A Space Explore Edition...

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Former Deputy Chief of Integrated Defence Staff.

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Space Industry in India is growing & the whole eco system is shaping up.

B. KARTIKEYA

Editor-in-chief

kartikeya@futureaviation.in

Hello my dear readers,

Spacepreneur Magazine has Completed 1 Year recently. I personally thank everyone who has been supported throughout the journey. Spacepreneur is the top source for news on astronomy, innovation, and space travel, documenting (and applauding) humanity's continued exploration of the last frontier. The news from the deepest parts of the enormous cosmos is brought to you in this episode of space exploration.

I really appreciate how Space Industry in India is growing & the whole eco system is shaping up. Different space associations are trying their level best to bridge the gap between policy makers, industry & academia. Private space industry is flourishing like never before in the world.

Our Special Editor Sanjay Singh in conversation with Lt Gen (Dr.) PJS Pannu, Former Deputy Chief of Integrated Defence Staff feels There are a few ways that smaller companies can amplify their brand in this rapidly expanding sector: Innovate and develop space cybersecurity solutions, Stay informed on industry trends and legislation, Establish thought leadership, Collaborate with

educational institutions, Participate in industry associations and events, Diversify service offerings, Create strategic alliances. In another conversation with Lt. Gen. AK Bhatt Director General, Indian Space Association (ISpA) says ISpA anticipates several key priorities and challenges for the future of the Indian space industry, which primarily includes "funding and generating demand". We plan to address these challenges by advocating for increased investment, fostering partnerships, and promoting the development of indigenous capabilities to meet the growing demand for space-based services and technologies.

"With fast growth and big numbers, the conclusion should be obvious, digital twin will no longer be an option beyond 2024. If your business hasn't gotten a start on digital twins in 2023, your competitors surely have. If you have started, step on the accelerator in 2024 by asking for more resources and spreading the word to expected users about the big, promised benefits of digital twins across the sectors. As digital twin technology continues to evolve, its impact on space exploration and satellite operations will become increasingly profound, shaping the future of space exploration and national security" says Cdr Rahul Verma (retd).

With that, I take your leave this month. More when we meet again in our next issue. Till then, stay safe, God bless.

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Team

B. Kartikeya
EDITOR-IN-CHIEF & PUBLISHER

EDITORIAL

Special Editor
Sanjay Singh

Contributing Editor
Dr (Hon) MRK Menon

SPACEPRENEUR CORRESPONDENTS
Rohith Reddy

Marketing

Head Marketing
Ms. Naheda Imtiyaz
+91 9492938822

Manager, Marketing (North & West)
Rohith Reddy

ART & DESIGN

Creative Head & Art Director
Swati Sharma (Design Garage)

PHOTOGRAPHER
Krishanth

INTERNATIONAL

For Europe Advertisements
Jubin Josepsh
+33 758933925,
jubin.joseph@bluespacegroup.com

SUBSCRIPTION

Sony

HOW TO REACH US

Hyderabad
No Villa No. 105,
Nakshatra Society, Siddanthi,
Shamshabad, Hyderabad,
Telangana 501218, INDIA

For all magazine related enquires

E-mail
kartikeya@futureaviation.in

1ST EUROPEAN TAKES OFF ON COMMERCIAL FLIGHT TO SPACE STATION

ESA project astronaut Marcus Wandt from Sweden blasted into space tonight from NASA's Kennedy Space Center in Florida, USA, at 21:49 GMT (22:49 CET, 16:49 local time). A SpaceX Falcon 9 rocket launched the Axiom Mission 3 (Ax-3) crew of four astronauts from launch pad 39A.

Marcus is sharing the ride on the Dragon capsule to the International Space Station with Walter Villadei from Italy, Alper Gezeravci from Türkiye and Michael López-Alegría, a dual US-Spanish citizen. Marcus is the first of a new generation of European astronauts to fly on a commercial human spaceflight opportunity with Axiom Space. Marcus's mission is called Muninn.

Journey to space

Just two and half minutes into the flight, the Falcon 9 first stage separated to land back on Earth. Marcus became weightless at around nine minutes after liftoff at 21:57 GMT (16:57 local time).

The rocket's second stage shut off its engines and a small teddy bear started to float free inside the spacecraft – a zero gravity indicator to show the Ax-3 crew that they had reached orbit. The trip to the International Space Station takes around 36 hours. The four astronauts are circling Earth at 28 800 km/h, safely heading towards their new home in orbit.

The journey to catch up with the Space Station is relatively calm because the Dragon spacecraft is designed to fly in a fully automated mode, requiring little input from the crew. Marcus travels as a mission specialist on the Dragon spacecraft. The capsule is set to dock with the Space Station on Saturday 20 January at 09:21 GMT (10:21 CET). The Ax-3 crew will not enter the orbiting laboratory until pressurization checks are complete. The Muninn mission will officially begin as soon as Marcus goes through the hatch. ESA astronaut Andreas Mogensen will welcome him as commander of the Space Station. This will be the first time two Scandinavians live and work together in space.

Live coverage of the docking, ingress and welcome messages will be shown on ESA WebTV channel 2 from 07:45 GMT/08:45 CET on 19 January.

Speedy boarding

Ax-3 is the first human commercial spaceflight mission for ESA. "Europe is redefining the pathway to show how fast-track missions in low Earth orbit can generate good science, outreach and education for a better life on Earth," says ESA Director General Josef Aschbacher.

"This short-duration flight is also a first step to prepare for the commercialisation of low Earth orbit in a future without the International Space Station. We are using private companies to help us run our science and technology programmes in space," he adds.

It is also the first time ESA flies a member of its astronaut reserve. Marcus was one of the 17 new astronaut candidates chosen from over 22 500 applicants from across ESA Member States in November 2022. As a project astronaut, his job at ESA is linked to this specific flight opportunity on a fixed-term contract. Marcus's mission is supported by the Swedish National Space Agency.

"A mission like Muninn is a very efficient way of running more European science in space. I am very proud to pioneer this fast-track formula of using commercial companies to get access to the Space Station in record time," says Marcus.

During his two-week mission, he has a full schedule of science and experiments planned for over 80 hours. Marcus will devote much of his time to scientific activities and technology demonstrations that could shape the way we live and work on Earth. In total, he will conduct around 20 experiments.

Follow the Muninn mission "Going to space and exploration in general is a very good tool to bring people together and drive progress. It is a great way to make cooperation happen and to spread knowledge," says Marcus.

Follow Marcus's journey on the Muninn website, check our launch kit in English or Swedish and connect with Marcus on his Instagram and X accounts, and on ESA social media channels. You can also shop the official Muninn collection online at the ESA Space Shop and tune into the official Muninn mission playlist.

SpaceX's Dragon Autonomously Docked With the ISS

SpaceX's Dragon autonomously docked with the International Space Station. Approximately 36 hours earlier at 4:49 p.m. ET on Thursday, January 18, Falcon 9 launched the spacecraft and Ax-3 to orbit from Launch Complex 39A (LC-39A) at NASA's Kennedy Space Center in Florida

During their time on the orbiting laboratory, the crew will conduct more than 30 scientific experiments and demonstrations focused on human physiology and technological industrial advancements.

SAFRAN TO EQUIP LEOSTELLA SATELLITE CONSTELLATIONS

LeoStella is pursuing its partnership with Syrlinks, a Safran Electronics & Defense company. The Rennes, France-based Company will equip LeoStella's latest-generation of LS-300 satellite buses with its high-performance, resilient N-SPHERE GNSS receiver for low-Earth orbit applications.

This latest contract further strengthens the collaboration between Syrlinks, a global leader in radio communication and geolocation systems for the space industry, and LeoStella, one of the main manufacturers of small satellite constellations in the United States. The two companies have agreed to integrate the N-SPHERE GNSS (global navigation satellite system) receiver from Syrlinks into LeoStella's latest satellite platform, the LS-300. This agreement positions Syrlinks as a major player of the international space industry.

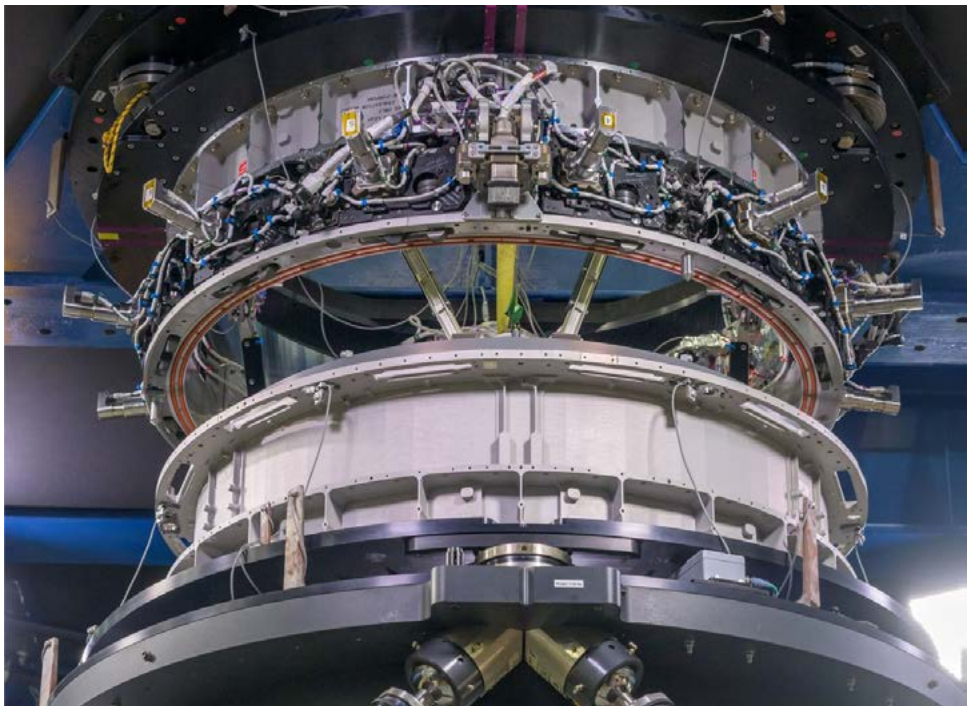
N-SPHERE solution is a new-generation GNSS receiver designed by Syrlinks, a Safran Electronics & Defense company. It implements the latest state-of-the-art positioning and synchronization techniques to achieve real-time precise onboard orbit determination (P2OD). N-SPHERE can be synchronized with various GNSS systems and offers high-precision positioning, of the order of 10 centimetres.

The integration of this very high precision localization capability into the LS-300 bus gives LeoStella access to international defense customers.

"We're delighted to be pursuing our collaboration with LeoStella, based on the selection of our advanced GNSS receiver," said Jean-Marie Bétermier, Senior Vice President Space, Safran Electronics & Defense. "There's no better vote of confidence than continued collaboration with a customer. It shows that our products are dependable and always at the forefront of technology."

"Syrlinks and LeoStella have built a solid partnership over the course of several collaborative programs," said Kylie Hall, Supply Chain Manager for LeoStella. "LeoStella is looking forward to building N-SPHERE into the development of its future satellite platforms, which marks an important milestone in our ongoing partnership."

NASA, SpaceX Test Starship Lunar Lander Docking System



As part of NASA's Artemis campaign that will establish the foundation for long-term scientific exploration at the Moon, crew will need to move between different spacecraft to carry out lunar landings. NASA and SpaceX recently performed qualification testing for the docking system that will help make that possible.

