Regulations:** The panel acknowledged the pace of progress in the space industry over the past two decades and noted the recent regulatory changes allowing private players to enter the market and accelerate the pace. They discussed security concerns and the importance of collaboration between private players and the government to ensure compliance and promote innovation.
- **Monitoring and Gathering Intelligence:** The utilisation of space assets for tracking, surveillance, and intelligence gathering was highlighted as a crucial factor in gaining a strategic advantage. The speakers underscored the significance of leveraging satellite data for geospatial analysis, emphasising the importance of frequent revisits in satellite imaging to enhance signal detection capabilities. Considering the activities of the People’s Liberation Army (PLA) and their swift buildup and deployment, the panel emphasised the need to develop imaging technologies for effective tracking and monitoring.
- **Ensuring Prompt Information Dissemination:** It was recognised that efficient communication and data delivery systems play a vital role in facilitating the timely dissemination of information. The private industry’s R&D efforts should prioritise leveraging AI-analysed data to provide real-time updates to ground personnel, thereby enhancing situational awareness and effective decision-making capabilities.
- **Investing in LEO Constellations:** The panel acknowledged the advantages of Low Earth Orbit (LEO) constellations in providing enhanced connectivity and continuous coverage, resulting in minimal disruption to data feeds and enabling near real-time transmission of information. Investments in LEO constellations were considered a substantial augmentation to India’s space capabilities.

- **Ensuring Accuracy and Context:** Efforts should be made to achieve high accuracy in intelligence analysis, considering the context and user persona. Recognising biases and predispositions in training data is crucial to ensure accurate interpretations. The importance of considering potential challenges associated with emerging technologies and the responsible use of automation in strategic decision-making was highlighted. The value of human intelligence in avoiding disproportionate use of force was deliberated. Maintaining a balance between automation and human intelligence was recommended, considering the potential for coding errors.



Looking ahead, the speakers envisioned a future where approximately 95% of intelligence would be accessible to those with the necessary knowledge and means. They stressed the need for careful consideration of automation processes and associated trade-offs. The challenges of aggregating vast amounts of data faced by the intelligence community were highlighted. Additionally, the importance of the military sector embracing cloud technology and thorough cost-benefit analyses for decision-making was discussed. Strategic and responsible decision-making, particularly regarding the implications of emerging technologies in conflicts, was underscored.



In conclusion, the panel discussion shed light on the complexities of safeguarding national interests in a changing world. Robust intelligence capabilities, including space intelligence and satellite imaging, were proposed as crucial for understanding adversaries' intentions and protecting national security. The importance of balancing automation and human intelligence, timely dissemination of information, responsible decision-making, collaboration, and investment in advanced technologies, were also highlighted. With these considerations, India can strengthen its national security and establish itself as a leading player in the space industry.

### A Dialogue on Resilient PNT

- **Dr PSR Srinivasa Sastry, Director DSP, DRDO**
- **Shri Manish A Saxena, Director SATNAV-PO, ISRO Headquarters**
- **Dr Roshan Srivastav Project Director Technology Innovation Hub, Positioning and Precision Technologies, IIT Tirupati**

A dialogue, Chaired by Dr PVR Sastry, Director DSP, DRDO, took place with Shri Manish A Saxena, Director SATNAV-PO, ISRO Headquarters, and Dr Roshan Srivastav, Project Director, Technology Innovation Hub, Positioning and Precision Technologies, IIT Tirupati, focusing on the importance of resilient Positioning, Navigation, and Timing (PNT) systems in today's technology-driven world. The discussion shed light on India's NavIC system and the challenges it faces in the market, as well as potential solutions for enhancing resilience.







The NavIC Constellation is composed of seven satellites positioned in geosynchronous orbit. However, it is worth noting that a few of these satellites are non-functioning or approaching the end of their operational life. Presently, the status indicates that four out of the seven satellites are operational, providing navigation services over the Indian region. The initial design of the system ensured a two-Sigma accuracy of 20 meters over India and a span of 1500 kilometres.

Due to the presence of four functional satellites, the targeted 20-meter accuracy is still achievable within India. However, in areas at the periphery of the coverage, where some satellites may not be visible, the accuracy may degrade. Nevertheless, for most purposes within the mainland, the accuracy and availability of our satellites align with the original conception of the system.

The NavIC system in India, comparable to popular GNSS systems like GPS and Galileo, is facing hurdles in gaining market share due to existing vendors' reluctance to switch from their current GPS systems. The adoption of other alternative systems also faced challenges in entering the mass-scale market. The competitive nature of the market and the potential implications on devices made manufacturers hesitant to embrace these new systems. NavIC emerged during this time frame and faced similar struggles in establishing its presence. However, with most 4G and 5G phones equipped to support NavIC, there is an opportunity for increased adoption.

Resilience in positioning and precision technologies involves three perspectives: service provision, space segment and ground segment, and user receivers.

To enhance service provision resilience, multiple signals from GNSS systems like GPS, Galileo, and NAVIC are incorporated, ensuring uninterrupted navigation and timing services. Expanding signal capabilities in the space and ground segments, such as incorporating the L5 band in GPS and the L1 band in NAVIC, improves system robustness against interference or jamming attempts.

At the user-receiver level, techniques like integrating alternative navigation and timing methods, establishing reference networks, and employing detection mechanisms enhance resilience. Implementing resilience-related features at the device level, including RF, digital, and processing aspects, enables accurate positioning even in challenging environments. The industry and innovation hubs are instrumental in developing and implementing these resilience capabilities.

The Indian government's National Mission on Interdisciplinary Cyber-Physical Systems aims to drive technological innovation with a budget of approximately 3600 crores. As part of this mission, 25 Technology Innovation Hubs have been established in collaboration with esteemed institutes such as IITs, NITs, and BITS Pilani. The Technology Innovation hub at IIT Tirupati focuses on positioning and precision technologies, including the development of atomic clocks for NavIC products.



The objective of this hub is multi-faceted. The TIH at IIT Tirupati prioritises technology development and translational research in positioning and precision technologies, with a special emphasis on Positioning, Navigation, and Timing (PNT). Significant funding of 100 crores has been allocated to support researchers and foster collaboration between individuals and industries.

Another crucial objective is the development of skilled manpower in this field. Fellowship programs for undergraduate, postgraduate, PhD students, and faculty members are available to ensure the availability of resources and funding for students and researchers from various institutes.

The hubs also aim to create a thriving startup ecosystem by providing funding opportunities and support for startups specialising in positioning and precision technologies, particularly in the PNT domain. International collaborations are actively sought to facilitate knowledge exchange and bring in intellectual property from abroad. Efforts are being made to reduce dependency on imported hardware, and projects and collaborations are initiated to improve accuracy through advanced algorithms and methodologies.

To achieve a more resilient PNT system, an integrated approach involving industry, academia, and R&D is being explored. This approach aims to bring together all stakeholders to identify requirements, discuss potential solutions, and translate these requirements into reality. By collaborating and leveraging available resources, India can strengthen the resilience of its PNT system, making it more competitive and reliable in the global market.

In conclusion, the dialogue underscored the challenges faced by the NavIC system in gaining market share and the importance of providing multiple signal options for enhanced resilience. Collaborative efforts between organisations, universities, and industries, supported by government funding, are essential for improving precision positioning models and advancing research capabilities. By integrating industry, academia, and R&D, India can fortify its PNT system, ensuring competitiveness and reliability in the rapidly evolving technological landscape.





## Space Security – Philosophy, Doctrines, and Strategies; connecting requirements and industrial capabilities.

- Lt Gen Vinod G. Khandare, PVSM, AVSM, SM (Retd.), Principal Adviser in the Ministry of Defence
- Lt Gen. Sunil Srivastava, AVSM, VSM\*\* (Retd), Director, CENJOWS
- Air Cmde Savinder Pal Singh, Senior Fellow, CAPS
- Gp Capt. Puneet Bhalla, (Retd), Sr Research Fellow, CENJOWS



**The recently released space policy marks a significant milestone for the Indian space industry, providing a strong impetus for its growth and development. The transformation of the Indian Air Force into an Indian airspace force, utilising space for ISR, navigation, targeting, SSA, and meteorological operations, is of utmost importance. We must prioritise the development of offensive and defensive technologies integrated with space capabilities to bolster our readiness. It is essential to maintain a high state of preparedness and proactively address challenges to effectively counter China and mitigate battlespace vulnerabilities.”**

—Lt Gen Vinod G. Khandare, PVSM, AVSM, SM (Retd.),  
Principal Adviser in the Ministry of Defence

Chaired by Lt Gen Vinod G. Khandare, the session on “Space Security – Philosophy, Doctrines, and Strategies; connecting requirements and industrial capabilities” laid out that the increasing reliance on interconnectedness and technology has elevated space as a crucial domain for nations to secure and utilise space for their national security. For India, a relatively new player in the defence space, it is essential to make optimum use of its space assets and resources. The key question is balancing between securitising space and using space for security. To answer this question, it is important to assess the capabilities and capacities of space assets and determine what needs to be secured and how to enhance our capabilities in this regard.



The discussion held under the Chatham House rules analysed the following:

**The Need for a Joint Defence Space Doctrine:** A defence space doctrine is essential for India to navigate the complexities of space as a domain for national security. It provides guidelines for protecting space assets, enhancing situational awareness, addressing emerging challenges, and ensuring effective utilisation of space capabilities for defence purposes. By having a well-defined doctrine, India strengthens its defence posture and supports its broader security interests in the evolving space environment.

**Strategic Space Imperatives for India's Defence:** Effective space capabilities are crucial for control and protection across all domains. Having sufficient space-based assets is essential for redundancy and preparedness against potential threats. India's strategic focus has expanded to include the Indo-Pacific region, where maintaining control and access to information is vital. Given its strategic importance, India needs to incorporate the space domain into its strategies for effective communication, security, and force development for national security including the Indian Ocean Region.