For the Artemis III mission, astronauts will ride the Orion spacecraft from Earth to lunar orbit, and then once the two spacecraft are docked, move to the lander, the Starship Human Landing System (HLS) that will bring them to the surface. After surface activities are complete, Starship will return the astronauts to Orion waiting in lunar orbit. During later missions, astronauts will transfer from Orion to Starship via the Gateway lunar space station. Based on SpaceX's flight-proven Dragon 2 docking system used on missions to the International Space Station, the Starship docking system can be configured to connect the lander to Orion or Gateway.

The docking system tests for Starship HLS were conducted at NASA's Johnson Space Center over 10 days using a system that simulates contact dynamics between two spacecraft in orbit. The testing included more than 200 docking scenarios, with various approach angles and speeds. These real-world results using full-scale hardware will validate computer models of the Moon lander's docking system.

This dynamic testing demonstrated that the Starship system could perform a "soft capture" while in the active docking role. When two spacecraft dock, one vehicle assumes an active "chaser" role while the other is in a passive "target" role. To perform a soft capture, the soft capture system (SCS) of the active docking system is extended while the passive system on the other spacecraft remains retracted. Latches and other mechanisms on the active docking system SCS attach to the passive system, allowing the two spacecraft to dock.

Since being selected as the lander to return humans to the surface of the Moon for the first time since Apollo, SpaceX has completed more than 30 HLS specific milestones by defining and testing hardware needed for power generation, communications, guidance and navigation, propulsion, life support, and space environments protection.

Under NASA's Artemis campaign, the agency will land the first woman, first person of color, and its first international partner astronaut on the lunar surface, and prepare for human expeditions to Mars for the benefit of all. Commercial human landing systems are critical to deep space exploration, along with the Space Launch System rocket, Orion spacecraft, advanced spacesuits and rovers, exploration ground systems, and the Gateway space station.

GENERAL ATOMICS AWARDED SPACE DEVELOPMENT AGENCY CONTRACT TO DEMO OPTICAL COMMUNICATION TERMINALS

General Atomics Electromagnetic Systems (GA-EMS) has been awarded a contract from the Space Development Agency (SDA) to demonstrate the capabilities of the company's Optical Communication Terminals (OCTs) hosted on GA-EMS' GA-75 (75 kilogram class) spacecraft while in Low Earth Orbit (LEO).

"We're excited to continue working with SDA and look forward to demonstrating our OCT capability developed, built, and tested by GA-EMS, and integrated on GA-EMS-designed and built spacecraft," said Scott Forney, president of GA-EMS. "This contract supports the deployment of next generation optical communication technologies that will provide faster, more secure, higher fidelity transmissions, and greater resiliency to ensure 24/7 connectivity from the earth to space."

GA-EMS is designing and building two OCTs to provide robust space-to-space communication in a degraded environment and establish and maintain links to meet SDA standards and requirements. The OCTs can support a vast network of satellites, data and information sharing, and collective on-orbit computing resources to support customer and mission requirements.

The OCTs will be integrated on two GA-EMS GA-75 spacecraft. The GA-75 is a resilient, modular, and configurable half-ESPA bus design with capabilities to support a variety of communications and Intelligence, Surveillance, and Reconnaissance (ISR) payloads and missions. The GA-75 is a commercially available platform that utilizes standard payload interfaces to enable seamless integration and mission-ready delivery times. It is also compatible with multiple launch vehicles and can package two spacecraft per ESPA port or fill a single ESPA port depending on mission payload size.

BAE SECURES REGULATORY APPROVALS FOR THE ACQUISITION OF BALL AEROSPACE

BAE Systems has now received necessary regulatory approvals to successfully complete the acquisition of Ball Aerospace, which will add market-leading space and defense capabilities to the company's portfolio of products and services. In the coming days, BAE Systems and Ball Corporation will be executing the steps needed to complete the transaction and close on the Ball Aerospace acquisition.

Ball Aerospace will operate under BAE Systems' U.S. business as a new sector called Space & Mission Systems, led by Dr. Dave Kaufman. Kaufman currently serves as Ball Corporation senior vice president and the president of Ball Aerospace. Previously, he served as chief operating officer of Ball Aerospace, as well as vice president and general manager of Ball's National Defense strategic business unit.

"This acquisition underpins our strategy to deliver growth and advance our technology and innovation portfolio in high priority areas identified in the U.S. National Defense Strategy and the U.S. Intelligence Strategy," said Tom Arseneault, president and CEO of BAE Systems, Inc. "Together we will leverage our combined capabilities to develop and deliver cutting-edge space, science and defense solutions to advance our customers' critical missions."

"This is an exciting time for us, and we look forward to joining one of the most respected companies in the aerospace and defense industry; a move that will only strengthen our ability to

continue to provide game-changing technologies and services to our customers," said Kaufman. "Not only does BAE Systems represent a great cultural fit for our employees, but this milestone will bring resources and support for continued growth that will enable our team to deliver our capabilities at a greater scale than ever before. As the new Space & Mission Systems sector, we'll continue to build on our reputation as a trusted mission partner established over the last 65-plus years as Ball Aerospace."

Ball Aerospace has a long and distinguished track record as a proven partner and pioneering innovator, with expertise in spacecraft, mission payloads, optical systems, conformal antennas, and electronically steered arrays. With trusted customer relationships among the Intelligence Community, U.S. Department of Defense and civilian space market, the Ball Aerospace team supports the delivery of a broad set of products and differentiating technologies to meet growing customer demands. The acquisition of Ball Aerospace will provide a robust platform for accelerating the company's space strategy in the U.S. as BAE Systems continues to deliver across its broad portfolio of franchise programs.

NASA's New Experimental Antenna Tracks Deep Space Laser

Capable of receiving both radio frequency and optical signals, the DSN's hybrid antenna has tracked and decoded the downlink laser from DSOC, aboard NASA's Psyche mission.

An experimental antenna has received both radio frequency and near-infrared laser signals from NASA's Psyche spacecraft as it travels through deep space. This shows it's possible for the giant dish antennas of NASA's Deep Space Network (DSN), which communicate with spacecraft via radio waves, to be retrofitted for optical, or laser, communications.

By packing more data into transmissions, optical communication will enable new space exploration capabilities while supporting the DSN as demand on the network grows. The 34-meter (112-foot) radio-frequency-optical-hybrid antenna, called Deep Space Station 13, has tracked the downlink laser from NASA's Deep Space Optical Communications (DSOC) technology demonstration since November 2023. The tech demo's flight laser transceiver is riding with the agency's Psyche spacecraft, which launched on Oct. 13, 2023. The hybrid antenna is located at the DSN's Goldstone Deep Space Communications Complex, near Barstow, California, and isn't part of the DSOC experiment. The DSN, DSOC, and Psyche are managed by NASA's Jet Propulsion Laboratory in Southern California.

"Our hybrid antenna has been able to successfully and reliably lock onto and track the DSOC downlink since shortly after the tech demo launched," said Amy Smith, DSN deputy manager at JPL. "It also received Psyche's radio frequency signal, so we have demonstrated synchronous radio and optical frequency deep space communications for the first time."

In late 2023, the hybrid antenna downlinked data from 20 million miles (32 million kilometers) away at a rate of 15.63 megabits per second – about 40 times faster than radio frequency communications at that distance. On Jan. 1, 2024, the antenna downlinked a team photograph that had been uploaded to DSOC before Psyche's launch.

Two for One

In order to detect the laser's photons (quantum particles of light), seven ultra-precise segmented mirrors were attached to the inside of the hybrid antenna's curved surface. Resembling the hexagonal mirrors of NASA's James Webb Space Telescope, these segments mimic the light-collecting aperture of a 3.3-foot (1-meter) aperture telescope. As the laser photons arrive at the antenna, each mirror reflects the photons and precisely redirects them into a high-exposure camera attached to the antenna's subreflector suspended above the center of the dish. The laser signal collected by the camera is then transmitted through optical fiber that feeds into a cryogenically cooled semiconducting nanowire single photon detector. Designed and built by JPL's Microdevices Laboratory, the detector is identical to the one used at Caltech's Palomar Observatory, in San Diego County, California, which acts as DSOC's downlink ground station.

"For decades, we have been adding new radio frequencies to the DSN's giant antennas located around the globe, so the most feasible next step is to include optical frequencies," said Tehrani. "We can have one asset doing two things at the same time; converting our communication roads into highways and saving time, money, and resources."

"It's a high-tolerance optical system built on a 34-meter flexible structure," said Barzia Tehrani, communications ground systems deputy manager and delivery manager for the hybrid antenna at JPL. "We use a system of mirrors, precise sensors, and cameras to actively align and direct laser from deep space into a fiber reaching the detector." Tehrani hopes the antenna will be sensitive enough to detect the laser signal sent from Mars at its farthest point from Earth (2 ½ times the distance from the Sun to Earth). Psyche will be at that distance in June on its way to the main asteroid belt between Mars and Jupiter to investigate the metal-rich asteroid Psyche. The seven-segment reflector on the antenna is a proof of concept for a scaled-up and more powerful version with 64 segments – the equivalent of a 26-foot (8-meter) aperture telescope – that could be used in the future.

An Infrastructure Solution

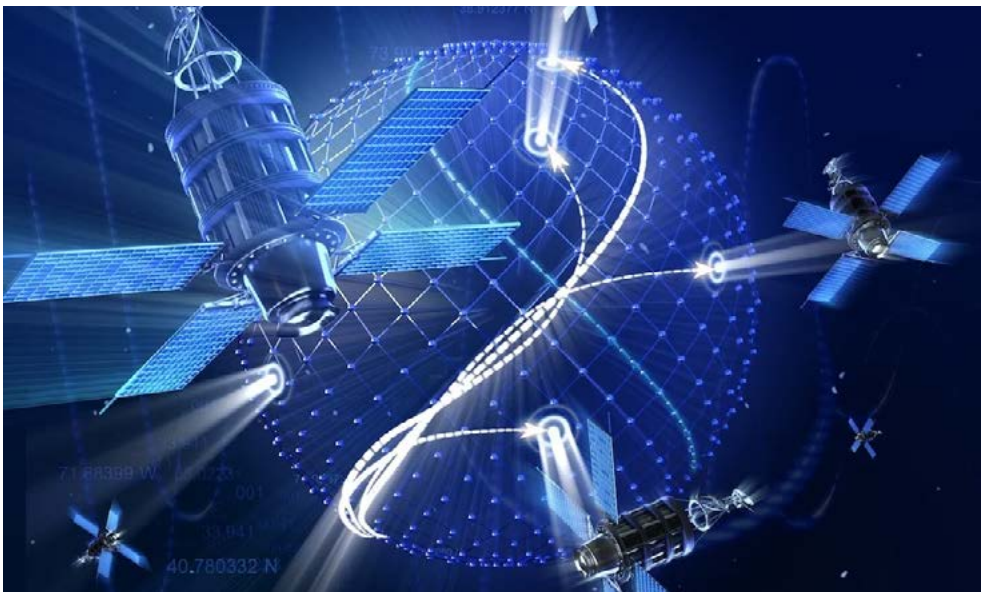
DSOC is paving the way for higher-data-rate communications capable of transmitting complex scientific information, video, and high-definition imagery in support of humanity's next giant leap: sending humans to Mars. The tech demo recently streamed the first ultra-high-definition video from deep space at record-setting bitrates.

Retrofitting radio frequency antennas with optical terminals and constructing purpose-built hybrid antennas could be a solution to the current lack of a dedicated optical ground infrastructure. The DSN has 14 dishes distributed across facilities in California, Madrid, and Canberra, Australia. Hybrid antennas could rely on optical communications to receive high volumes of data and use radio frequencies for less bandwidth-intensive data, such as telemetry (health and positional information).

Navigating the Cosmos: The Imperative of Digital Twins in Space Exploration

Venturing into the cosmos, our journey is illuminated by the twin stars of innovation and resilience. Within the vast expanse of space exploration, digital twins emerge as the indispensable navigators, guiding us towards unprecedented discoveries and safeguarding our celestial endeavours.

Cdr Rahul Verma (retd)



In the vast expanse of space, where government, military, and commercial entities are expanding their presence, a critical challenge emerges, the need to safeguard assets against potential adversaries. The repercussions of losing control over a single space platform could be catastrophic, disrupting essential systems such as communications and transportation, and wreaking havoc on vital infrastructure. With the proliferation of space platforms, both traditional and commercial, the threat landscape has evolved, necessitating robust cybersecurity measures to counter modern-day threats. However, the development lifecycle of traditional defense and intelligence space assets often lags behind technological advancements, leaving them vulnerable to cyber-attacks. Similarly, commercial systems, though developed more rapidly, may overlook cybersecurity priorities, creating potential vulnerabilities.

Over the years, space systems have undergone significant transformations. Early spacecraft, like those utilized in the Apollo missions, operated as standalone systems, collecting and transmitting data independently. However, contemporary space systems are characterized by interconnectedness, both among themselves and with terrestrial networks. This interconnectedness expands the attack surface, making it possible for threats to propagate throughout the system. In response to these challenges, digital twins have emerged as a vital tool in spacecraft design, verification, and operations. From aiding ground control during critical missions to testing thermal protection on spacecraft, digital twins have become indispensable in ensuring the success and sustainability of space operations.

At its core, a digital twin refers to a virtual replica of a physical entity, calibrated based on real-time telemetry data. In the context of satellites, a digital twin serves as a virtual representation of the physical satellite, mirroring its behaviour and characteristics as closely as possible. This virtual counterpart enables engineers and operators to simulate various scenarios, identify vulnerabilities, and optimize performance without risking the integrity of the physical satellite.

The satellite industry is witnessing a rapid transformation, driven by the entry of new space tech companies and the proliferation of commercial low Earth orbit (LEO) satellite constellations. Digital twin technology has emerged as a promising approach for designing and managing complex satellite networks. Although still evolving, digital twin solutions are increasingly in demand, with companies specializing in this sector experiencing significant growth. The number of satellites launched into orbit has seen a remarkable increase in recent years, For the past six decades, around 100 satellites were launched into orbit each year. In 2020, that number rose to more than 1000, in 2022 to more

than 1400 and in 2023 it was 2777. The count for last year is as follows: US, 2,234; China, 213; Russia, 67; and Europe, 253. India accounted for nine, and North Korea, one. This was driven largely by initiatives such as SpaceX's Starlink internet constellation. Additionally, countries like India are ramping up their space exploration efforts, with ambitious launch schedules and collaborations with international partners.

Despite the advancements in digital twin technology, cybersecurity remains a pressing concern for space systems. The interconnected nature of modern space networks increases the likelihood of cyber-attacks, potentially compromising the integrity and functionality of critical assets. While efforts have been made to enhance cybersecurity measures, including the adoption of digital twins for vulnerability assessments and threat detection, significant challenges persist. Legacy methods of cybersecurity assessment, such as paper-based evaluations, are ill-suited to the complexities of modern space systems. Additionally, ensuring data quality and ownership rights poses significant challenges, requiring clear standards and protocols to address.

Artificial intelligence (AI) plays a crucial role in enhancing the capabilities of digital twins. By analysing vast amounts of data and identifying patterns and anomalies, AI algorithms can provide valuable insights into satellite performance and potential vulnerabilities. Moreover, AI can autonomously run tests and simulations, enabling digital twins to adapt and evolve in response to changing conditions. For example, AI-powered digital twins could optimize satellite operations, predict maintenance needs, and mitigate cybersecurity risks in real-time. The integration of AI into digital twin technology represents a significant step forward in enhancing the resilience and efficiency of space systems.

Governments around the world are recognizing the importance of digital twins in safeguarding space assets and ensuring national security. In the United States, agencies like the Air Force and the Space Development Agency (SDA) are leveraging digital twins to enhance the resilience of military satellites and space networks. Collaborations between government agencies and private sector firms are driving innovation in digital twin technology, with initiatives aimed at enhancing space situational awareness and mitigating cybersecurity threats. Similarly, countries like India are investing in digital twin technology to bolster their space exploration capabilities and support emerging space startups.

In India currently, there are over 150 start-ups operating in various domains, including the

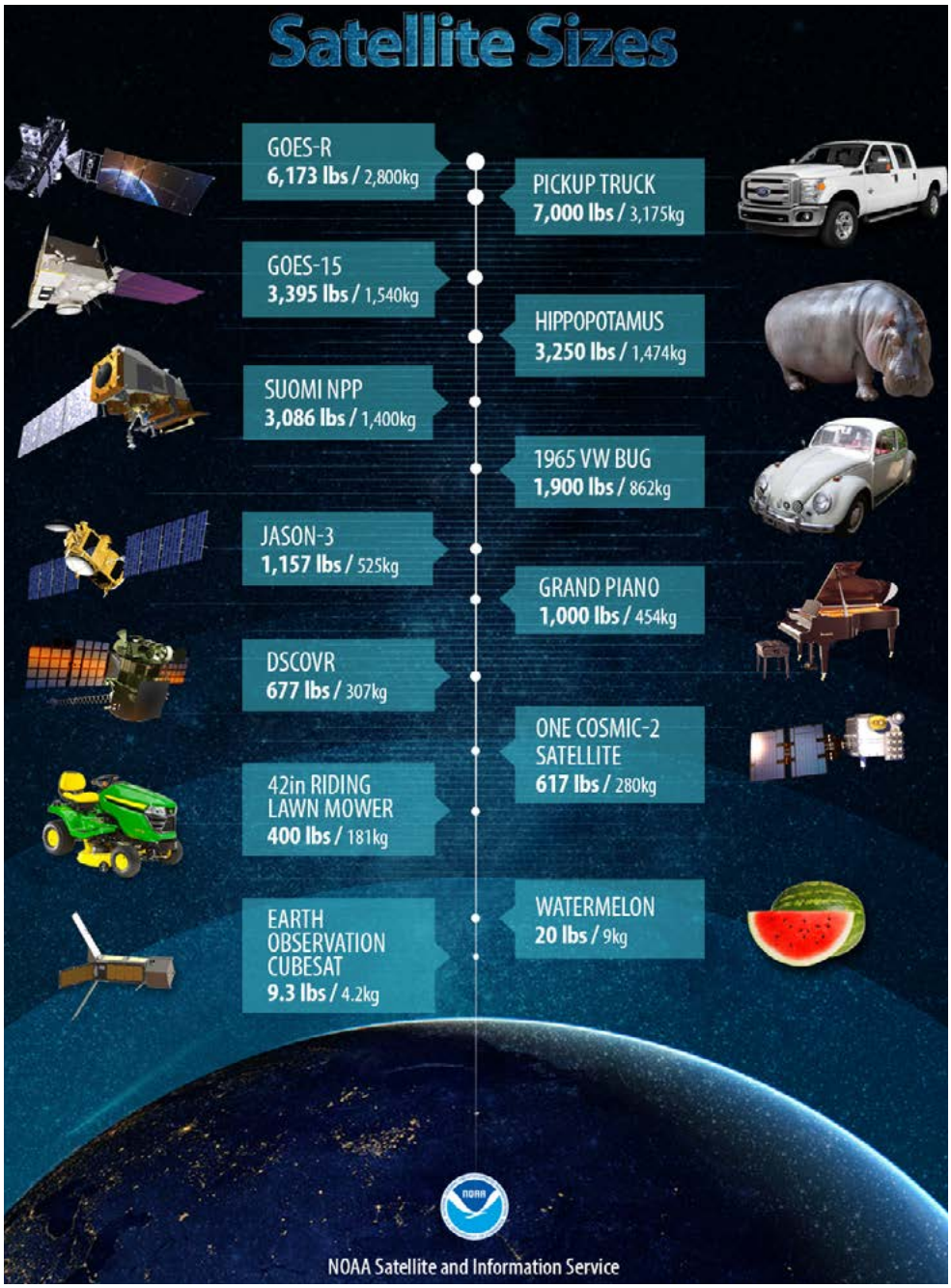
development of launch vehicles or rockets, the design of advanced satellite, the creation of Space Situational Awareness (SSA) solutions, and the construction of application based on space technology. However, the as per the data online there are only 25 Digital Twin start-ups in India. The Indian government's push for this tech is meant to pave the way for creation of virtual replicas of physical assets, allowing real-time monitoring, simulation and analysis facilitating iterative experimentation and feedback loops to effectively adapt to changes and optimise outcomes. Some Indian Space Start-ups have already commenced their collaborations with their digital twinning counterparts to create a mature and optimised solutions like Galaxeye and Tardid technologies. How would this replicator/ cloning going to help in the growth strategy would be cleared in a couple of year and hence this space needs to be watched carefully.

From a market perspective there are three main drivers for the use of digital twins:

(a) Digitalisation trends
(b) Space congestion
(c) Growth of the New Space sector in India

According to industry experts, space congestion, if not addressed, is set to become a serious problem. However, it is not only 'space junk' that is becoming an issue; the increasing number of active satellites can lead to signal interferences. Digital twin technology could contribute to the reduction of space debris by, for example, using AI-based collision and signal interference prediction models. They can support existing tracking methods and enhance collision avoidance systems of satellites. What-if scenarios could be used to avoid potential collisions with debris while optimising fuel usage. From a company perspective, increased service availability is one of the major benefits of implementing digital twins. Service availability is dependent on satellite performance, which is mainly determined by the satellite's longevity, achieved through self-repair, and by the prevention of unintentional collisions or cyber-attacks. Since technology is developing quickly, an accurate lifespan prediction is becoming more important. Digital twin technology makes it possible to model a whole set of scenarios in a safe environment and maximise performance by engineering out single points of failure as early as possible to ensure persistent coverage. Reduced operational cost is also a significant benefit, arising from cheaper and better testing, and early risk identification. Testing in a safe, virtual environment reduces the cost of failure and risk detection prevents expensive losses. Live system testing today can sometimes take down the whole network. Simulating the satellite in orbit and how it contends with conditions such as radiation and extreme temperatures helps to de-risk the entire operation.

Despite the promising potential of digital twin technology, several challenges must be addressed to realize its full benefits. Trust and acceptance of the technology remain significant barriers, requiring clear communication and quantification of the benefits. Additionally, data quality and ownership rights must be addressed to ensure the integrity and security of digital twin models. Skills development is another key challenge, requiring a digitally enabled workforce equipped with the technical expertise and strategic mindset needed to harness the full potential of digital twin technology. To provide interoperability in digital twins is only possible if compatible communication mechanisms are used and if the semantics of parameters and behaviour are clear to all participating digital twins .That is why various global standards development organizations (SDOs) have come up with specifications related to the digital twin. ISO 23247



is a standard for creating digital twins. So far, a total of 765 standards have been developed for the industrial data sector. For example, the 3rd Generation Partnership Project (3GPP) is developing standards for 5G, which can provide high-speed and reliable communication functions required for digital twins, and the Open Geospatial Consortium (OCG) manages geospatial information used in smart cities and other domains. ISO/TC 184 covers industrial data standards used in various domains such as manufacturing, industrial automation, and information systems. Furthermore, oneM2M, a global initiative to standardize a service layer IoT platform, defines common service functions for digital twins.

The global digital twin market is poised for significant growth in the coming years, driven by increasing adoption across various industries, including aerospace and defense. According to Allied Market Research, estimates of the global digital twin market spending for 2021 are already in the low billions of dollars. Compound annual growth rates are generally projected at nearly 40 %, which points to a digital twin market in 2030 of about US$126 billion. Under the amended FDI policy, 100 %foreign investment is allowed in Indian space companies.As per the details made available by the government in regards to the entry route, it is important to realize that 100% investment is possible only in the sectors associated with the manufacturing of components and systems/sub-systems for satellites, ground segments, and user segments. This is exactly the advantage of utilising the AI based Digital Twins fits perfectly.