**Securing Space Capabilities:** Ensuring the security of space assets is crucial as they play a vital role in a nation's interests and overall progress. Communication satellites, reconnaissance spacecraft, and scientific probes are examples of such assets. Robust security measures are essential to safeguard and ensure uninterrupted access to these capabilities. This includes physical protection, regular maintenance, and continuous performance monitoring. Any disruption or deterioration of space assets can have severe implications for national security and development.





**A Process-Oriented Mindset:** To ensure robust and usable space assets during both peace and war, a process-oriented mindset should be adopted. A process-oriented mindset enables comprehensive assessments of space asset capabilities and vulnerabilities, identifying areas for improvement. It also facilitates the identification and implementation of necessary security measures to safeguard against potential threats and disruptions. By continuously updating practices and incorporating emerging technologies, a process-oriented mindset allows for the adaptation and enhancement of space asset capabilities in response to evolving challenges.

**Engaging the Industrial Capabilities:** To enhance collaboration with the commercial space industry, both domestically and internationally, the focus should be on leveraging technological advancements and entrepreneurial innovation to develop new capabilities at reduced costs. This can be achieved by fostering a culture of innovation in space-related acquisition, utilising best commercial practices to enhance efficiency and teamwork. Additionally, promoting India's leadership in domestic space-related industries and cultivating a robust supplier base that secures business interests and aligns with national interests will always ensure the availability of critical capabilities to support defence functions effectively.

**Civil-Military Integration:** Civil-military integration furthers the collaboration and coordination between civilian and military entities, enabling the effective utilisation of resources and capabilities to address complex challenges. This integration enables sharing of expertise, technologies, and data, leading to enhanced situational awareness, operational capabilities, and overall security in the space domain. By leveraging the strengths of both sectors, civil-military integration optimises defence space operations and strengthens a nation's defence posture.

**Partnerships and Cooperation for Defence Space:** By joining forces with other nations, India can leverage expertise, resources, and technological advancements to enhance its defence space capabilities. Collaborative efforts facilitate knowledge sharing, joint R&D, and the exchange of best practices, ultimately leading to more robust and effective defence space systems. These partnerships also promote interoperability, enabling seamless coordination and cooperation in critical space operations. In an increasingly interconnected and interdependent world, international collaborations in the defence space strengthen global security and contribute to the collective defence of nations.

In summary, space has become a critical domain for national security and overall development. A cooperation framework between the government, military, and private industry, is essential for leveraging space assets effectively. A joint doctrine is necessary to facilitate integration, prevent redundancies, and ensure smoother warfighting capabilities. By addressing the challenges posed by the space domain and optimising resources, India can achieve effective space capabilities and secure its assets for national security and advancement.



# Day 3 of the DefSAT 2023 Conference

## Summary of the Proceedings

The proceedings of Day 3 at DefSAT began with an opening plenary featuring Dr Subbarao Pavuluri, Dr Ranjana N and Dr Anupam Sharma who discussed the business opportunities in the military's demand for space assets, the importance of space in the military domain, and the need for evaluation and collaboration in the defence space sector. The discussions highlighted the growing demand for civilian and military space assets and stressed the significance of collaboration among stakeholders.

Panel discussions covered topics such as secure satellite communication (Satcom) and its integration with IoT systems, uninterrupted access to space, civil-military fusion to address supply chain challenges, and the integration of drones, HAPS, and satellites to counter hypersonic threats. These discussions delved into various aspects including technology advancements, cybersecurity, surveillance, policy frameworks, R&D, and the importance of international cooperation.

The closing plenary brought together distinguished guests and key figures, expressing gratitude to organisers and knowledge partners. The emphasis was on collaboration between industry, the scientific community, defence forces, academia, and regulators to achieve a technological advantage in space warfare. The importance of a strong educational system, addressing challenges, and preparing for the future battlespace through collaboration and dialogue were highlighted. The conference concluded that defining industry needs and fostering synergistic collaboration is essential for success.





## Opening Plenary

- **Dr Subbarao Pavuluri CMD Ananth Technologies and President SIA-India**
- **Dr Ranjana, Director DSTA, DRDO**
- **Dr Anupam Sharma, Associate Director DSP, DRDO**

During the opening plenary, Dr Subbarao highlighted the significant business opportunities offered by the military's demand for space assets to the private sector. While civilian applications such as communication and navigation are in high demand, the military's requirements are far more substantial. Dr Anupam Sharma emphasised the importance of space in the military domain, noting its diverse and contested nature. They discussed the transformation of the space industry, where civil and military needs have become intertwined, leading to the development of dual-use technologies. Dr Ranjana N underscored the need for careful evaluation, adaptation, and collaboration in the defence space sector, emphasising system-level thinking and the critical role of collaboration between industry, academia, and government institutions.

Dr Subbarao highlighted the significant business opportunities that the military's demand for space assets offers to the private sector. While there is a growing demand for civilian applications such as communication and navigation, the military's requirements are far more substantial. These include tracking earth-based assets, including missiles and submarines, monitoring hypersonic and cruise missiles, and enabling precise manoeuvrability in space. Furthermore, the military's space assets and space situational awareness (SSA) necessitate the integration of meteorological systems for weather tracking and analysis.





Dr Anupam Sharma explained the importance of space in the military domain, highlighting its diverse, deceptive, disorderly, congested, and contested nature. Currently, 29 nations have space programs focused on building military satellites to safeguard their national security interests. He focused on the transformation of the space industry, where civil and military needs have become intertwined, leading to the development of dual-use technologies. He mentioned the significant contribution of private players in meeting military ISR requirements, showcasing advanced systems developed by these entities.

The challenges in space were explained, including the lack of unified adherence to treaties and agreements, resulting in coordination gaps and risks. Interference issues due to limited bandwidth and the threats posed by anti-satellite mines, orbital warfare, lasers, high-power microwave systems, and emerging technologies like particle beams are emphasised. He also emphasised the need for proactive investment and collaboration to ensure readiness and mitigate these challenges.

The involvement of industry and the effective communication of defence requirements to the industry is deemed crucial in achieving the level of capability that comes with the need for a large number of constellations adhering to disaggregation principles, ensuring resilience and eliminating single points of failure. He urged the recognition of the evolving nature of this domain and active engagement with the industry to meet requirements. By fostering collaboration, encouraging innovation, and investing in critical technologies, they believe that capabilities can be strengthened, and national interests in space can be secured.

Dr Ranjana N emphasised the importance of system-level thinking with system analysis guidelines, evaluating alternatives, feasibility, integration, and commercial viability of the available options in the defence space sector. She illustrated this with the example of the evolution of programming, from C programming and the waterfall model to agile methodologies, however, implementing agile in the military presented challenges in balancing agility with reliability and safety, especially in critical technologies like electronic warfare and satellite components.

Technology trends focus on enhancing optical resolution and surveillance capabilities that not only need integration with the overall system architecture, but caution is also necessary to avoid misleading technology claims. Following system analysis guidelines, considering integration methods, and efficient project management are critical.

Additionally, protecting assets in space and ensuring cybersecurity, including quantum key distribution, requires strategic planning. Collaboration between industry, academia, and government institutions is crucial, as demonstrated by initiatives like the Technology Development Fund (TDF) and Centres of Excellence established by DRDO in India. Maximising return on investment relies on technology placement, application, utility, and timing. Safety, security, and collaboration among industry,





academia, and government institutions play pivotal roles in shaping the future of space technology. Dr Ranjana N underscored the need for careful evaluation, adaptation, and collaboration in the defence space sector.

In conclusion, the opening plenary shed light on the growing demand for both civilian and military space assets, highlighting the pivotal role of military space in gaining a strategic advantage. The discussion covered the ongoing research and development of new space-based weapons and the complexities involved in software development for space assets. It was evident that the success of future space programs relies on effective collaboration among government agencies, private sector entities, and academic institutions. Adherence to industry standards and the development of robust compliance strategies were deemed vital for ensuring the success and security of future space endeavours.



**The survival and success of the space industry hinge on investing in and supporting the development of new technologies and capabilities that align with market demands. The downstream sector, particularly in the app arena, holds significant financial potential by creating applications and software for defence and space-related activities. Specific defence or space projects typically necessitate a minimum distance of 3000 km and at least 11 satellites, with additional satellites required based on the project's lifecycle. Furthermore, the grave vulnerability of GPS to cyber-attacks underscores the imperative nature of fortifying cybersecurity measures to safeguard against potential threats.”**

—Dr Shailesh Nayak, Director NIAS and Former Secretary MoES



## Secure Satcom and Integration with IoBT/IoMT Systems

- **Maj Gen Sanjiv Sharma, SM, ADG Tac C, DG Signals**
- **Dr Ranjana N, Director DSTA, DRDO**
- **Mr Sanjeev K Gupta, Associate Director, Satcom Applications, SATCOM-PO, ISRO Headquarters**
- **Mr Vinod Kaul, RVP South and South-East Asia, Gilat Satellite Networks**
- **Mr Sai Krishna, CEO, Pinaca Labs**
- **Mr Dilip Singh, CTO, QuNu Labs**

The panel discussion on “Secure Satcom and Integration with IoBT/IoMT Systems” was chaired by Maj Gen Sanjiv Sharma and brought together industry experts, military officials, and policymakers to discuss the critical aspects of secure satellite communication (Satcom) and its integration with the Internet of Battlefield Things (IoBT) and Internet of Military Things (IoMT) systems. The primary goal was to explore the challenges and opportunities in ensuring secure, reliable, and efficient communication in military operations while addressing the cybersecurity concerns associated with interconnected devices.

### Key Discussion Points:

**Importance of Reliable Satcom Solutions:** The need for robust, resilient, and scalable Satcom infrastructure was underscored to meet the evolving demands of defence, commercial enterprise, and telecom sectors. Besides the space assets, industry experts highlighted the role of advanced ground equipment technology, including baseband modems, antennas, and terminals, in ensuring seamless connectivity between military assets and command centres.