With fast growth and big numbers, the conclusion should be obvious, digital twin will no longer be an option beyond 2024. If your business hasn't gotten a start on digital twins in 2023, your competitors surely have. If you have started, step on the accelerator in 2024 by asking for more resources and spreading the word to expected users about the big, promised benefits of digital twins across the sectors. As digital twin technology continues to evolve, its impact on space exploration and satellite operations will become increasingly profound, shaping the future of space exploration and national security.

In conclusion, digital twin technology represents a paradigm shift in space exploration, offering unprecedented capabilities for monitoring, simulation, and optimization of space systems. By leveraging digital twins, space agencies, governments, and commercial entities can enhance the resilience, efficiency, and security of space assets, ensuring continued progress in space exploration and national security. As we look to the future, collaboration and innovation will be key drivers in unlocking the full potential of digital twin technology, paving the way for new discoveries and advancements in the cosmos. In the words of Steve Jobs, 'Innovation distinguishes between a leader and a follower.' Let us embrace the future of space exploration with courage, foresight, and the relentless pursuit of discovery.

(Commander Rahul Verma (Retd) is an Emerging Technology and Prioritization Scout for a leading Indian Multi National Corporation, focusing on advancing force modernization through innovative technological applications and operational concepts. With 21 years as a Naval Aviator, including a distinguished role in the Indian Navy's Technology Development Acceleration Cell, he brings diverse aviation experiences, from Seaking Pilot to RPAS Mission Commander and Flying Instructor. His expertise spans Product and Innovation Management, Aerospace Law, UAS, Space Law and Flight Safety. Armed with an MBA and certifications from prestigious institutions like Olin Business School, NALSAR Hyderabad, Axelos, and IIFT, Cdr Verma is dedicated to contributing to aerospace, unmanned technology, and tech policy discussions. Through his written contributions, he aims to leverage his deep domain knowledge for the advancement of space, unmanned and autonomous systems, creating significant value for Atmanirbhar Bharat)

COLLINS AEROSPACE ANNOUNCES DEVELOPMENTAL MILESTONE OF NEXT-GENERATION SPACESUIT

Collins Aerospace, an RTX business with partners ILC Dover and Oceaneering, completed the Crew Capability Assessment test, a key step in the design process on its next-generation spacesuit for the International Space Station, under NASA's Exploration Extravehicular Activity Services, or xEVAS, contract.

The Collins team validated suit performance in a manufactured zero-gravity environment onboard an aircraft, performing a series of demonstrations performed by experienced former NASA astronauts. The primary objectives of the flight test included evaluation of the suit's pressure garment system fit and functionality, use of International Space Station tools and interfaces, and reviewed performance of the new Extravehicular Mobility Unit, or EMU, against the current design.

"The test allowed us to examine specific objectives

of the design that can support a broad range of crewmember sizes and crew tasks in a controlled environment," said Peggy Guirgis, general manager, Space Systems, for Collins Aerospace.

"ILC Dover's pressure garment design leverages decades of innovation and experience to fit more astronauts than ever before, ensuring the safety and comfort of the next generation of space explorers," said Rob Reed, president of Space & Engineered Solutions at ILC Dover. "The successful test signals that we're one step closer to sustaining human life in space with the most advanced spacesuit yet."

Collins' next-generation suit is lighter weight and lower volume than NASA's current spacesuit. Its open architecture design will allow the suit to be easily modified as missions change or technology becomes more advanced. The company has engaged with current and former astronauts to guide engineering and design choices.

Ahead of a critical design review, additional evaluations are scheduled including a thermal vacuum test and an underwater test to be held at NASA's Neutral Buoyancy Lab in Texas.

Blue Origin Debuts New Glenn on Our Launch Pad

Our New Glenn vehicle successfully rolled out and upended for the first time on the pad at Launch Complex 36 (LC-36). This milestone represents the first view of the advanced heavy-lift vehicle, which will support a multitude of customer missions and Blue Origin programs, including returning to the Moon as part of NASA's Artemis program.

Everything on the pad is real New Glenn hardware. The upending is one in a series of major manufacturing and integrated test milestones in preparation for New Glenn's first launch later this year. The test campaign enables our teams to practice, validate, and increase proficiency in vehicle integration, transport, ground support, and launch operations. These tests do not require engines, which are hotfiring at the historic 4670 Test Stand in Huntsville and Launch Site One in West Texas.

The journey to the pad began in December when New Glenn's first-stage modules were transported from our factory to the Integration Facility nine miles away. The tests will conclude in the coming weeks following several demonstrations of cryogenic fluid loading, pressure control, and the

vehicle's venting systems. Our launch pad and ground systems are complete and will be activated for the first time during the test campaign.

New Glenn is named after John Glenn, the first American to orbit Earth. The rocket stands more than 320 feet (98 meters) high—roughly the height of a 30-story building—and features a seven-meter payload fairing, enabling twice the volume of standard five-meter class commercial launch systems. The fairing is large enough to hold three school buses. Its reusable first stage aims for a minimum of 25 missions and will land on a sea-based platform located roughly 620 miles (1,000 km) downrange. Reusability is integral to radically reducing cost-per-launch.

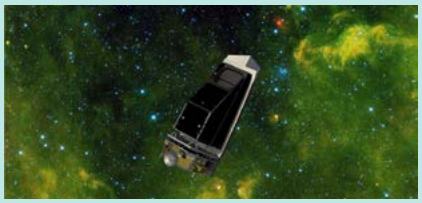
The vehicle is powered by seven of Blue Origin's BE-4 engines, the most powerful liquid oxygen (LOX) / liquefied natural gas (LNG) engine developed since Saturn V's F1 engines. LNG is cleaner-burning and higher-performing than kerosene-based fuels.

Blue Origin has several New Glenn vehicles in production and a full customer manifest. Customers include NASA, Project Kuiper, Telesat, and Eutelsat, among others. Blue Origin is certifying New Glenn with the U.S. Space Force for the National Security Space Launch (NSSL) program to meet emerging national security objectives.

Thales Alenia Space Will Provide Communication Equipment to NASA's NEO Surveyor Mission

Thales Alenia Space, the joint venture between Thales (67%) and Leonardo (33%), has signed a contract with prime contractor Ball Aerospace to supply communications equipment for NASA's NEO Surveyor mission. The main goal of this five-year mission is to advance efforts to defend our planet against near-Earth objects like asteroids and comets, specifically within 50 million kilometers from our planet's orbit. NEO Surveyor will employ an infrared space telescope designed to discover and characterize at least two-thirds of the near-Earth objects more than 140 meters (460 feet) across capable of causing significant damage should they impact the Earth.

Managed by NASA's Jet Propulsion Laboratory in Southern California, NEO Surveyor will journey 1.5 million kilometers to a region of gravitational stability – called the L1 Lagrange point – between Earth and the Sun, where the spacecraft will orbit during its five-year primary mission. From this location, NEO Surveyor will view the solar system in infrared wavelengths – light



that is invisible to the human eye and mostly blocked by the Earth's atmosphere. By using two heat-sensitive infrared imaging channels, the NEO Surveyor space telescope will be capable of detecting comets, both bright and dark asteroids, which are the most difficult type to find, and to make accurate measurements of NEO sizes and gain valuable information about their composition, shapes, rotational states, and orbits.

Thales Alenia Space will provide S-band Transponder, K-band Modulator and K-band Travelling Wave Tube Amplifier (TWTA) equipment for the NEO Surveyor spacecraft. The S-band Transponders are the units in charge of receiving the telecommands sent from NASA's Deep Space Network, and transmitting the spacecraft's telemetries back to Earth, as well as the ranging signals used to measure the spacecraft's distance. The K-band Modulators and Power Amplifiers are in charge sending to Earth the images captured by the NEO Surveyor telescope.

Emmanuel Terrasse, Vice President Equipment of Thales Alenia Space, said "We are thrilled to provide key communications equipment for the NEO Surveyor mission, which will represent a significant advance in NASA-led planetary defense efforts to protect our planet from hazardous asteroids and comets. We are grateful to prime contractor Ball Aerospace for their choice and trust in Thales Alenia Space. For more than 40 years Thales Alenia Space has contributed to hundreds of missions providing critical communications technologies, from Low Earth Orbit to Deep Space, including flagship NASA missions to explore the Universe such as the James Webb Space Telescope and the Nancy Grace Roman Space Telescope."

UN Office for Outer Space Affairs and Exolaunch Sign Agreement for Launching CubeSats into Space

The United Nations Office for Outer Space Affairs (UNOOSA) and Exolaunch GmbH (Exolaunch) have signed an agreement to provide free of charge launch opportunities to space for Cube Satellites (CubeSats).

This collaboration is part of the Access to Space for All initiative, which aims to foster capacity-building in space science and technology by providing hands-on and educational opportunities. Access to Space for All allows the participants to acquire invaluable knowledge and gain experience, supporting the development of space activities in developing countries. Especially through the Satellite Development Track activities, the initiative has supported 4 countries to launch the first satellite of their country and more CubeSats and payloads being developed. The CubeSats have not only built capacity in human capital but also contributed to the different Sustainable Development Goals through their missions, engaged governments in aligning with international space law, registration practices, and guidelines, and motivated

the young generations in their countries to pursue STEM education and space careers.

The development of CubeSats has become more affordable and is an achievable entry point to space activities. With the clear need from the community to have more options for accessing space, this joint CubeSat launch opportunity will offer more chances for UN Member States to be engaged in space activities. As the awareness of the significant role that satellites play in our current world is becoming more understood, UNOOSA and Exolaunch will continue to promote the development of space activities and cooperation in the peaceful uses of outer space.

Director of UNOOSA Aarti Holla Maini said: "I would like to thank Exolaunch for providing us with the opportunity to offer more developing countries access to space and with it the increased benefits of space technology and applications in support of the Sustainable Development Goals. I look forward to opening the call soon."

Founder and Chief Executive Office of Exolaunch Dmitriy Sternharz said: "Exolaunch is honoured to collaborate with UNOOSA in providing free of charge launch opportunities through the Access to Space for All initiative. This collaboration reflects our commitment to fostering growth in the STEM field and empowering developing countries to participate in space activities. We are excited about the positive impact this partnership will have on global space endeavours and look forward to contributing to the implementation of Sustainable Development Goals."

NGC Completes 1st BOLE Solid Rocket Motor Segment for NASA's SLS

Northrop Grumman Corporation completed the first Booster Obsolescence and Life Extension (BOLE) motor segment for the next-generation Space Launch System (SLS) solid rocket booster. BOLE adds nearly five metric tons of payload capacity for SLS Block 2 Moon and Mars missions above the enhancements already in work for the SLS Block 1B configuration slated to fly on Artemis IV. The new solid rocket boosters will be used on Block 2 beginning with Artemis IX when all the recovered and refurbished shuttle-era steel cases have been expended.

Building on the foundation of the largest and most powerful solid rocket boosters ever flown, Northrop Grumman's BOLE booster incorporates cutting-edge carbon fiber technology and a weight-saving composite case. Combined with other upgrades, it generates 11% more total impulse than the current five-segment solid rocket boosters. The first BOLE demonstration test is scheduled for this year, featuring a full-scale static test with all five segments integrated and horizontally fired in a test bay.