**Evolution of Satellite Technology:** The discussion acknowledged the rapid evolution of satellite technology and its impact on military communications. The emergence of software-defined satellites, reduced delivery times, and the utilisation of various orbits (e.g., Geo, MEO, and LEO) were identified as key advancements. Experts highlighted the ongoing shift towards terabyte capacity in the Geo constellation, while the deployment of Low Earth Orbit (LEO) satellites offered promising investment opportunities.

**IoT in Military Applications:** The integration of the Internet of Things (IoT) and IoMT devices in military environments was a focal point of the discussion. The panel explored the deployment of sensor networks on the battlefield and how Satcom plays a pivotal role in connecting these sensors. The two methodologies discussed were satellite-as-a-gateway and direct-to-satellite communication, enabling efficient data collection, real-time communication, and improved situational awareness for military forces.



**Ensuring Secure and Scalable Satcom:** Panellists emphasised the importance of secure and scalable Satcom networks to support loBT and loMT devices in military operations. The discussion centred around the benefits of Satcom in providing connectivity anytime and anywhere, facilitating cohesive networks, situational awareness, risk assessment, and faster response times for military forces. The panel also addressed the need for redundancy and resilience in Satcom systems to mitigate potential disruptions and cyber threats.

**Cybersecurity Challenges and Solutions:** The vulnerability of satellite networks to cyber-attacks was a significant concern addressed by the panel. The discussion focused on the importance of robust cybersecurity measures to protect Satcom networks and sensitive military communications. Encryption, zero-trust security models, anomaly detection, vulnerability assessments, and penetration tests were identified as essential components of a comprehensive cybersecurity framework for Satcom. The panellists stressed the need for constant monitoring, threat intelligence sharing, and collaboration between industry, government, and military sectors to enhance collective defence against cyber threats.

**Quantum Communication and Encryption:** Panellists recognised the potential of quantum technologies in revolutionising secure communication. The application of Quantum Key Distribution (QKD) was highlighted as a promising method for secure key exchange, leveraging the principles of quantum mechanics to enable unbreakable encryption. The panellists discussed the challenges and opportunities associated with implementing QKD in Satcom systems and the need for further research and development to enhance its practicality in military operations.

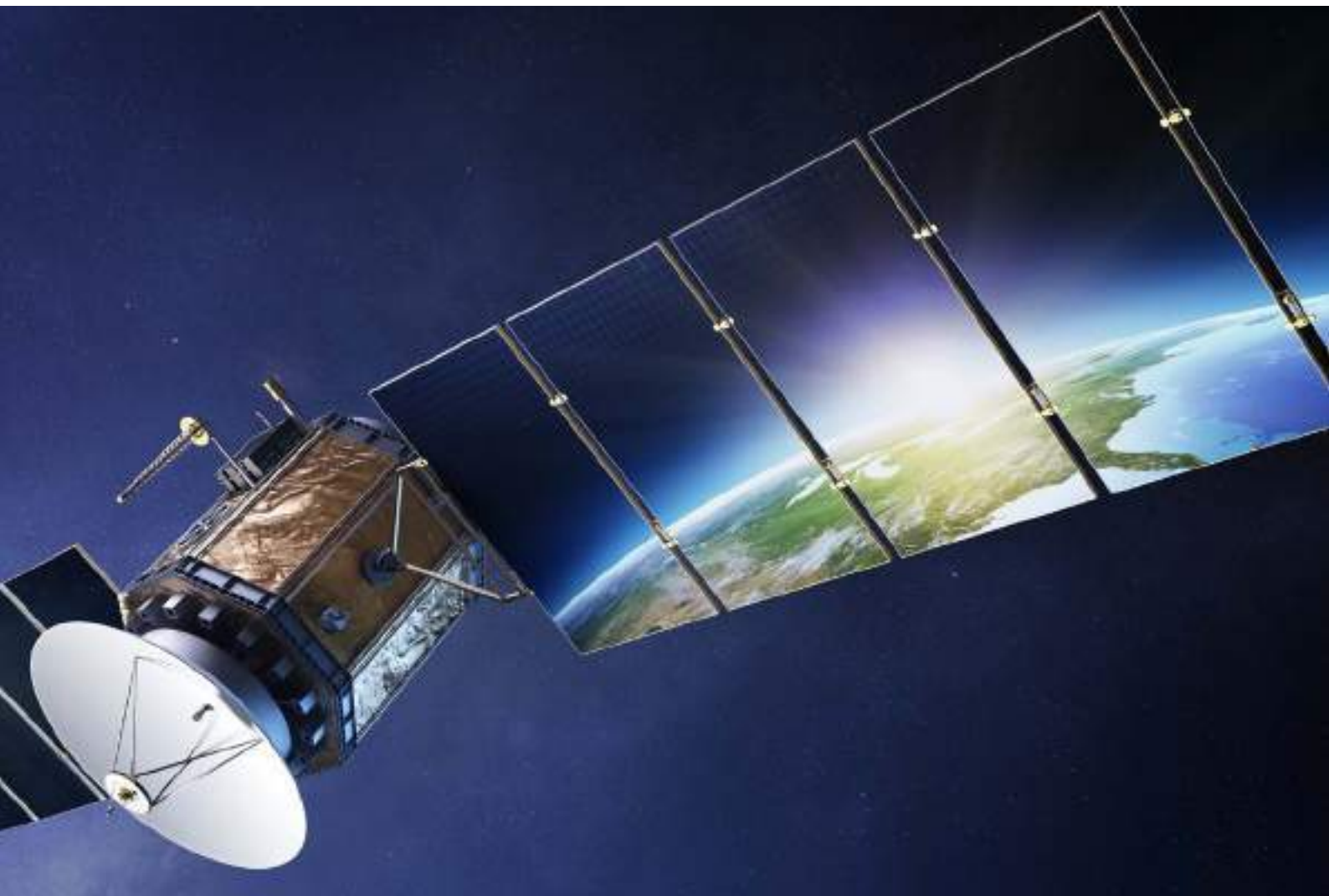
**Standardisation and Integration:** The discussion highlighted the significance of standardisation in communication protocols, data standards, and connectivity between various elements of loBT and loMT. Standardisation was identified as a critical factor in ensuring seamless integration of Satcom with existing weapons and defence systems, providing better control and enhancing situational awareness. The panellists emphasised the need for industry collaboration and the establishment of common standards to facilitate interoperability and avoid vendor lock-in.

**AI and Analytics:** The discussion explored the potential of AI and analytics in enhancing military communications. While AI analytics offered significant opportunities, concerns regarding rogue behaviour and the accuracy of answers generated by AI systems were raised. Experts stressed the need for developing AI standards, optimising data storage for monitoring systems, and utilising AI-driven software-defined radios to ensure the effective utilisation of loBT and loMT solutions.



**Collaborative Approach:** The panel concluded with a call for collaboration between industry, government, and military sectors to address cybersecurity challenges and establish a robust legal framework for critical information infrastructure. The importance of monitoring networks and establishing a cybersecurity data exchange centre for the anonymous sharing of attack information was highlighted as an effective way to enhance collective defence and response capabilities.

The panel discussion on “Secure Satcom and Integration with IoBT/IoMT Systems” provided valuable insights into the challenges and opportunities associated with ensuring secure military communication in an interconnected world. The discussion encompassed the importance of reliable Satcom solutions, integration of IoT in military applications, cybersecurity measures, standardisation, and the role of quantum communication and encryption. The recommendations and insights shared during the panel will guide policymakers, industry leaders, and defence strategists in developing comprehensive strategies and frameworks to enhance national security and mission success.







## Enabling Uninterrupted Access to Space – Impact Prevention, Mitigation, Preparedness, Response, and Recovery.

- **Dr Anupam Sharma, Associate Director, DSP, DRDO**
- **Shri Jidesh, Associate Director, SIPO, ISRO Headquarters**
- **Gp Capt TH Anand Rao, Senior Fellow, CAPS, Space Security and Policy Analysis**
- **Mr Sasmith Reddi, Director, Global Sales Engineering, STE iDirect**
- **Dr Dibyendu Nandi, Head, Centre of Excellence in Space Science, Indian Institute of Science Education and Research (IISER) Kolkata**
- **Capt (IN) Arun Mannath (Retd), Frost and Sullivan**
- **Dr Rachit Bhatia, Space Safety Analytics & Research Lead, Leolabs Inc.**

This session was chaired by Dr Anupam Sharma and moderated by Shri Jidesh. During the session, it was highlighted that maintaining uninterrupted access to space is crucial for national security. The threat surface includes adversary action, unintended accidents or planetary occurrences and requires building resilience by hardening, detecting potential threats and remedial measures. Some potent technologies in the toolkit help in preventing and mitigating impacts, preparing for contingencies, responding to emergencies, and recovering from disruptions towards a structured approach in addressing the threat of denial, degradation, disruption or destruction of space capabilities.

**Importance of Space Traffic and Debris Management:** The discussion emphasised the pressing importance of efficient space traffic management and effective management of space debris. With the rapid deployment of operational satellites in low Earth orbit, there is a critical need for timely policy and regulations. Responsible stakeholders have shown proactive efforts to protect their assets. However, the increasing accumulation of debris in certain areas raises concerns and calls for the implementation of active debris removal (ADR) measures to mitigate risks.

**U.S. Leadership in Space Surveillance:** The United States is recognised as the global leader in space surveillance, operating the Space Surveillance Network under the Space Command. Utilising various sensors, including the Space Fence system, the U.S. can detect objects ranging from one centimetre to 10 centimetres in size. Furthermore, the development of the Deep Space Advanced Radar System for geostationary objects is underway.



**Role of Commercial Entities:** Commercial entities have a substantial impact on space surveillance through the operation of a global network of ground and space-based sensors. These entities provide timely information on space objects, offering near real-time data and issuing conjunction alerts within 15 minutes of a pass. By utilising cloud platforms, they enhance intelligence and provide valuable insights into space activities with greater accuracy and more frequent updates compared to traditional systems such as NORAD and spacetrack.org.

**Uninterrupted Operations in Space:** While uninterrupted access to space is crucial, equal emphasis should be placed on uninterrupted operations in space. Continuous monitoring of space traffic, space weather, and mission operations is vital. Recent changes in mission life guidelines from 25 years to five years in low earth orbit reflect the commitment to ensuring uninterrupted operations.

**Space Traffic Management Challenges and Solutions:** With the projected significant rise in space traffic by 2030, the panel highlighted the importance of multilateral discussions on space traffic management. Factors such as multiple rocket launches, recoverable rockets, space planes, high-altitude balloons, and UAVs operating in suborbital and orbital regions contribute to the increasing complexity. Effective space traffic management requires regulations, standard operating procedures (SOPs), and active control mechanisms.

**Proposal for Regional Space Traffic Management Control Centre:** The panel proposed the establishment of a regional Space Traffic Management Control Centre in India, leveraging the country's geographical location. The Indian Air Force is viewed as having a significant role in this endeavour.

**Protection of Commercial Satellites and International Cooperation:** The protection of commercial satellites was highlighted as a priority, with a commitment to safeguarding these assets. Further development of rules and liabilities related to outer space activities is necessary, with the United Nations and the Office of Outer Space Affairs playing crucial roles. While there is no global mandate for space traffic management, individual countries ensure safety and clearance during satellite launches. The Indian Space Research Organisation (ISRO) in India has policies and manoeuvring capabilities to address close approaches by other satellites and protect its satellites.

In conclusion, the panel discussion highlighted the importance of advanced surveillance systems, real-time data analysis, responsible space practices, and the need for effective space traffic and debris management. The rapid increase in space traffic calls for proactive measures and international cooperation to ensure the sustainability of space activities. It is essential to continue exploring innovative technologies and regulations to address the challenges of space traffic management and protect valuable assets in space.



## Civil-Military Fusion – Catalysing the Industrial Base and Overcoming Supply Chain Challenges

- **Shri Hari Babu Srivastava, Director General, Technology Management, DRDO**
- **Prof. Chaitanya Giri, Associate Professor, FLAME University and Consultant RIS**
- **Air Marshal (Dr) Rajeev Sachdeva AVSM (Retd.), Fmr. Deputy Chief of Integrated Defence Staff and also officiated as Additional Secretary (Air) at DMA, under CDS MoD**
- **Col. Kuber Kandalai, E&Y**
- **Capt Vishal Kanwar, PWC**
- **Col. Rajiv Chib (Retd), CEO, Insighteon Consulting**

Civil-military fusion has emerged as a critical approach to catalysing the industrial base and overcoming supply chain challenges in various sectors, including the space industry. The session chaired by Shri Hari Babu Srivastava and moderated by Prof. Chaitanya Giri, advocated creating a framework for closer collaboration and communication between the civilian and military sectors, that can help to identify and develop technologies and capabilities that meet the needs of both sectors. This can lead to more efficient and effective procurement processes and a stronger and more resilient industrial base that can better support national security objectives.

The areas of focus within the space industry ecosystem can be categorised into three distinct segments: space for Earth, space for space, and access to space. The speakers explained that there are similarities and significant synergies across these areas, which can benefit from civil-military fusion. Some of the key points that were discussed are:

**Need for an Integrated Capability Development Framework:** To address the existing challenges, there is a need for an Integrated Capability Development System rather than just a process change. A suggested approach involves documenting and analysing national threats, existing capabilities in the government and private sector, and future requirements to identify any gaps that may exist. The speakers urged that in the constantly evolving defence space realm, the military needs to adopt a forward-thinking approach by determining the necessary timeframes to develop capabilities based on future requirements.

**Concerns with Existing Procurement Norms:** The observations also shed light on challenges related to the L1 (lowest financial bid) procurement method and the issues related to mandating and assessing the indigenisation content across various procurement categories. The observations stressed the importance of considering these factors and avoiding similar challenges in the defence space sector.



**Engaging the Private Sector:** The panellists pointed out that globally recognised space agencies like NASA, ESA, and JAXA have played the role of enablers, facilitators, customers, and research partners for both the public and private sectors. They highlight the case of SpaceX, which received support from NASA and exemplifies how government and public sector agencies contribute to disruptive technology growth. Similarly, large enterprises are well poised to take up projects of large magnitudes and leverage those industrial capabilities across different sectors for scale and business continuity.

**The Role of MSMEs:** The speakers emphasised the need to create industry unicorns and champions from the MSMEs by accelerating procurements to achieve such growth in the defence space sector. Assurance of business opportunities and a clear technology roadmap are necessary to align their efforts and investments accordingly. The MSMEs are uniquely poised towards technology absorption and scaling for market access in other geographies besides domestic procurements. Engaging with the MSMEs directly, instead of as subcontractors to large enterprises will be imperative to achieve this goal. It was also observed that demand generation through market-driven technology roadmaps will align their efforts and investment and attract capital for achieving scale and maturity.

**Funding and Support for Startups:** The funding challenges faced by startups, particularly in the valley of death phase, were addressed. While some funding is available through initiatives like IDEX and Technology Development Fund (TDF), sustained support is necessary to bridge the gap between technology development and commercialisation. It was suggested to invest more in mentoring programs, pro bono and in an aggressive manner, to facilitate the profitability and success of startups within a short period and to help startups in ensuring their technologies are productised and converted into revenue. The need for creative funding approaches, including domestic capital and venture domestic capital, was considered. Mobilising stock exchanges, mutual funds, and support from local municipal corporations can contribute to supporting startups and university research.

**Equal Opportunities for the Private Sector:** The observations highlighted the challenges faced by the Indian private industry in participating on equal terms. While a significant portion of the defence budget was allocated to R&D, it was mostly benefiting DPSUs rather than the private sector. Additionally, certain products and technologies were exclusively reserved for the Defence Research and Development Organisation (DRDO) or DPSUs. It would be advisable to avoid the repetition of the same mistakes in the defence space sector.





**Joint Research & Development:** It was informed during the discussions that DRDO (Defence Research and Development Organisation) has already identified 108 items where they will not conduct R&D, instead supporting the industry to take the lead in those areas. Furthermore, they mention that another list is being developed where industry-led R&D will be encouraged and DRDO will provide the necessary mentoring, funding, and facilities to support the Indian industry's initiatives. The panel also mentioned successful models like UK's R&D collaboration platform involving the private sector, government, space agency, and academia.

**A Catalysing Policy Environment:** The speakers suggested various policy initiatives to encourage civil-military fusion and foster the growth of the industrial ecosystem in the defence space. They proposed implementing schemes like Production Linked Incentives (PLI) for the space sector, classifying space as an infrastructure sector, and providing tax benefits for R&D specifically in the space sector. These policy measures would create an enabling environment for growth and development.

**Leveraging Technology Breakthroughs at Academia:** It was emphasised that integrating academic institutions of excellence into the national strategy was crucial and required careful consideration. It was informed that DRDO has established Industry Academia Centres of Excellence in various Indian Institutes of Technology (IITs) and universities across the country, including centres focused on space technology.

**Intellectual Property (IP) Creation:** To excel in any domain, it is essential to create distinctive intellectual properties (IPs). The roles of academia, industry, and government in initiating and supporting IP creation were posited. The risk of valuable IP that is generated in the academic, research and industry settings, being acquired by players in other nations necessitates identifying responsibilities and addressing the problem.

**Cooperation and Collaboration:** Cooperation and collaboration were identified as essential factors in overcoming the mindset of working in isolation. The panel stressed the need for cooperation and collaboration among intelligent and excellent people from different fields to drive progress. Breaking down barriers and encouraging cooperation can bring forth new technologies and systems.

**Learning from Other Countries:** Examples from successful endeavours in other countries, both in the West and the East, were discussed. As an example, the Chinese universities' fusion centres of excellence identify technological requirements for their forces and invest accordingly and provide a strategic approach that can be considered for developing India's startup ecosystem. PRC has prioritised leveraging innovations from the civil sector for military use, involving national assets (public, private, and academic institutions) in their development and breakthroughs are immediately incorporated into military applications.



**Creating an Industrial Ecosystem:** The speakers suggest the establishment of two space clusters, strategically located within the defence industrial corridors in Tamil Nadu and Uttar Pradesh. These clusters would leverage synergies with the aerospace sector and create a comprehensive ecosystem for the space industry. The speaker proposes the establishment of a state spaceport and a small satellite launch vehicle spaceport within these clusters to cover the entire value chain of space activities.

**Cost-Effectiveness and Resource Allocation:** Considering limited resources, including funds, capabilities, and capacities, was deemed crucial for all initiatives. Given the high-tech nature of space-related activities, addressing questions related to resources and capabilities was identified as essential. Optimising resource allocation and ensuring cost-effectiveness were highlighted as important factors to be considered while pursuing strategic initiatives.

**Bridging the Talent Gap:** Talent development was identified as another crucial area. The speakers highlighted the current talent deficiency across the entire space ecosystem and reasoned that space, as a multidisciplinary field, requires expertise in various disciplines. They proposed the creation of a Space Sector Skill Council, similar to the other Sector Skill Councils, to address this talent gap.

**Secure Information Sharing Frameworks:** The panellists stressed the need for secure information sharing between the armed forces and industry. Establishing mechanisms, like the United States, where companies with industrial licenses can access confidential information, could facilitate such collaboration. Bringing academic institutions under the Indian Official Secrets Act would enable the armed forces to tap into scientific and academic expertise for a more comprehensive and secure approach that is aligned with the national security goals.

**Alignment with National Policies:** The importance of coordination between the Ministry of Defence, Ministry of External Affairs, and other relevant ministries was emphasised to ensure that procurement decisions remain in line with national policies. This coordination would prevent conflicts arising from changing positions and ensure clarity and consistency in decision-making.