Kratos Orders 9 Zeus 1 and Zeus 2 Rocket Motors in Preparation for Initial Customer Funded Flights

Kratos Defense & Security Solutions, Inc. a Technology Company in Defense, National Security and Global Markets announced that its Space & Missile Defense (SMDS) business unit has ordered a combined total of nine new Zeus 1 and Zeus 2 rocket motors in preparation for upcoming initial customer funded flights. The Kratos developed Zeus family of Solid Rocket Motors (SRMs) is in direct response to the urgent need for affordable commercial launch vehicle stages for hypersonic test, ballistic missile target, sounding rocket and "other" customer missions. SMDS applied its significant experience to establish the Zeus 1 and Zeus 2 motor requirements and specifications in close coordination with respective customer and user communities. Kratos, through internal investments, funded development of the Zeus SRMs which are designed and manufactured to Kratos' specifications by key merchant supplier and partner, Aerojet Rocketdyne.

The Kratos Zeus 1 and Zeus 2 SRMs provide substantial performance improvements over similar legacy and heritage SRMs within the same relevant form factor, allowing existing vehicle designs and launch infrastructure to remain unchanged while also promoting rapid integration of leading technology systems and payloads, including those currently under development by Kratos. These and other key attributes will provide Kratos' customers opportunities to fly more often, faster and farther, using fewer stages, at a substantially reduced cost.

The Zeus 1 and Zeus 2 are high-performance 32.5-inch diameter SRMs, designed with versatility and affordability in mind as a complement to Kratos' internally funded investments in the Erinyes hypersonic test "flyer" that is expected to debut later this year. Kratos Zeus SRMs will also complement Kratos' internally funded, follow-on Dark Fury hypersonic system, which nature and performance characteristics are highly classified. These Kratos investments in the hypersonic and other relevant areas create a versatile family of test, evaluation and "other" products that offer complete systems, SRMs, and flyers. With the Zeus SRMs, and the Erinyes, Dark Fury, and other Kratos front ends, Kratos is one of the only companies boasting both launcher and "Flyer" systems within one organization, providing unmatched innovation, disruptive capabilities, mission responsiveness and affordability to the customer.

Dave Carter, President of Kratos Defense & Rocket Support Services Division, said, "The Kratos Zeus family of SRMs is representative of our strategy to internally fund, rapidly develop, be first to market and field affordable, relevant systems to the United States Department of Defense and our Allies. At Kratos, affordability is a technology, and the low cost of these incredibly effective, high-performance systems, is driving significant interest from the relevant customer and user communities, as represented by this initial order of Zeus SRMs."

Eric DeMarco, President and CEO of Kratos, said, "Kratos Zeus family of SRMs demonstrates our internally funded investment strategy of delivering relevant products and systems, not power points or renditions, to the National Security market. Kratos Zeus family of motors, similar to other Kratos systems, including tactical drones like Valkyrie, our Oriole rocket, and our hypersonic flyers Erinyes and Dark Fury, are not only rapidly developed and demonstrated, but are also engineered up front for affordable mass production at quantity, an additional Kratos differentiator and value enhancer for our government customers and also for our traditional prime system integrator partners."

Spacepreneur Editor Kartikeya in conversation with

Lt. Gen. AK Bhatt

Director General, Indian Space Association (ISpA)

Q Can you provide an overview of the current priorities and goals of the Indian Space Association (ISpA)?

A The current priorities and goals of ISpA are collaborating with government agencies, research institutions, and private companies to advance space exploration and technology in India, contributing to work in the deep space ecosystem, supporting the commercialization of space activities ensuring 'Ease of Doing Business', promoting research and development in areas such as satellite technology and space-based applications, and advocating for the interests of the Indian space sector on the global stage. We are most happy that our efforts have resulted in a liberal FDI policy and a harmonious method of allocation of spectrum.

In your assessment, where does India stand in its overall capacity in space, both civil and military?

India has made significant strides in both civil and military space capacities. While there could be many views as to where we, the fact is that we are amongst the four nations that have successfully executed missions on the moon like Chandrayaan 3. With successful missions like this India has demonstrated its growing capabilities and has captured the imagination of entrepreneurs and citizens alike.

Q Is it fair to say that Gaganyaan has ignited the imagination of all entrepreneurs and all citizens?

A Yes, the Gaganyaan mission has indeed ignited the imagination of entrepreneurs and citizens across India, but more than that, it is the Chandrayan3 mission that has garnered us laurel all over the world apart from boosting the confidence of our entire scientific community. However, an ambitious mission like the Gaganyaan mission takes us as a nation to outer space, this followed by establishment of space stations, and later having humans on a moon base station. The Gaganyaan mission will showcase India's capabilities in human spaceflight and will generate further interest in the space sector.

Q How does ISpA collaborate with government agencies, research institutions, and private companies to advance space exploration and technology in India?

A We work closely with all government agencies, research institutions, and private companies to foster collaborations, share knowledge, and drive innovation in space exploration and technology. We facilitate partnerships, promote joint research and development initiatives, and provide a platform for stakeholders to come together and contribute to India's space growth story via MoUs, seminars, active lobbying, and awareness.

Q What are some of the recent achievements or milestones of the Indian space program that ISpA has been involved in?

A ISpA's itself has none, it is our members' successes that are ISpA's achievements. ISpA has been actively involved in various milestones of the Indian space program, working closely with stakeholders to achieve remarkable feats. Some of the recent achievements include the HAL-L&T consortium very soon building 5 PSLVs for ISRO, Skyroot Aerospace successfully launching its first sub-orbital launch vehicle, Vikram-S, from Sriharikota, Agnikul Cosmos successfully test-firing its first 3D-printed semi-cryogenic rocket engine, the Agnilet and hopefully soon having its sub orbital launch very soon. The launching of 72 satellites of OneWeb launched by ISROby the LVM3 M2 mission, Digantara successfully launching the world's first commercial, space-based space weather monitoring system, Pixxel's 'Anand' satellite successfully launched in ISRO PSLV C54 mission, Dhruva Space launching 2 nanosatellites in ISRO PSLV C54 mission, Nelco & Telesat completing successful LEO demonstrations in India, and the launch of Azista-BST's satellite.

Q How does ISpA address challenges such as budget constraints, technological advancements, and international competition in the space sector?

A As you are aware funds for private sector are a challenge in this high risk sector where returns on investment take a very long time. We are happy that the government has announced a liberal FDI policy that will attract forgein capital. The Government also declared some lower GST. We are lobbying for tis to be expanded to more areas. Also for this sector to grow more liberal fiscal incentives will need to be provided. These include Tax holidays, liberal low interest loans, grants for R &D, import exemptions and inclusion in PLI incentive.

As for technological development, research funds to academia and adequate funds for ISRO are a must to keep us up. As for international competition, I am sure that in years to come our space sector will become a net exporter meeting global standards in cost and technology.

Q How does ISpA support the commercialization of space activities and foster partnerships with private industry players?

A We extend our support to the private space players by creating a favorable ecosystem for private industry players. We work towards streamlining regulations, promoting investor-friendly policies, and facilitating access to infrastructure and resources. Fostering partnerships between private companies and government agencies to encourage collaboration and jointly develop space technologies and services. Notable examples include the Mission DefSpace (75 challenges- iDEX Prime & Make I) launched by Hon'ble Prime Minister & its feasibility study. We are also working with the Ministry of Agriculture & Farmers' Welfare on downstream applications for farming in India.

Q Can you elaborate on ISpA's efforts to promote space education and inspire the next generation of space scientists, engineers, and entrepreneurs?

A We as an association place a strong emphasis on space education and inspiring the next generation of space professionals. One of our key members, SpaceKidz India, actively develops space-related curricula, organizes workshops and seminars to raise awareness about space careers, and provides mentorship and guidance to students interested in the space sector. We also support IN-SPACe initiatives that encourage innovation and entrepreneurship in the space domain, like the recently concluded workshop on "A2Z of Satellite Technology" - one of many workshops organized by IN-SPACe.

Q What role does ISpA play in shaping national space policy

and advocating for the interests of the Indian space sector on the global stage?

A ISpA is the apex and primary voice of the Indian private space industry. We are fortunate to interact with the Department of Space (DoS), INSPACe, Department of Telecommunications (DoT), Wireless Planning & Coordination Wing (WPC), and Department of Science and Technology (DST), and they do take note of our recommendations made on behalf of the industry and start-ups. For example, ISpA played a crucial role in providing inputs for the national space policy, FDI policy and Telecommunication Act. We endeavour for providing inputs and recommendations to policymakers which are focussed for growth of this sector and development of the Indian space sector.

Q How does ISpA ensure that space activities align with broader national objectives, such as economic development, scientific research, and national security?

A We work closely with all possible stake holders ie government agencies, industry, academia, research agencies, defence forces and other user ministries to align space activities with broader national objectives, and we are aware of the national aspirations -contributing to the formulation of space policies and strategies that prioritize economic development, scientific research, and national security. We also promote the application of space technologies in various sectors, such as agriculture, disaster management, and urban planning, to ensure that the benefits of space reach every corner of the nation and last mile.

Q Looking ahead, what are the key priorities and challenges that ISpA anticipates for the future of the Indian space industry, and how does it plan to address them?

A ISpA anticipates several key priorities and challenges for the future of the Indian space industry, which primarily includes "funding and generating demand". We plan to address these challenges by advocating for increased investment, fostering partnerships, and promoting the development of indigenous capabilities to meet the growing demand for space-based services and technologies.

Q Given the strides made in the space domain by some of the technologically advanced countries, do you feel that India will be able to catch up with them? How soon will that be, and have we identified the priority areas?

A While some technologically advanced countries have made significant progress in the space domain, for India, it's not about catching up. We need to be positive, and ISRO has already showcased its technological prowess with missions like Chandrayaan, Aditya L1 and XpoSAT etc. The key is maintaining the technological heritage we have among the leading space faring nations, thanks to ISRO; this in future needs to be replicated in the private sector. By identifying priority areas such as satellite technology, space exploration, and space-based applications, and leveraging the capabilities of Indian startups and industry players, we can accelerate our space endeavors.

Do you think one of the Indian startups has the caliber to become SpaceX in the coming decade? We would also request you to comment on investor and finance, as to become SpaceX, there is a substantial amount of investment required.

SpaceX has two things: a) disruptive technology and b) the ability to secure large investments. Indian startups have immense potential, and with the right support and ecosystem, it is possible for one of them to achieve remarkable feats like SpaceX. However, becoming a SpaceX-like entity requires substantial investment and a conducive environment for innovation and risk-taking. We in India have the calibre and brain power to produce the best tech, but finance is an issue that requires more effort and deliberation. We are working towards creating a favorable investment climate and connecting startups with potential investors to support their growth and ambitions.

Q Do you think AI and digital twins have the capability to disrupt satellite manufacturing and space as such?

A Absolutely! AI and digital twins do have the potential to revolutionize satellite manufacturing and the space industry as a whole. These technologies can enable more efficient design, testing, and simulation processes, leading to faster development cycles and cost optimization. The 3D-printed engines by Agnikul is an example of how these new technologies are already being applied in the space sector.

Q Could you share the opportunities which you can foresee for the Indian downstream space technology and auxiliary industry?

A The Indian downstream space technology and auxiliary industry present numerous opportunities for growth and innovation. Areas such as earth observation, remote sensing, satellite communication, and navigation services have immense potential for commercial applications. ISpA, along with NASSCOM and Deloitte, have explored this in full length in a report titled "Exploring Opportunities for Indian Downstream

SpaceTech," where we identified 200 potential Use cases in sectors like communication, agriculture, transportation, urban planning, and disaster management, where space-based solutions can provide valuable insights and support decision-making.

Q Please share what are the likely global trends in earth observation as per ISpA?