Civil-military fusion presents a significant opportunity to catalyse the industrial base, enhance national security, and overcome supply chain challenges. By strategically integrating the civilian and military sectors, the government can leverage synergies, promote innovation, and create resilient supply chains. Policy interventions, public-private partnerships, and international cooperation are essential components in realising the potential of civil-military fusion. With careful planning and implementation, India can achieve self-reliance, enhance defence capabilities, and drive economic growth in a rapidly evolving global landscape.



## Closing Capability Gaps and Retaining the High Ground by Integrating Drones, HAPS, and Satellites

- **Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Aerospace and Defence Committee at SIA-India**
- **Lt Gen Dr VK Saxena, PVSM, AVSM, VSM (Retd), Fmr Director General of the Corps of Army Air Defence**
- **Air Marshal GS Bedi, AVSM, VM, VSM (Retd) Former DGIS**
- **Mr Tobby Simon, Founder & President, Synergia Foundation**
- **Mr Raj Sharma, President, National Association of Drone Developers & Space Organisation (NADDSO)**
- **Mr Naveen Navlani, Associate Director, Global Military Sales, ideaForge Technology Ltd**
- **Mr Jayant Sinha, Program Manager, Elcomponics Aerob Technologies India Pvt Ltd**

Chaired by Lt Gen PJS Pannu the panel discussion concluded that together, these technologies can provide a complete picture of the security landscape and help to identify and mitigate potential threats more quickly and effectively. However, in the hypersonic era that is evolving, integrating drones, HAPS, and satellites requires a coordinated and well-planned approach that considers each technology's unique capabilities and requirements.

### Keynote Address: “Emerging challenge of Hypersonic technology” by Lt Gen Dr VK Saxena, PVSM, AVSM, VSM (Retd), Fmr Director General of the Corps of Army Air Defence

Hypersonic weapons have gained prominence, rendering it imperative for industry players to recognise the relevance of this subject and address the Hypersonic challenge head-on. Hypersonic weapons refer to vehicles that travel at speeds greater than Mach 5, with even faster missiles currently being developed and deployed. These missiles, such as the Zircon and Avangard Hypersonic missiles, reach astonishing speeds of 8.6 Mach and 20 to 27 Mach, respectively, equating to velocities of 32,000 to 33,000 kilometres per hour, thus presenting a substantial threat.

**Advantages and Challenges of Hypersonic Weapons:** There are three combat virtues of Hypersonic weapons that make them particularly formidable.

Firstly, there's the speed. While the qualifying standard for hypersonic weapons may be Mach 5, there are missiles like the Zircon missile, the Kinzhal missile, and the Avangard Hypersonic missile of Russia that can reach speeds of 20 to 27 Mach. These vehicles are flying at speeds of 32,000 to 33,000 km per hour, and they are a real and live threat.



The second virtue is manoeuvrability. Hypersonic weapons, such as hypersonic cruise missiles and hypersonic glide vehicles, are fully powered and manoeuvrable. Their ability to cover vast areas and rapidly change targets necessitates a significant deployment of resources to counter them adequately.

The third virtue is altitude. The lower the altitude, the greater the difficulty for conventional radars to detect these vehicles. Additionally, the high speeds at which they travel generate extreme heat that breaks air molecules into ions, creating a plasma that effectively blocks radio waves, making detection, communication and interception extremely difficult.

**The Emerging Threat and Detection Capabilities:** The threat posed by hypersonic weapons is substantial, especially from countries such as China, which began its hypersonic development efforts in the 2013-2015 timeframe. By 2018, the observation of hypersonic vehicles, including cruise missiles and glide vehicles, became evident. Recent intelligence leaks confirm the successful testing of a DF-27 long-range ballistic missile with an average speed of Mach 8.6 and a range of 5,000 to 8,000 km.

To counter this growing threat, various nations are focusing on developing detection capabilities. For instance, the United States has deployed a constellation of satellites for missile warning. These satellites, combined with high-altitude platforms and distributed surveillance architecture, provide a global lookout capability within the likely threat domain.

**Neutralising Hypersonic Threats:** While detection is crucial, neutralising hypersonic threats poses a significant challenge. Traditional ballistic missile defence systems are inadequate to intercept targets travelling at such high speeds. Proposed solutions include directed energy weapons like lasers and high-power microwaves, which generate beams of sufficient strength to destroy hypersonic missiles. However, these weapons face challenges related to range, power requirements, and real-time targeting.

**Coordinated Approach and Future Strategies:** Effectively countering hypersonic threats requires the coordination of various systems, including detection satellites, distributed architectures, and effectors (weapon systems that can effectively neutralise hypersonic threats) and nations are investing heavily in these capabilities.

In conclusion, the development of near-space capabilities is crucial in countering hypersonic threats. By leveraging advanced surveillance and detection systems deployed in space, we can enhance our situational awareness and response capabilities. The space industry, governments, and defence organisations need to collaborate and invest in R&D to stay ahead of the hypersonic curve. Only through concerted efforts can we ensure the security of our nations and effectively neutralise the emerging hypersonic threat.





## The Panel Discussion

The panel discussion delved into the concept of near space, discussing its significance, the limitations faced by both aircraft and satellites in this realm, and the potential applications of near-space capabilities. The discussion highlighted the importance of near space in bridging the gap between traditional aircraft operations and satellite-based activities and explored the utilisation of unmanned systems, such as drones and high-altitude pseudo satellites (HAPS), to enhance surveillance, communication, and defence capabilities. Furthermore, the discussion analysed the need for collaboration, research, and development to counter emerging threats, particularly concerning hypersonic technologies.

The discussion began by introducing the topic of near space and its relevance in understanding the continuum of air and space. It outlined the questions to be addressed, including the definition of near space, its unique features compared to space and the air domain, and the potential capabilities and limitations of aircraft and satellites in this region.

**Understanding Near Space:** Near space is the space between approximately 20-100 km above the Earth's surface. Some key factors differentiate near space from the air and space domains, such as the balance between lift and centrifugal force for aircraft and satellites, respectively.

**Limitations of Aircraft in Near Space:** The discussion explored why aircraft cannot sustain themselves above a certain altitude in near space. It discussed the importance of lift and thrust in aircraft operations and how the decrease in air density and reduced thrust production at higher altitudes limit their ability to operate effectively. The concept of the absolute ceiling, where available thrust matches drag, was explained as a limiting factor for aircraft. Some alternative propulsion systems such as ramjets, scramjets, or rocket engines can enable aircraft to reach near space. For example, the MKII Aurora rocket-powered space plane has demonstrated its potential capabilities in near space.

**Limitations of Satellites in Near Space:** The discussion then delved into the challenges faced by satellites in near space, particularly in the altitude range of 70-80 km. Satellites rely on orbital speed to generate centrifugal force, and as altitude decreases, orbital speed needs to increase. However, other factors such as kinetic heating and sovereignty issues prevent satellites from operating effectively below 100 km.



**Utilising Balloons and Unmanned Systems:** To overcome the limitations faced by both aircraft and satellites in near space, the discussion proposed the use of balloons and unmanned systems. It highlighted the potential of balloons for surveillance, anti-access area denial, and missile detection purposes. The concept of launching expendable drones from balloons for immediate battlefield intelligence and their role in collaborative and unmanned teaming scenarios was considered.

**Commercial and Defence Applications:** The discussion further explored the commercial and defence applications of near-space capabilities. It discussed the potential of HAPS as a bridge between satellite communication and aircraft operations, highlighting its ability to provide internet connectivity, surveillance, and enhanced imaging capabilities. The discussion also considered the use of drones in various fields, including agriculture, defence, and maritime security, affirming their role in improving situational awareness and surveillance effectiveness.

**Coordinated Approach and Future Strategies:** The discussion stressed the need for a coordinated approach in developing near-space capabilities to counter emerging threats, particularly related to Hypersonic technologies. It highlighted the importance of collaboration between the space industry, governments, and defence organisations in R&D, and investment to stay ahead of the curve.

The panel concluded by summarising the key findings and highlighting the potential of near-space capabilities in enhancing surveillance, communication, and defence systems. It underscored the need for further R&D to optimise the utilisation of unmanned systems, such as drones and HAPS, and underscored the significance of collaboration to ensure security and technological advancements in the near space domain.





## Closing Plenary

Distinguished guests and key figures of DefSAT were invited to join the stage, including Dr Subbarao Pavuluri, the President of SIA India and CMD of Ananth Technologies, Lt Gen Vinod G Khandare, Principal Advisor in the Ministry of Defence, Lt Gen PJS Pannu, former Deputy Chief Operations of Integrated Defence Staff and Chair of the Defence Aerospace Committee at SIA India, Lt Gen Sunil Srivastava, Director of CENJOWS, AVM D V Khot, Director General of the Defence Space Agency, and Anil Prakash, Director General of SIA-India. Additionally, Ms Riddhi Malhotra, a young student who captivated everyone with her questions, was also invited as a guest on stage.

Expressions of gratitude were extended to Lt Gen Khandare, Lt Gen Srivastava, AVM D V Khot, and AVM Rajiva Ranjan for their unwavering support, encouragement, and guidance in organising DefSAT. The foundational role and support of knowledge partners such as CENJOWS, CAPS, CLAWS, and NMF were acknowledged for their significant contributions to the success of the event.

Special recognition was given to Lt Gen Pannu, who curated the event and played a crucial role in the immense success of IndSpace Exercise, India's first Industrial Space Wargame. Dr Subba Rao Pavuluri was also acknowledged for their invaluable support, without which the event may not have been possible. The team at SIA-India was complimented for their dedicated efforts in executing the three-day program of DefSAT, India's inaugural International Conference and Expo on Defence Space, to perfection.

India has grown in the space technology domain and contributed enormously to the space sector and the defence space cannot be left behind. The Indian industry must understand the defence concerns and empower the Indian Space Warfare capability.

To ensure our future battles have a cutting-edge technological advantage, a collaboration between the industry, the scientific community, defence forces, bureaucrats, technocrats, academia, and regulators is vital. Building a strong educational system that incorporates military education and promotes scientific and industrial knowledge is crucial. The establishment of an Indian Defence University and continuous dialogue among stakeholders are essential to shaping our future.