A Likely global trends in earth observation include the increasing use of high-resolution imaging, hyperspectral imaging, and synthetic aperture radar (SAR), the integration of AI and machine learning for data analysis and edge computing, and the development of constellation systems for continuous monitoring. There is also a growing demand for near-real-time data and analytics to support various applications such as environmental monitoring, resource management, and disaster response.

Q Could you describe how ISpA is aiming to make India an economic space hub, along with some timelines or deadlines?

A We are committed to making India an economic space hub by fostering a vibrant space ecosystem, attracting investments, and promoting the commercialization of space activities. Space Technology Parks would help, along with continued support from the government. Our efforts include advocating for favorable policies, supporting the development of space infrastructure, and facilitating partnerships between industry, academia, and government agencies. While specific timelines are subject to various factors, ISpA is working towards achieving significant milestones in the next 5-10 years to position India as a global space economic hub in lines with IN-SPACEs' decadal vision of $44 Billion economy.

Q How can ISpA help Indian startups collaborate with foreign startups? Last year's French interest can be taken to other countries.

A Building upon the French (GIFAS) interest from last year at the 2nd Indian Space Conclave 2023, we are actively exploring partnerships with space associations like the US-India Business Council (USIBC), US-India Strategic Partnership Forum (USISPF), ITRI (Taiwan) and startups from other countries. ISpA provides a platform for networking, knowledge sharing, and technology exchange between Indian and foreign startups. We through our outreach also assist in identifying potential collaboration opportunities, navigating regulatory frameworks, and facilitating joint ventures or partnerships.

Q How would the entry of big players like TASL change the whole growth structure?

A The entry of TASL (Tata Advanced Systems Limited) into the Indian space sector is expected to have a significant impact on the growth structure. TASL being a Tata company brings finance, experience, and expertise. With their extensive resources, expertise, and global networks, these large corporations can accelerate the development of space technologies and services. The collaboration between big players and startups can also lead to technology transfer, mentorship, and increased opportunities for the entire space ecosystem.

Q What would you define as the motto for your organization in the long term and advise your members in the short term?

A ISpA's motto "Bhumandal se Brahmand tak" (From Earth to the Universe) encapsulates our long-term vision to position India as a global leader in the space domain, harnessing the power of space technology for socio-economic development, scientific advancement, and national security. The aim is to create a self-reliant and internationally competitive space industry that contributes significantly to India's growth story. In the short term, we aim to guide and assist our members to focus on innovation, collaboration, skill development, and capturing a large share of the global space economy aligning with our Government"s forward looking Vision.

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Boeing-built X-37B Orbital Test Vehicle Embarks on 7th Mission

The Boeing built X-37B autonomous spaceplane launched aboard a SpaceX Falcon Heavy rocket, marking the beginning of its seventh mission.

"The X-37B government and Boeing teams have worked together to produce a more responsive, flexible, and adaptive experimentation platform," said William D. Bailey, Director, Department of the Air Force Rapid Capabilities Office. "The work they've done to streamline processes and adapt evolving technologies will help our nation learn a tremendous amount about operating in and returning from a space environment."

As it has with every mission, the Orbital Test Vehicle will validate new technologies, fostering innovation and pushing the boundaries of space exploration and utility. On this seventh flight, the X-37B will test future space domain awareness

technology experiments that are integral in ensuring safe, stable and secure operations in space for all users of the domain.

"The technological advancements we're driving on X-37B will benefit the broader space community, especially as we see increased interest in space sustainability," said Michelle Parker, Space Mission Systems vice president at Boeing Defense, Space & Security. "We are pushing innovation and capability that will influence the next generation of spacecraft."

Since its inaugural launch in April 2010, the X-37B has consistently set new endurance records, surpassing the initial design mission duration of 270 days. Its sixth mission set a new record with an impressive 908-day journey before returning to Earth in November 2022.

The X-37B, which will now build on its more than 1.3 billion miles traveled during its 3,774 days in space, exemplifies the successful partnership between the Department of the Air Force Rapid Capabilities Office and the United States Space Force. Boeing teams deliver program management, engineering, production, test and mission support.

In 2019, the X-37B was awarded the Robert J. Collier Trophy for advancing the performance, efficiency and safety of air and space vehicles.

ULA Successfully Launches 1st Next Generation Vulcan Rocket

United Launch Alliance (ULA) marked the beginning of a new era of space capabilities with the successful launch of its next generation Vulcan rocket on Jan. 8 at 2:18 a.m. EST from Space Launch Complex-41 at Cape Canaveral Space Force Station. The Vulcan provides industry-leading capabilities to deliver any payload, at any time, to any orbit.

"Vulcan's inaugural launch ushers in a new, innovative capability to meet the ever-growing requirements of space launch," said Tory Bruno, ULA's president and CEO. "Vulcan will provide high performance and affordability while continuing to deliver our superior reliability and orbital precision for all our customers across the national security, civil and commercial markets. Vulcan continues the legacy of Atlas as the world's only high-energy architecture rocket."

Vulcan will leverage the world's highest-performing upper stage to deliver on ULA's industry-leading legacy of reliability and precision. Centaur V's matchless flexibility and extreme endurance enables the most complex orbital insertions within the most challenging and clandestine orbits.

"The successful development and flight of this evolutionary rocket is a true testament to the unrivaled dedication and ingenuity of our

workforce," said Mark Peller, vice president of Vulcan Development. "Vulcan's purpose-built design leverages the best of what we've learned from more than 120 combined years of launch experience with Atlas and Delta, ultimately advancing our nation's space capability and providing unprecedented mission flexibility."

The first certification flight (Cert-1) mission included two payloads: Astrobotic's first Peregrine Lunar Lander, Peregrine Mission One (PM1), as part of NASA's Commercial Lunar Payload Services (CLPS) initiative to deliver science and technology to the lunar surface, and the Celestis Memorial Spaceflights deep space Voyager mission, the Enterprise Flight.

The Cert-1 mission served as the first of two certification flights required for the U.S. Space Force's certification process. The second certification mission (Cert-2) is planned to launch in the coming months, followed by a summer launch of the first Vulcan mission to support national security space.

"As we build on today's successful launch, the team will continue to work towards our future bi-weekly launch rate to meet our customers' manifest requirements, while continuing to develop future Vulcan upgrades including SMART reuse plans for downrange, non-propulsive recovery of Vulcan engines," said Bruno.

ULA has sold more than 70 Vulcan launches to date, including 38 missions for Amazon's Project Kuiper and multiple national security space launch missions as the part of the country's Phase 2 launch procurement.

Rocket Lab Successfully Launches Mission Designed to Investigate Removing Space Junk from Orbit

Rocket Lab USA, Inc a global leader in launch services and space systems launched its 44th Electron rocket, successfully deploying an orbital debris inspection satellite for Astroscale Japan Inc.

The mission, named "On Closer Inspection", launched from Pad B at Rocket Lab's Launch Complex 1 in New Zealand at 03:52 NZDT February 19th, 2024 (14:52 UTC, February 18th). Electron deployed the Active Debris Removal by Astroscale-Japan (ADRAS-J), a satellite designed to test technologies and operations for approaching and monitoring debris objects in orbit, also known as space junk. The mission is the first phase in assessing the potential for satellites to rendezvous with orbital debris objects in future and assist in de-orbiting them, supporting space sustainability for future generations.

Following the successful launch on Electron, the 150-kilogram ADRAS-J satellite will now approach an aged, derelict rocket stage in orbit to observe it closely, understand how it behaves and determine potential methods for its assisted deorbiting in future. The rocket stage it will be observing is the Japanese H-2A upper stage left in low Earth orbit after the launch of the GOSAT Earth observation satellite in 2009. ADRAS-J will fly around the stage, 11 meters long and four meters in diameter, inspecting it with cameras and sensors. Astroscale's full mission will take between three and six months to complete.

"Congratulations to the Astroscale team on this historic mission that paves the way for new and innovative ways to reduce orbital debris and ensure space remains safely accessible," said Rocket Lab founder and CEO Peter Beck. "It's a real honor to provide a dedicated launch service and enable the kind of precise orbital maneuvers required for an advanced mission like this."

To enable the ADRAS-J satellite to rendezvous with the derelict H-2A upper stage in orbit, Rocket Lab had to design a mission with strict launch timing and precision orbital deployment parameters. Rocket Lab only received the final perigee, apogee, and inclination from Astroscale 20 days before launch, parameters that are typically determined many months in advance of a launch. Only then could argument of perigee targets for different days within the launch window be selected, essentially determining the timing of Electron Kick Stage burns to facilitate the unique elliptical orbit required depending on the launch date. The mission demanded highly accurate orbital insertion with tighter margins than required on most standard missions. The exact T-0 was only able to be defined the day prior to launch and the required LTAN accuracy only allows for +/- 15 seconds, demonstrating Rocket Lab's capability to deliver rapid and responsive advanced guidance, navigation and control analysis.

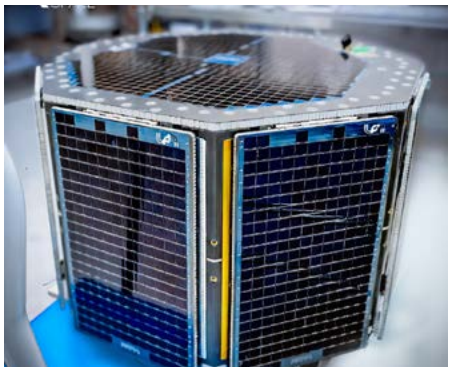
"Today's successful launch of ADRAS-J marks another milestone toward our efforts to grow the on-orbit servicing sector while creating a sustainable space environment," said Astroscale founder & CEO Nobu Okada. "We are grateful for the collaboration with Rocket Lab, whose expertise in dedicated launch services has been instrumental to the start of this ground breaking mission."

SUCCESSFUL LAUNCH OF OVZON 3

Ovzons proprietary developed satellite Ovzon 3 has now successfully been launched from SpaceX Cape Canaveral launch site in Florida, USA. Ovzon 3 will enter into service by mid-year 2024, when it has reached its orbital position.

Ovzon 3 is a revolutionary geostationary communications satellite. It is the first in its class of communications satellites that has been specifically designed and developed to provide the highest degree of performance, mobility and resiliency - offering superior performance for all mission critical assignments.

"We are immensely proud of the fact that Ovzon 3 is the first privately funded and developed Swedish geostationary communications satellite ever to be launched. The close teamwork with our partners Maxar and SpaceX has, despite delays and unfortunate circumstances in the wake of the pandemic, come to fruition, and we are grateful to all the people working relentlessly together to design, build, finalize, and launch the satellite in the last couple of years. Nevertheless, as always when working in space many risks still remain before the satellite has entered into service. I would also, sincerely, like to express my gratitude to our long-term shareholders who have supported us in every step of this journey. We now preparing for Ovzon's next chapter, with all the capabilities in our hands to enable our customers to fully take advantage of Ovzon's unique SATCOM-as-a-Service solutions", says Per Norén, CEO of Ovzon.



Sidus Space LizzieSat Arrives at Vandenberg Space Force Base Ahead of Launch

Sidus Space a multi-faceted Space and Data-as-a-Service company, is proud to announce that its LizzieSatTM satellite has arrived at Vandenberg Space Force Base, California. This marks a significant milestone as LizzieSat gears up for its inaugural mission, which is scheduled to launch no earlier than March 2024 on SpaceX's Transporter-10 mission.

Upon arrival, the Sidus Space team began final flight preparations ahead of LizzieSat's integration with the launch vehicle. LizzieSat's primary mission involves coincident data collection via multiple sensors to support agriculture, maritime and oil and gas industries. These sensors and receivers include hyperspectral, multispectral, AIS, and optical. Additionally, the Company's onboard FeatherEdge AI, near real-time, actionable intelligence will process the imagery and sensor data offering tailored solutions to customers. Delivery of data is expected to begin 30 days after deployment of LizzieSat.

"We are thrilled to reach this crucial stage in our mission. This spacecraft embodies our commitment to providing cutting-edge solutions and valuable data across various industries. The integration of advanced sensors and AI capabilities positions LizzieSat as a pioneering force in the realm of space-based data collection," stated Carol Craig, CEO and Founder of Sidus Space.

In addition to serving commercial industries, this mission holds a pivotal role in delivering essential data payloads for NASA and Mission Helios. Sidus Space is committed to advancing space exploration and contributing valuable insights to further scientific endeavors.

Merah Putih-2 Telecommunications Satellite Successfully Launched

Merah Putih-2 telecommunications satellite, formerly named Telkomsat HTS 113BT, was successfully launched atop a SpaceX Falcon9 vehicle from Cape Canaveral in Florida.

Designed to strengthen connectivity infrastructure throughout Indonesia, Merah Putih-2 aims to enhance digital businesses by offering superior quality of service to the Indonesian society. Based on Thales Alenia Space's historical Spacebus 4000B2 platform, Merah Putih-2, named after Indonesia's flag colors, will contribute to bridging the digital divide across the archipelago by providing a capacity exceeding 32 gigabit per second.

The contract to build the High Throughput Satellite was signed in 2021 between Thales Alenia Space, the joint venture between Thales (67%) and Leonardo (33%), and the leading satellite service provider in Indonesia, PT Telkom Satelit Indonesia (Telkomsat) as subsidiary of PT Telkom Indonesia (Persero) Tbk (Telkom) a state-owned digital telecommunication company.

Thales Alenia Space spearheaded the program as the prime contractor, overseeing the satellite's design, construction, testing, and on-ground delivery. In addition, the company furnished the ground control segment and conducted comprehensive theoretical and hands-on training sessions for Telkomsat engineers, held in both France and Indonesia, aimed at preparing them for the satellite operations. Thales Alenia Space is also in charge of the early orbital positioning phase (LEOP), in-orbit tests (IOT) and will provide in-orbit support all along the satellite lifetime.

With a launch mass of 4 tons, Merah Putih-2 will operate in C-band/Ku-Band and be positioned in orbit at 113° East for a design life of 15 years.

"It is a source of pride to witness the successful launch of Merah Putih-2, a mission that will provide better quality of telecommunications services in Indonesia." said Marc-Henri Serre, Thales Alenia Space Executive Vice President, Telecommunications. "This program was developed through our productive collaboration with Indonesian stakeholders, following the construction of Palapa-D, Telkom-3S, Telkom 3 payload, and SATRIA satellites, all of which are instrumental in bridging Indonesia's digital divide".

Virgin Galactic Completes 11th Successful Spaceflight

Virgin Galactic Holdings, Inc. announced the completion of its first spaceflight of 2024 and 11th mission to date. Galactic 06' flight marked the first time all four seats aboard VSS Unity were occupied by private astronauts.

Michael Colglazier, CEO of Virgin Galactic, said: "Today the incredible team at Virgin Galactic supported another successful mission and delivered an unforgettable experience for four new astronauts. The success of 'Galactic 06' and the Company's other commercial spaceflights in recent months only increases our confidence in the repeatability of our product and our ability to deliver a superlative experience to our customers. With the production of our next-generation Delta-class ships underway, we look forward to expanding our flight capacity with testing expected to start next year and commercial service in 2026."

Onboard 'Galactic 06':

Astronaut 023 – Lina Borozdina, Ukraine and Nevada, U.S.

Astronaut 024 – Robie Vaughn, Texas, U.S.

Astronaut 025 – Franz Haider, Austria

Astronaut 026 – Neil Kornswiet, California, U.S.

Today's launch was watched from the ground at Spaceport America by more than 150 guests alongside Virgin Galactic's team.

VSS Unity was commanded by C.J. Sturckow with pilot Nicola Pecile. Michael Masucci commanded mothership VMS Eve joined by pilot Dan Alix.

'Galactic 06' Flight Facts

Take-off Time 10:00 am MT

Altitude at Release 44,493 ft

Apogee 55.1 miles

Top Speed Mach 2.98

Landing Time 10:56 am MTVirgin Galactic Completes 11th Successful Spaceflight

Rocket Lab Successfully Launches 1st Electron Mission of Busy 2024 Launch Schedule

Rocket Lab USA, Inc. a global leader in launch services and space systems launched its first Electron mission for 2024, a space-junk focused mission for Spire Global, Inc ("Spire") and NorthStar Earth & Space ("NorthStar").

The 'Four Of A Kind' mission for Spire's customer NorthStar successfully launched from Rocket Lab Launch Complex 1 in New Zealand at 19:34 NZDT / 06:34 UTC. Rocket Lab's Electron rocket deployed four Space Situational Awareness (SSA) satellites to a 530km circular Earth orbit where the satellites, built and operated by Spire, will monitor near-Earth objects from space to provide timely and precise information for space object detection, tracking, orbit determination, collision avoidance, navigation, and proximity alerts. The mission was Rocket Lab's 43rd Electron launch overall, bringing the Company's record of successfully deployed satellites to 176. The mission was the first of a busy launch year for Rocket Lab, with the Company scheduled to launch more in 2024 than any previous year since the Company began missions in 2017.

The mission also resulted in the successful return of the rocket's first stage after launch as part of Rocket Lab's plan to evolve Electron into a reusable rocket. After launch and stage separation, Electron's booster made its way back to Earth under a parachute and splashed down in the Pacific Ocean at approximately 17 minutes post lift-off. Rocket Lab's recovery operations are currently underway to retrieve the stage and bring it back to the Company's production complex for a post-launch review and analysis before proceeding to one of the program's final tasks: reusing a previously-launched first stage on a future mission.

Rocket Lab founder and CEO, Peter Beck, says: "The success of today's mission to deliver Spire & NorthStar to orbit, and the completion of our secondary mission to return Electron to Earth after launch, has been a fantastic start of what is set to be Rocket Lab's busiest year ever. We have more missions booked in 2024 than we've ever scheduled before, and it is a real privilege to continue to deliver small launch reliability for our satellite customers on advanced missions like these and for all the missions to come in 2024."

'Four Of A Kind' is Rocket Lab's first Electron launch in a sold-out 2024 mission manifest that includes multiple upcoming launches for NASA; hypersonic technology tests on suborbital HASTE missions from Rocket Lab Launch Complex 2 in Virginia; the beginning or continuation of block launches for satellite operators BlackSky, Synspective, and Kineis; and several other launches for commercial and defense sector mission partners.

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Spacepreneur Special Editor Sanjay Singh in conversation with

Lt Gen (Dr.) PJS Pannu

Former Deputy Chief of Integrated Defence Staff.

Q How do advancements in space technology impact the strategic capabilities of modern armed forces?

A The advancements in space technology significantly and directly impact the armed forces in contemporary and developing future strategic capabilities. The Space is considered as the fourth frontier of warfare. The digital and electronic wars have contributed to the speed, reach and accuracy of weapon systems causing disruption in the conventional war fighting technologies. In warfare, ISR (Intelligence Surveillance and Reconnaissance) capabilities are foundational. It provides the military, information and details of the adversarial targets through specific process which is a larger domain than just Satellite Earth Observation. In the battlefield one needs persistent day and night surveillance that should lend itself into meshed intelligence for executing meshed operations. This needs satellite based multi-modal and multi-sensor payloads of EO (Electro-optical), SAR (Synthetic Aperture Radar) and ELINT (Electronic Intelligence). This field is evolving and in the future LIDAR and optical links combination would enhance its efficiency of meshed warfare. The networked ISR and Secure communications with use of AI have taken the smart battlefields to adopt the configuration of C5-I2-STAR2 (Command, Control, Communications, Computers and Cyber – Information, Intelligence – Surveillance, Target Acquisition, Reconnaissance

and Robotics). In sum, military warfighting shall be largely reliant on space capabilities of nation to win wars in the future.

Q What strategies are being implemented to protect commercial satellites from potential ASAT capabilities?

A The Outer Space Treaty prohibits weaponization of space. However, certain nations, including India, have demonstrated a direct assent Anti-Satellite (ASAT) capability. In 2019, India achieved a kinetic kill targeting her own satellite in the LEO. Similarly, Rendezvous Proximity Orbits (RPO) can be a potential threat from close proximity observation of own satellites and the ability target the satellites with Directed Energy Weapons (DEWs) and achieving a direct kill. Triggering collusion, creating debris or a use of a robotic arm disturbing the stability of a satellite, or interfering with the electronics can all lead to counter-space capability. Similarly, satellites that are Quantum enabled are a potential security threat as these can be used for snooping or disruption of satellite communications. Currently, It is a challenge to protect commercial satellites from such counter-space or ASAT capabilities. Even to legally press a charge against an aggressor or indemnify for such actions, there is a need to provide hard evidence. It is therefore, imperative to invest in Space Situational Awareness (SSA) as also in counterspace capabilities to achieve space deterrence. It is also important to build redundancies through constellations. Space diplomacy has a subtle role in ensuring that our satellites do not get threatened in space.

Q Could you elaborate on how artificial intelligence is being integrated into defence systems to enhance operations in space?

A Satellites are getting smatter with each passing day. The edge computing as allowed the satellites to process information and send signals that are analysed for use, thereby, shortening the processing and decision cycles. This is more a trend with the new age satellites that have faster on board systems, but shorter life. AI has enabled the use of Robotics in sensors, as also using robotic arms for on-board servicing and repair of satellites. The AI enables the upgradation of software and alter/ modify the programs or even self-heal the satellites. The increasing reliance on constellations working as teams, broadband internet through space that need very high throughput. To ensure that these abilities working as mesh need harmonisation capabilities in space. The Inter Satellite Links can also ensure that a constellation can provide analysis through AI enablement. The future lies in autonomous wars where mosaic warfare would be largely enabled by Space AI enablement.

Q What measures are needed to counter the threat of GPS spoofing on critical infrastructure and military operations?

A GPS is the American Positioning, Navigation and Timing (PNT) constellation being most widely used for navigation and tracking globally. Countries which do not have their own PNT are largely subscribing to either GPS or PNT services of another country such as BeiDou, Glonass, Galileo etc. India has developed IRNSS or the Navic with regional reach, however, the system has not fully operationalised. It is important to get the aggregate PNT services available that allows of switch between services should one of the constellation get spoofed, the others would back up. Ground based PNT is a good back up. However, when it comes to fighting deep, precision battles, it is extremely important that shooter, sensor, and PNT meshing is perfect. Any spoofing would not only create as issue into aircraft navigation systems but also will be able to redirect deep missile strike or drone missions away from designated targets. It is therefore important that ISRO uses indigenous chipsets and secure cyber networks for NaviC military applications to keep it spoof proof.

Q Can you discuss any international collaborations or agreements aimed at addressing security concerns in space?

A India is a signatory to the Outer Space Treaty (OST) that was signed in 1967 and ratified by the US, the Soviet Union and 63 other participants of the United Nations on the 27th January. India signed OST in March same year, however, ratified the treaty only in 1982 - fifteen years later. As of February 2021, 111 countries are parties to the treaty, while another 23 have signed the treaty but have not completed ratification. The treaty forbids countries from deploying nuclear weapons or any other kinds of weapons of mass destruction in the outer space. The term "weapons of mass destruction" is not defined, but it is commonly understood to include nuclear, chemical, and biological weapons.