Space warfare presents unique challenges as it lacks immediate physical impact, making it challenging to determine the status of satellites. The growing number of satellites, launches, and privatisation of space technology necessitates training our soldiers to absorb the advancements effectively. Collaboration among universities, scientific institutions, and the military is necessary to prepare for the future battlespace.

The conference concluded that while implementation speed is crucial, clearly defining industry needs and priorities is equally important. The focus should be on synergistic collaboration rather than a relay race.

## Message from Anil Prakash, Director General, SIA-India



Space has emerged as the final frontier in modern warfare, playing a crucial role in the offence and defence strategies of nations. For India, space-based capabilities are instrumental in enhancing defence preparedness, providing strategic depth, and ensuring national security in both peaceful and conflict situations. Our Space, Aerospace, and Defence sectors must evolve to address the realities of the 21st century.

In the current geopolitical landscape, where technology plays a pivotal role in warfare, seamless and secure network communication is of paramount importance. To optimise national resources and avoid duplication in research and development efforts, India needs a cohesive fusion of civil, commercial, and defence space programs. Coordinated actions, guided by clear policies, a forward-looking roadmap, long-term planning, and an interdisciplinary approach involving all stakeholders are essential for efficient technological advancements that cater to diverse needs. This approach will not only drive economic growth and employment opportunities but also boost research and development activities.

We are grateful for the leadership and vision demonstrated by the Prime Minister, the Ministry of Defence, and ISRO, which have paved the way for the successful organisation of the first edition of DefSAT-23 [Conference and Expo]. We extend our heartfelt thanks to esteemed organisations such as NITI-Aayog, ISRO, NSIL, DRDO, and the Department of Defence Production, Ministry of Defence, for their invaluable support. We are also indebted to our knowledge partners, CENJOWS, CAPS, CLAWS, and NMF, whose contributions have been instrumental in making this event a resounding success.

We express our gratitude to our associations, industry partners, and media partners for their unwavering support. This comprehensive outcome report, containing key recommendations, will be shared with the relevant ministries and departments to facilitate informed decision-making and drive positive change.

As we look to the future, let us embrace the opportunities presented by the convergence of space, aerospace, and defence, and work together towards building a modern and future-ready sector that aligns with India's aspirations and safeguards its interests.





# Consolidated Recommendations

Srl	Description
1	<b>Space in the National Security Framework</b>
1a	As the fourth frontier, space needs to be an important component of our defence strategy and it is imperative to procure, establish, maintain and make available the assets, services, data and insights across space and ground. Enhance capabilities for monitoring and observing space activities, enabling secure communications, and leveraging artificial intelligence to analyse data and derive valuable insights.
1b	Establish India's Defence Space Policy, Strategy, and Doctrines to align and drive the overall efforts in this direction. A joint doctrine is necessary to facilitate integration, prevent redundancies, and ensure smoother warfighting capabilities. Create a comprehensive policy framework that focuses on enhancing indigenous capabilities, promoting collaboration among government, military, and private players, and addressing emerging challenges.
1c	Foster coordination and synergy between civil, commercial, and defence space programs to leverage the dual-use nature of the sector and optimise the use of national resources. Focus on key areas that align with national security and economic interests, ensuring the efficient allocation of resources.
1d	There is a need for an Integrated Capability Development System that involves documenting and analysing national threats, existing capabilities in the government and private sector, and future requirements to identify any gaps that may exist.
1e	Promote a process-oriented mindset for comprehensive assessments of space asset capabilities and vulnerabilities, identifying areas for improvement. By continuously updating practices and incorporating emerging technologies, a process-oriented mindset allows for the adaptation and enhancement of space asset capabilities in response to evolving challenges.



2	Accelerating Industrialisation of Defence Space Capabilities
2a	Develop a multi-year roadmap of requirements and prioritisation based on need, availability, and the dots in between. This roadmap will also drive the efforts towards technological advancements and implementation. This will help solution providers in their innovation, capacity expansion, and investment decisions to align with the timelines of requirements.
2b	Enable the Space sector for discharge of offset obligations for fostering the indigenous industrial capability to achieve business continuity, scale, and maturity by plugging into global supply chains.
2c	Establish a mechanism for monitoring the national industrial capability readiness for the current and upcoming requirements with timely interventions to ensure supply chain readiness from national and global suppliers.
2d	Expand the supplier base by supporting SMEs and startups through grants, tax incentives, and incubation programs. While some funding is available through initiatives like IDEX and Technology Development Fund (TDF), sustained support is necessary to bridge the gap between technology development and commercialisation. It was suggested to invest more in mentoring programs, pro bono and in an aggressive manner, to facilitate the profitability and success of startups.
2e	Some policy measures to create an enabling environment for industrial ecosystem growth and development like Production Linked Incentives (PLIs) for the space sector, classifying space as an infrastructure sector, and providing tax benefits for R&D specifically in the space sector need to be implemented.
2f	Encourage public-private partnerships to foster innovation, investment, and job creation in the space sector.
2g	Foster collaboration and technology transfer among domestic and international stakeholders, driving expertise sharing and technological advancements in the defence space industry.
2h	Implement measures that promote equal opportunities and fair competition for the private sector in the defence space sector by not placing them at a disadvantage against government institutions or DPSUs.
2i	Establish two space clusters, strategically located within the defence industrial corridors in Tamil Nadu and Uttar Pradesh. These clusters would leverage synergies with the aerospace sector and create a comprehensive ecosystem for the space industry. A state spaceport and a small satellite launch vehicle spaceport within these clusters can be established to cover the entire value chain of space activities.



3	Defence Space Acquisition and Fulfilment
3a	Develop and update the acquisition policies regularly to ensure effective acquisition practices in the defence space industry. This should be done with input from stakeholders, considering industry insights and future requirements.
3b	The ever-changing landscape of technology demands a procurement methodology that can keep pace with its rapid evolution. The current norms and procedures outlined in the Defence Acquisition Procedures (DAP) fall short in terms of agility. To address this, it is necessary to establish and incorporate special provisions within the DAP that would cater to the rapid response requirements of the nation, facilitating swift decision-making and timely acquisitions.
3c	Embrace innovative procurement models by utilising Capex, Opex, and Mixed-mode models for acquiring commercial space services, addressing supply chain visibility and security.
3d	Standardisation was identified as a critical factor in ensuring seamless integration of Satcom with existing weapons and defence systems, providing better control and enhancing situational awareness. Develop national MIL standards for procurement, standardisation, and certifications aligned with international norms, ensuring efficiency and interoperability and avoiding vendor lock-in.
3e	A judicious mix of large integrator contracts and direct orders to MSMEs to develop relationships across the sector for the dual objective of building large integration capabilities and growth of the MSME segment ensuring supply chain redundancies.
3f	The requirement roadmap from point 2b and the monitoring mechanism of 2d above will also drive the balance between domestic and global procurements with the policy objectives of Atmanirbharta and Make in India.
3g	Set measurable targets for domestic procurements and indigenisation metrics and gradually increase the requirement for indigenous production, reducing dependence on foreign supplies for promoting self-sufficiency. Standardise effective methods for calculating indigenous content in technology to achieve self-reliance and reduce dependency on imports.



4	Technology Development Roadmap
4a	The roadmap outlined in point 2b above will also help in driving a roadmap for technological advancements and implementation.
4b	Encourage collaboration and information sharing among stakeholders to leverage expertise and technological advancements across sectors. Encourage closer cooperation between the military and civilian entities to leverage expertise, resources, and technology for mutual benefit.
4c	Facilitate participation and collaboration among the defence practitioners and defence think tanks to collectively contribute to the thought process and industry roadmap.
4d	Facilitate absorption of technology advancements in related sectors of communications, positioning, remote sensing and cybersecurity for leveraging diverse capabilities.
4e	Encourage collaboration between industry and academia to bridge the gap between theoretical knowledge and practical applications, driving innovation and skill development. Facilitate partnerships, joint initiatives, and knowledge-sharing programs to leverage the expertise of both sectors for mutual benefit.
4f	Promote the establishment of research centres dedicated to defence and space studies, fostering innovation, knowledge creation, and technological advancements.
4g	Emphasise system-level thinking with system analysis guidelines, evaluating alternatives, feasibility, integration, and commercial viability of the available options in the defence space sector.
4h	The risk of valuable IP that is generated in the academic, research and industry settings, being acquired by players in other nations needs to be mitigated by identifying responsibilities and addressing the problem.
4i	To fulfil the need for secure information sharing between the armed forces and industry, establishing mechanisms, like in the United States, where companies with industrial licenses can access confidential information, could facilitate such collaboration. Bringing academic institutions under the Indian Official Secrets Act would enable the armed forces to tap into scientific and academic expertise for a more comprehensive and secure approach that is aligned with the national security goals.
4j	Establish a coordinated approach in developing near-space capabilities to counter emerging threats, particularly related to Hypersonic technologies.





<b>5</b>	<b>Downstream application development</b>
5a	Promote and ensure accessibility and integration of satellite data insights into strategic and tactical decision-making.
5b	Encourage collaborations between satellite data providers, data scientists, and technology providers. Leverage their expertise and capabilities to develop robust applications and solutions that address real-world challenges and actionable insights.
5c	Implement mechanisms that facilitate easy access and sharing of satellite data among researchers and stakeholders. Promote open data policies and platforms that encourage collaboration and accelerate application development.
5d	Ensure that researchers and stakeholders have access to necessary resources, expertise, training data and advanced tools for analysing satellite data. Support them in extracting valuable insights and developing innovative applications.
5e	Maintain a balance between automation and human intelligence. Recognising biases and predispositions in training data is crucial to ensure accurate interpretations. This is important, considering the potential challenges associated with emerging technologies and the responsible use of automation in strategic decision-making.
<b>6</b>	<b>Enhance NAVIC capabilities</b>
6a	Enhance the NAVIC capabilities for global coverage, wider national acceptability and advancing to resilient PNT services for use in National Security.
6b	Leverage the capabilities of the Indian Regional Navigation Satellite System (IRNSS) to enhance joint operational capabilities. By integrating IRNSS with DSA operations, the military can benefit from improved navigation, communication, and situational awareness capabilities in the space domain.



7	<b>Safeguarding Space Capabilities and Cybersecurity</b>
7a	Robust security measures are essential to safeguard and ensure uninterrupted access to these capabilities. This includes physical protection, regular maintenance, and continuous performance monitoring. Any disruption or deterioration of space assets can have severe implications for national security and development.
7b	Develop comprehensive frameworks that encompass threat intelligence, continuous monitoring, and robust encryption for space systems. These frameworks should provide guidelines and standards for secure space operations.
7c	Create a dedicated task force comprising experts from government agencies, cybersecurity firms, and space industry stakeholders. The task force should assess vulnerabilities in space systems and recommend measures to enhance their security.
7d	Invest in technologies powered by AI and machine learning to detect and respond to sophisticated cyber threats. These systems can continuously monitor space systems, identify anomalies, and initiate timely responses to mitigate potential risks.
7e	Develop robust and secure communication systems for defence and space operations to ensure reliable and protected data transmission. Employ secure waveforms, strong encryption algorithms, and redundancies for protected data transmission in space systems. This will safeguard critical information from unauthorised access and ensure data integrity during transmission.
7f	Establishment of a Regional Space Traffic Management Control Centre in India, leveraging the country's geographical location.
8	<b>Capacity Building and Skill Development</b>
8a	Invest in building the capabilities and skills of the workforce in the defence and space sectors, fostering a strong talent pool to support future advancements. Allocate resources to skill development programs and initiatives to enhance the capabilities of professionals amongst the defence practitioners and the space industry. Offer specialised training, workshops, and courses to build technical expertise in relevant areas.
8b	Form strong partnerships with educational institutions, such as engineering and science colleges, to promote space-related education and research. Nurturing present and future talent through multidisciplinary space studies programs is crucial for the growth of the defence and space sectors.



9	International Collaboration & Outreach
9a	Officials at India's diplomatic missions abroad require the skills and knowledge to navigate the evolving technological landscape and advocate for India's space industry. They play a crucial role in representing India's interests and promoting collaborations internationally. By staying informed about emerging technologies, policies, and industry dynamics, they can effectively engage with other nations, foster understanding, and advance India's strategic objectives in space.
9b	Bolster global collaborative efforts such as joint R&D, shared asset utilisation, and trade. These measures were identified as crucial for fostering mutual trust, promoting transparency which enables streamlining operations, boosting competitiveness, and positioning India as an attractive global space hub.
9c	Collaborate with international partners and organisations in sharing information and establishing common guidelines for secure space operations. This collaborative approach can help address emerging threats and promote the exchange of best practices.
9d	Promote dialogue and diplomatic negotiations to address emerging challenges and enhance existing space governance frameworks. Collaborate with like-minded nations to collectively address the challenge of space weaponisation and update existing treaties and regulations.
9e	Engage in collaboration and diplomacy to maintain space safety, foster trust, and develop strategic relationships with other countries and space agencies. Participate in international forums, engage in dialogue, and equip diplomatic attaches with the necessary skills and knowledge for active participation in space diplomacy efforts.
9f	As a robust democracy and a leading nation, we need to have reach and access to geographies and information not just within national boundaries but at an international scale. It is imperative for establishing ground facilities overseas for our positioning and communications reach across wider geographies.
9g	Leverage international relations to expand access to markets, providing the indigenous industry with economies of scale and maturity for driving self-reliance. Facilitating export in space sector growth is not just trade diplomacy but an integral part of the defence strategy.
9h	Establish mechanisms for sharing space situational awareness (SSA) data and Earth observation data to support global initiatives on climate & Weather monitoring, disaster management, improve space traffic management and reduce risks associated with space debris.



# Conference Agenda

Start	End	Duration	Description
<b>Day One - Thursday 27-Apr 2023 (By Special Invitation only)</b>			
09:30	12:30	03:00	<p><b>SI01: IndSpace Exercise: Industrial Space Wargame (Entry by invitation only, NO walk-ins)</b> - A simulated, scenario-based, interactive tabletop exercise that tests the capability of the space industry to respond to contingency or crisis situations. Factors such as resources, logistics, sequence of action, and how long each phase of the plan will take can be tested. The defence practitioners and industry stakeholders put their heads together to assess the requisite industrialised solution, disruptive innovations and technology discovery in space and counter-space capabilities that are needed by India to protect its national security interests in simulated scenarios. This is the first in a series of many such exercises to be unfolded periodically.</p> <p><b>Chair:</b> Lt General Vinod G. Khandare, PVSM, AVSM, SM (Retd), Principal Adviser in the Ministry of Defence</p> <p><b>Convenor:</b> Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Aerospace and Defence Committee at SIA-India</p>
12:30	13:00	0:30	Exhibition & Registration Open (RXL)
13:00	14:00	1:00	Networking Lunch
14.00	14.30	0.30	<p><b>SI02: Opening Plenary</b></p> <p>Welcome Address: Dr Subba Rao Pavuluri, President, SIA-India</p> <p>Special Address: Dr P. K. Jain, Director PMAD, IN-SPAcE</p> <p>Special Address: Dr Shailesh Nayak, Director NIAS and Former Secretary MoES</p>



Start	End	Duration	Description
14:30	16:00	1:30	<p><b>SI03: Space Diplomacy &amp; International Collaboration in Defence Space (Entry by invitation only, NO walk-ins)</b></p> <p>The role of space in future global conflicts is expected to grow as countries increasingly rely on space-based assets. Space diplomacy is becoming increasingly important as countries seek to establish norms and regulations governing the use of space-based assets for military purposes. Collaborative efforts such as trade, joint R&amp;D and shared use of space-based assets can help establish mutual trust, promote transparency, and reduce the risk of misunderstandings.</p> <p><b>Chair and Moderator:</b> Dr Bhaskar Balakrishnan, Fmr. Ambassador &amp; Fellow for Science Diplomacy, Research and Information System (RIS)</p> <p><b>Speakers:</b></p> <p>Dr P. K. Jain, Director PMAD, IN-SPACE</p> <p>Dr Chaitanya Giri, Associate Professor, Flame University</p> <p>Cdr Subhash Ahlawat IN (Retd), Director Sales, Centum Electronics</p> <p>Mr Sameer Guduru, Director, Digital Economy, Aerospace &amp; Defence, USIBC</p> <p>Air Cmde Terry Van Haren DSM, Retd., Managing Director, LeoLabs Australia</p>
16:00	16:30	00:30	Networking Tea - End of Day One of Conference & Exhibition
16:30	18:00	1:30	<p><b>SI04: Power session: Forging Global Cooperation in Trade, Strategy, and Space Diplomacy. (Entry by invitation only, NO walk-ins)</b></p> <p>A discussion with Industry representatives to explore opportunities for the Indian Space Economy growth.</p> <p><b>Chair &amp; Moderator:</b> Amb. Rakesh Sood, Foreign Affairs, Economic Diplomacy and International Security</p> <p><b>Speakers:</b></p> <p>Dr Subbarao Pavuluri, CMD Ananth Technologies and President, SIA-India</p> <p>Mr Deepak Mathur, Executive Vice President, SES Inc.</p>





Start	End	Duration	Description
<b>Day Two – Friday 28-April 2023 (Ashok Hall)</b>			
8:30	9:00	0:30	Registration
9:00	10:30	1:30	<b>GI01: Inaugural Session</b>  Welcome Address: Dr Subbarao Pavuluri, President SIA-India and Chairman, Ananth Technologies Limited  Thematic Address: Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Aerospace and Defence Committee at SIA-India  Special Address: Air Marshal Surat Singh AVSM VM VSM, Director General Air (Operations)  Special Address: Lt Gen Tarun Kumar Aich, AVSM, Deputy Chief of Army Staff (Strategy)  Chief Guest: Shri S. Somanath, Secretary Department of Space and Chairman, ISRO (Special Guest of Honour)  Vote of Thanks: Lt. Gen Sunil Srivastava, AVSM, VSM** (Retd) Director, CENJOWS
10:30	11:00	0:30	<b>Exhibition Open at RXL and Networking Tea Break</b>
11:00	11:30	0:30	<b>GI02: Keynote Address:</b> Environmental Scan by Lt. Gen Sunil Srivastava, AVSM, VSM** (Retd) Director, CENJOWS



Start	End	Duration	Description
11:30	12:30	1:00	<p><b>GI03: A Dialogue on Defence Space Realm and Required Capabilities</b></p> <p>By combining space-based assets with ground-based assets, we can significantly improve our military capabilities and give our services a clear advantage in any conflict. To achieve this, we need to work closely with industry partners to identify new technologies and capabilities that can be developed to meet the unique needs of our military. It is also important to collaborate with international partners to leverage their expertise and knowledge in this area.</p> <p><b>Chair and Moderator:</b> Air Vice Marshal DV Khot, AVSM, VM, Director General Defence Space Agency</p> <p><b>Speakers:</b></p> <p>AVM Rajiva Ranjan VM, ACAS OPS Space</p> <p>Col ADS Herr, Col Strategic Planning (Space)</p> <p>Captain Chandra Kant Kothari, Captain (NSO) Space</p>
12:30	13:00	0:30	<p><b>GI04: Tech Brief</b> – Dr Rao Ramayanam, HawkEye 360</p>
13:00	14:00	1:00	Networking Lunch