Space is not confined to national boundaries. Like other space agencies in the world, the Department of Space/ ISRO is having international presence, cooperation and coordination for technology exchange and development. Since ISRO was confined to peaceful space programs, the International cooperation was influenced

by political, economic, cultural environment, as well as scientific and technological factors. While exploratory missions beyond the earth are the natural contenders for such cooperative efforts, there are many other themes like climate change, impact on earth, space science and planetary exploration that are of interest to international cooperation because of their global impact.

International cooperation has been part of Indian space programme since inception. Establishment of Thumba Equatorial Rocket Launching Station (TERLS), conduct of Satellite Instructional Television Experiment (SITE) and Satellite Telecommunication Experiment Project (STEP), launches of Aryabhata, Bhaskara, Ariane Passenger Payload Experiment (APPLE), IRS-IA, IRS-IB satellites, INSAT series of satellites, Mission to Moon, etc., have the components of international cooperation. However, when it comes to military application of space, nations have to rely on indigenous innovation and R&D.

Formal cooperative arrangements in the form of either Agreements or Memoranda of Understanding (MoU) or Framework Agreements have been signed with 63 countries. Also formal cooperative instruments have been signed with international multilateral bodies like European Centre for Medium Range Weather Forecasts (ECMWF), European Commission, European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), European Space Agency (ESA) and South Asian Association for Regional Cooperation (SAARC).

Q How critical is space domain awareness in ensuring national security, and what advancements are being made in this area?

A India needs to greatly expand on its domain awareness to prevent airspace incursions. A transparent and public-facing approach on the issue which actively involves data from diverse sources, is essential to reversing this trajectory and ensuring a secure and thriving space future for India. The difference between space domain awareness (SDA) and space situational awareness (SDA) is that while SSA deals with object detection and tracking, SDA relates to both on detection and characterisation of intent. Space situational awareness entails being informed of the potential hazards to space activities and the space environment. SSA can help reduce problems like orbital collusions intentional and space junk. Space is not only heavily contested but also congested. Such collisions could result in a cascading effect, known as the Kessler Syndrome, where debris from collisions causes further collisions. Space superiority is, "the degree of control in space of one force over any others that permits the conduct of its operations at a given time and place without prohibitive interference from terrestrial or space-based threats".

Q What steps are being taken to ensure responsible conduct and prevent the escalation of conflicts in space warfare?

A India is a respectable Space faring nation. India has largely used space for peaceful and experimental purposes. Space is a global common where every space fairing nation has the right to explore by extending her assets into outer space so far it is meant for peaceful purposes. Space and celestial bodies are exempt from national claims of ownership. The outer space treaty provisions state that: Space should be accessible to all countries and can be freely and scientifically investigated. India as I mentioned earlier is a signatory to the Outer Space Treaty. To ensure that we continue to ensure responsible conduct and prevent the escalation of conflicts in space, the UN recommends the negotiation and development of a new treaty should ensure peace, security and the prevention of an arms race in the outer space. This treaty would establish international norms, rules, and principles to address emerging threats and promote responsible space activities. It prohibits countries from placing into orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction. It requires that celestial bodies shall be used by all parties exclusively Countries are to avoid contaminating and harming space or celestial bodies. Space must therefore be explored for peaceful purposes and no weapon can be stationed on them. While, the nations are using space for military purposes enabling military operations on land through space based assets but arming satellites with weapons is and should remain strictly prohibited.

Q How are cyber threats affecting the security of space assets, and what strategies are being developed to mitigate these risks?

A One of the biggest space cybersecurity threats is hacking into spacecraft and satellites. Cybercriminals can easily take control of vital systems, manipulate controls, and steal confidential data. Jamming and spoofing methods are often used to disrupt or slow down the communication of data from satellites. Cybersecurity for space has been a challenge due to the older systems being used. Most governments have yet to implement adequate cybersecurity

measures in space. The complexity, interconnection, and rapid growth of the space sector also make it a wider target surface for hackers. Most countries around the world are battling to stay ahead in the space race.

Between the complex operations between space, ground, links, and users, there are several potential vulnerabilities to contend with when it comes to space and ground infrastructure. Cyber threats now also have a larger target with the growing interest from private and commercial organizations. A few of the potentially vulnerable areas in existing space cybersecurity include: Software-Defined Radio compromise, Insider threats, Hacking ground systems to interact with satellites, Using design and hardware development to imbed malicious features, Communications hacking through command link injections, replay attacks, or electronic attacks such as jamming and spoofing. Cyber-attacks on space infrastructure can include malware installation, ransomware attacks, and data or system breaches. All these attacks can disrupt communications, supply chains, national security, internet access impacting global economies. Space missions affected by cyber-attacks can also lead to the injury or death of astronauts, the destruction of property, and the halting of progress in space exploration.

As the space race intensifies and nations rush to create new and innovative technologies, cybersecurity for space is becoming a lucrative market. Smaller businesses can seize this opportunity to fill the demand for cybersecurity measures for space technology. India needs to develop Space Cyber Security Standards to ensure the ubiquitous use of smart devices in smart battles. China has tested use of Quantum Technology for securing land and space communications. In the future battles all warfighting would have smart machines that would need high throughput. It is assessed that one square Kilometer would have upwards of one million networked sensors that would need terabytes of digital capacities. Such operations need uninterrupted and undisrupted power supply and secure communications without latency.

There are a few ways that smaller companies can amplify their brand in this rapidly expanding sector: Innovate and develop space cybersecurity solutions, Stay informed on industry trends and legislation, Establish thought leadership, Collaborate with educational institutions, Participate in industry associations and events, Diversify service offerings, Create strategic alliances.

Q What ethical considerations surround the deployment of artificial intelligence in space-related defence applications?

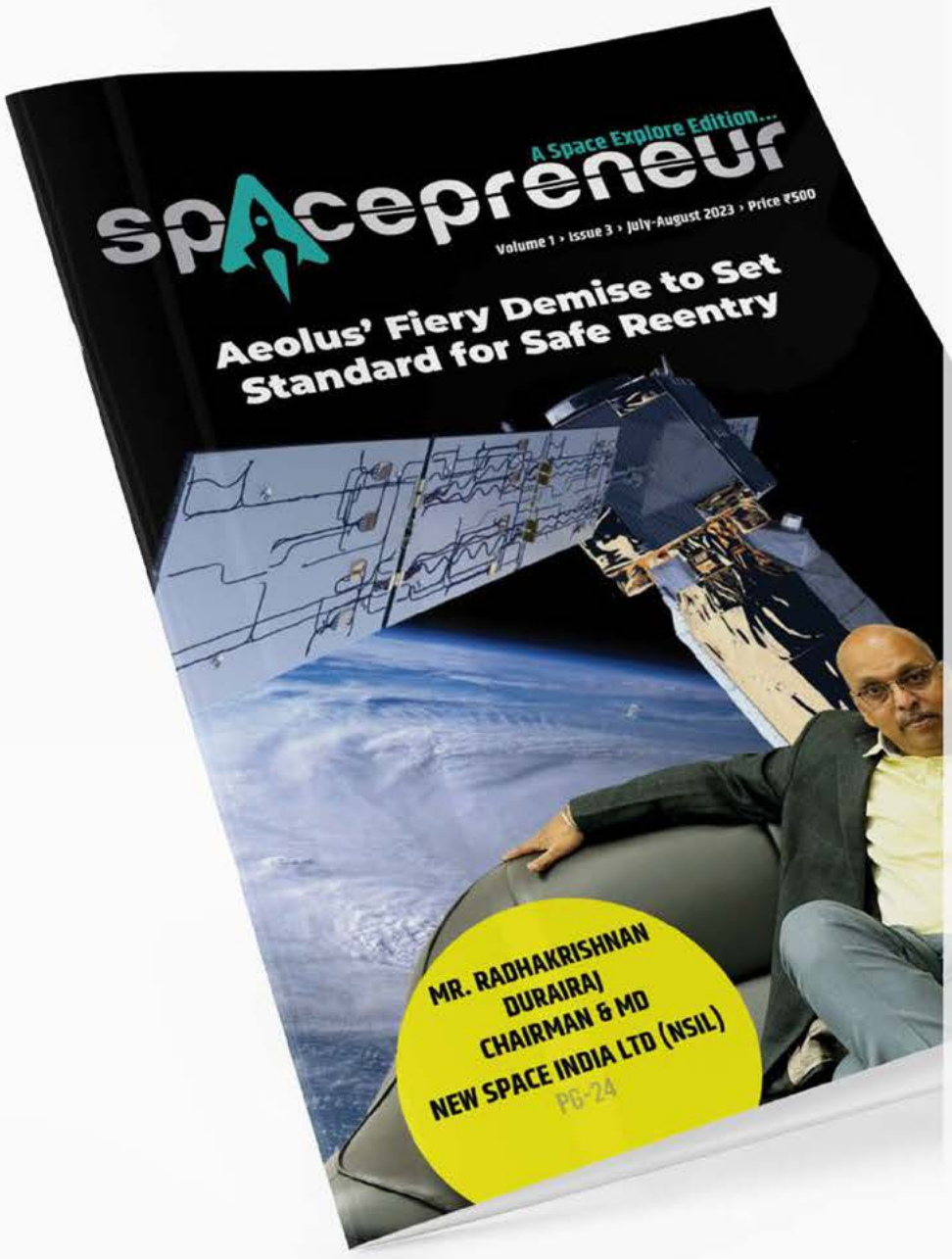
A The role of AI in space exploration is transformative, processing vast data from celestial bodies and predicting risks like solar storms and space debris. It enhances spacecraft autonomy, reduces human reliance, and aids astronauts with operations, navigation, and satellite monitoring. The adaptability and significance of AI in space exploration are shown by certain use cases, which make missions safer, more productive, and more efficient while also deepening our understanding of the cosmos. The applications of AI in space are in Mission Planning and Decision Making, Resource Utilization, Space Debris Management, Satellite Maintenance and Repair, Autonomous Rovers, Data Analysis, Trajectory Optimization, Robotics, Medical Monitoring of Astronauts, Exoplanet Exploration.

Q How do you suggest a balance security measures with civilian access to space services and technologies?

A Space has a majority of common applications or dual use cases between civilian and military application. The space is a high ground or a vantage point that gives a clear observation of the earth that it orbits. Depending on the altitude and the angle of orbit, the area of interest can be focused in greater detail. Which can be put to a military use. All remote sensing satellites have the ability to undertake ISR missions provided the payloads are adjusted. It needs to be understood what makes a satellite military grade? The ability to provide secure, precise and timely intelligence that can be processed for meshed operations in the military area of interest can be categorised military grade. Such payloads can be carried on satellites that meet military needs through the application of Communications, broadband internet, PNT, SSA, counter space etc.

Profile:

Lt Gen (Dr.) PJS Pannu is a former Deputy Chief of Integrated Defence Staff, who pioneered the raising of Defence Space Agency, Defence Cyber Agency and Armed Forces Special Forces Division. He commanded the 14 Corps, the highest battlefield of the world. He has authored two books Role of Niche and Disruptive Technologies in India's Deterrence and War Fighting Capabilities, and Power of Future Machines. He is a distinguished fellow of the USI)



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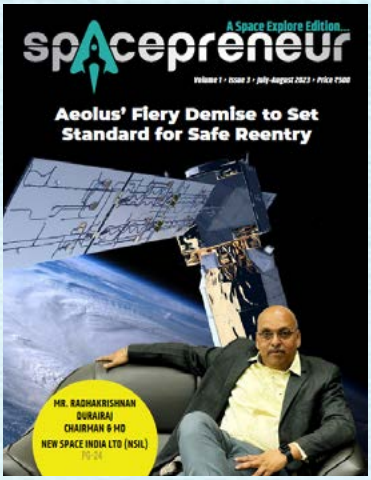

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