Start	End	Duration	Description
14:00	15:30	1:30	<p><b>GI05: Intelligence Preparation of Battlefield – Sensors, Data, Information, Intelligence, and Everything in Between</b></p> <p>As a crucial part of the Intelligence Preparation of the Battlefield (IPB) process, it is essential for the industry to provide advanced Space Intelligence, Surveillance, and Reconnaissance (ISR) capabilities. This can be achieved using various technologies such as satellite imagery, radar, and signals intelligence to analyse the environment and threats, thus maximizing the combat power of forces at critical locations and times on the battlefield. In today's world where the volume and complexity of INT data make it challenging to identify and address security threats in a timely manner, analytics and AI are playing a critical role in extracting national security intelligence from information to provide insights that can help identify potential security intel.</p> <p><b>Keynote Address: “Space Enablement – Intelligised IPB for Multi Domain Battlefront”</b> Brig Anshuman Narang, Author and ISR Domain Expert</p> <p><b>Chair and Moderator:</b> Lt Gen PJS Pannu, PVSM, AVSM, VSM(Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Defence Space Committee at SIA-India</p> <p><b>Speakers:</b></p> <p>Mr Prateep Basu, Co-Founder, KaleidEO, a Satsure Company</p> <p>Dr Rao Ramayanam, HawkEye 360</p> <p>Brig Anshuman Narang, Author and ISR Domain Expert</p> <p>Lt. Col Amandeep Singh, Spatial Domain Expert and Author Gp Capt Arvind Pandey (Retd), Sr. Fellow, Geospatial Intelligence in Military Operations, CAPS</p> <p>Mr Tobby Simon, Founder &amp; President, Synergia Foundation</p>



Start	End	Duration	Description
15:30	16:10	0:40	<b>GI06: A Dialogue on Resilient PNT</b> <b>Chair and Moderator:</b> Dr PSR Srinivasa Sastry, Director DSP, DRDO <b>Speakers:</b> Shri Manish A Saxena, Director SATNAV-PO, ISRO Headquarters Dr Roshan Srivastav Project Director Technology Innovation Hub, Positioning and Precision Technologies, IIT Tirupati
16:10	16:30	0:20	Networking Tea Break



Start	End	Duration	Description
16:30	18:00	1:30	<p><b>SI05: Space Security –Philosophy, Doctrines, and Strategies; Connecting Requirements and Industrial Capabilities (Entry by invitation only, NO walk-ins)</b></p> <p>A roundtable discussion on the modern national security doctrines and strategies and space security as a critical component of that. National security doctrines and strategies should be developed with a comprehensive approach to space security, incorporating both defensive and offensive capabilities. As we move further into the space age, it is essential that governments work closely with industry to develop the necessary capabilities to defend their space-based assets and maintain their strategic advantage.</p> <p><b>Chair &amp; Moderator:</b> Lt General Vinod G. Khandare, PVSM, AVSM, SM (Retd.), Principal Adviser in the Ministry of Defence</p> <p><b>Speakers:</b></p> <p>Lt Gen. Sunil Srivastava, AVSM, VSM** (Retd), Director, CENJOWS</p> <p>Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Aerospace and Defence Committee at SIA-India</p> <p>Air Commodore Savinder Pal Singh, VSM (Retd.), CAPS</p> <p>Gp Capt. Puneet Bhalla, (Retd), Sr Research Fellow, CENJOWS</p> <p>Capt (IN) Kamlesh K Agnihotri, National Maritime Foundation</p>

**End of Day 2 of the Conference and Exhibition**





Start	End	Duration	Description
<b>Day 3 - Sat 29 Apr 2023 (Ashok Hall)</b>			
8:30	9:00	0:30	Registration
9:00	10:00	1:00	<b>GI07: Opening Plenary</b> Welcome Address: Dr Subbarao Pavuluri, President SIA-India and Chairman, Ananth Technologies Limited Special Address: Dr Anupam Sharma, Associate Director, DSP, DRDO Special Address: Dr Ranjana N, Director DSTA, DRDO
10:00	10:20	0:20	Exhibition Open at RXL and Networking Tea Break



Start	End	Duration	Description
10:20	11:40	1:20	<p><b>GI08: Secure Satcom and Integration with loBT/loMT Systems</b></p> <p>Industry can support the objective of secure military Satcom and integration with loBT/loMT systems by providing reliable and secure Satcom solutions and developing rugged and secure loBT/loMT devices. Besides ComSec and Transec, a space cybersecurity framework become essential for implementing effective threat detection and countermeasure systems. This must be supported with an adequate spectrum to help the military achieve its mission and protect national security.</p> <p><b>Chair and Moderator:</b> Maj Gen Sanjiv Sharma, SM, ADG Tac C, DG Signals</p> <p><b>Speakers:</b></p> <p>Dr Ranjana N, Director DSTA, DRDO</p> <p>Mr Sanjeev K Gupta, Associate Director, Satcom Applications, SATCOM-PO, ISRO Headquarters</p> <p>Mr Vinod Kaul, RVP South and South-East Asia, Gilat Satellite Networks</p> <p>Mr Sai Krishna, CEO, Pinaca Labs</p> <p>Mr Dilip Singh, CTO, QuNu Labs</p>



Start	End	Duration	Description
11:40	13:00	1:20	<p><b>GI09: Enabling Uninterrupted access to Space –Impact Prevention, Mitigation, Preparedness, Response, and Recovery</b></p> <p>Maintaining uninterrupted access to space is crucial for national security. The threat surface includes adversary action, unintended accidents or planetary occurrences and requires building resilience by hardening, detecting potential threats and remedial measures. Some potent technologies in the toolkit are SSA, RPO, OSAM, redundancy by design, replacing assets, and launch on-demand that helps in preventing and mitigating impacts, preparing for contingencies, responding to emergencies, and recovering from disruptions towards a structured approach in addressing the threat of denial, degradation, disruption or destruction of space capabilities.</p> <p><b>Chair:</b> Dr Anupam Sharma, Associate Director, DSP, DRDO</p> <p><b>Moderator:</b> Shri Jidesh, Associate Director, SIPO, ISRO Headquarters</p> <p><b>Speakers:</b></p> <p>Gp Capt TH Anand Rao, Senior Fellow, CAPS, Space Security and Policy Analysis</p> <p>Mr Sasmith Reddi, Director, Global Sales Engineering, STE iDirect</p> <p>Dr Dibyendu Nandi, Head, Centre of Excellence in Space Science, Indian Institute of Science Education and Research (IISER) Kolkata</p> <p>Capt(IN) Arun Mannath(Retd), Associate Director, Aerospace &amp; Defence, Frost and Sullivan</p> <p>Dr Rachit Bhatia, Space Safety Analytics &amp; Research Lead, Leolabs Inc.</p>
13:00	14:00	1:00	Networking Lunch



Start	End	Duration	Description
14:00	15:20	1:20	<p><b>GI10: Civil-Military Fusion –Catalysing the Industrial Base and Overcoming Supply Chain Challenges</b></p> <p>By creating a framework for closer collaboration and communication between the civilian and military sectors, CMF can help to identify and develop technologies and capabilities that meet the needs of both sectors. This can lead to more efficient and effective procurement processes and a stronger and more resilient industrial base that can better support national security objectives. It is imperative to provide the industry with a multi-year roadmap and interventions with policy tools including innovative procurement methodologies for these industrial capabilities to be developed, built, and invested in.</p> <p><b>Chair:</b> Shri Hari Babu Srivastava, Director General, Technology Management, DRDO</p> <p><b>Moderator:</b> Prof. Chaitanya Giri, Associate Professor, FLAME University and Consultant RIS</p> <p><b>Speakers:</b></p> <p>Air Marshal (Dr) Rajeev Sachdeva AVSM (Retd), Fmr. Deputy Chief of Integrated Defence Staff and also officiated as Additional Secretary (Air) at DMA, under CDS MoD</p> <p>Col. Kuber Kandalai, E&amp;Y</p> <p>Capt Vishal Kanwar, PWC</p> <p>Col. Rajiv Chib (Retd), CEO, Insighteon Consulting</p>
15:20	15:50	0:30	Networking Tea Break



Start	End	Duration	Description
15:50	17:10	1:20	<p><b>GI11: Closing Capability Gaps and Retaining the High Ground by Integrating Drones, HAPS, and Satellites</b></p> <p>Together, these technologies can provide a more complete picture of the security landscape and help to identify and mitigate potential threats more quickly and effectively. However, integrating drones, HAPS, and satellites requires a coordinated and well-planned approach that considers each technology's unique capabilities and requirements.</p> <p><b>Keynote Address:</b> Lt Gen Dr VK Saxena, PVSM, AVSM, VSM (Retd), Fmr Director General of the Corps of Army Air Defence*</p> <p><b>Chair and Moderator:</b> Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Aerospace and Defence Committee at SIA-India</p> <p><b>Speakers:</b></p> <p>Lt Gen Dr VK Saxena, PVSM, AVSM, VSM (Retd), Fmr Director General of the Corps of Army Air Defence</p> <p>Air Marshal GS Bedi, AVSM, VM, VSM (Retd) Former DGIS</p> <p>Mr Tobby Simon, Founder &amp; President, Synergia Foundation</p> <p>Mr Raj Sharma, President, National Association of Drone Developers &amp; Space Organization (NADDSO)</p> <p>Mr Naveen Navlani, Associate Director, Global Military Sales, ideaForge Technology Ltd</p> <p>Mr Jayant Sinha, Program Manager, Elcomponics Aerob Technologies India Pvt Ltd</p>
17:10	17:30	0:20	<p>Closing Plenary</p> <p>Closing Remarks; Dr Subba Rao Pavuluri, President SIA-India and CMD Ananth Technology</p> <p><b>GI12: Closing Summary:</b> Lt Gen PJS Pannu, PVSM, AVSM, VSM (Retd) Former Deputy Chief Indian Integrated Defence Staff (Operations) and Chair of the Aerospace and Defence Committee at SIA-India</p>
<b>End of Day 3 and Closing of the Conference and Exhibition</b>			





# Organising and Program Committee

## Organising Committee

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- Dr Subba Rao Pavuluri, President, SIA-India and CMD, Ananth Technology Limited
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