

# spacepreneur

A Space Explore Edition...

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**Dr. Kirankumar A.S.**  
Chair of ISRO's Committee of  
Earth Observation Satellites [CEO]



**Dr. Subba Rao**  
CMD, Ananth Technologies



**Prof. V. Balakista Reddy**  
Head-Centre for Aerospace and Defense laws  
NALSAR University of law



**Pawan Kumar Chandana**  
Co - Founder of Skyroot  
Aerospace

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Dr. SUBBA RAO PAVULURI, CHAIRMAN & MANAGING DIRECTOR,  
E-mail : [subbarao@ananthtech.com](mailto:subbarao@ananthtech.com)

## Headquarters

ANANTH TECHNOLOGIES PVT LTD.

Ananth Info Park, Plot No.39,  
Phase-II Madhapur

Hyderabad – 500 081

Tel:+91-40-6615 6615

Fax:+91-40-6615 6531

E-mail: [subbarao@ananthtech.com](mailto:subbarao@ananthtech.com)

[mail@ananthtech.com](mailto:mail@ananthtech.com)

## Satellite Facilities

ANANTH TECHNOLOGIES PVT LTD.

No:64, KIADB Bangalore  
Aerospace Park, Singahalli Village,  
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North Taluk

Bangalore – 562129

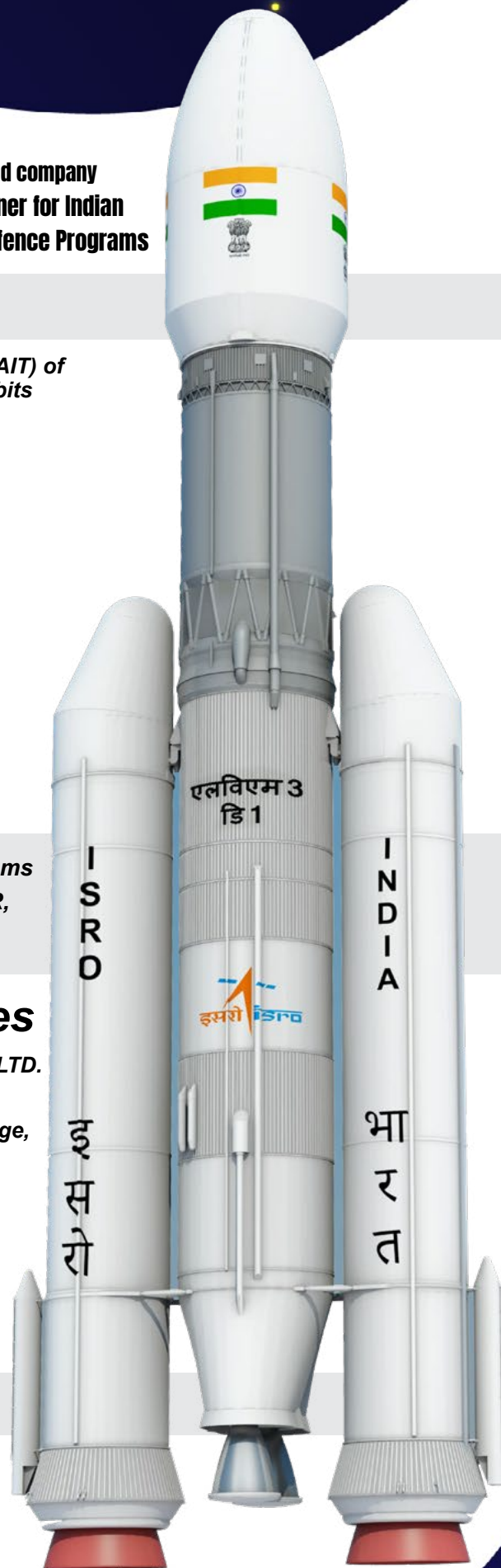
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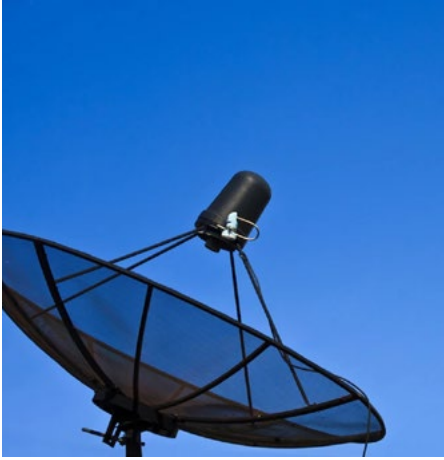
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Menamkulam Sub-Dist : Kazhakuttom Thiruvananthapuram, Kerala

Tel:+91-471-2315913 E-mail: [mail@ananthtech.com](mailto:mail@ananthtech.com)





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# EDITORIAL



**B. KARTIKEYA**

Hello my dear readers,

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.

You will learn about the sixth GPS III satellite built by Lockheed Martin and its successful launch on the Small Satellite Launch Vehicle (SSLV) as part of the constellation modernization. The cover story has a pleasant interaction between Spacepreneur Special Editor Prof. Vivekananda and Dr. Kiran Kumar A.S., Head of ISRO's Committee of Earth Observation Satellites [CEO], which you may read by moving on to the Moon and Asteroid section. You may increase your understanding of space by going through his ideas.

In the "Appointments" section, you will learn about the numerous outstanding individuals appointed to various positions in the global space department hierarchy. Review the interviews with Pawan Kumar Chandana and Naga Bharath Daka, co-founders of Skyroot, and Prof. V. Balakista Reddy, head of the NALSAR University of Law's Institute for Aerospace and Defense Laws. Don't forget to look at the most recent articles in the Mobility and Acquisition areas, too.

The writers for this publication write about a wide range of subjects important to owners and operators of space stations. We always strive to bring up pertinent business challenges and highlight critical aspects of the astronomy sector's expansion. A collection of well-known accomplished professionals and journalists with years of experience and considered authorities in their industries have written the pieces for this magazine. I acknowledge everyone who took the time to write for us as a distinguished guest author.

With that, I take your leave this month. More when we meet again in our next issue.

Till then, stay safe, God bless.

# spacepreneur

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Editor-in-Chief ♦ B. Kartikeya

## EDITORIAL

Special Editor ♦ Prof D.Vivekananda

SPACEPRENEUR  
CORRESPONDENTS ♦ Rohith Reddy

CREATIVE HEAD ♦ Swati Sharma (Design Garage)

PHOTOGRAPHER ♦ Krishanth

## MARKETING

Head Marketing ♦ Dr Pranay Kumar,  
+91 80836 30500  
pranay@futureaviation.in

## (NORTH & WEST)

Manager, Marketing ♦ Rohith Reddy

## FOR EUROPE ADVERTISEMENTS:

Jubin Josepsh  
Tel : +33 758933925  
jubin.joseph@bluespacegroup.com  
SUBSCRIPTION : Sony

## EDITORIAL & ADVERTISING OFFICES SPACEPRENEUR

No 27, Rd Number 2a, Tirumala Hills , Asmangad,  
Hyderabad, Telangana 500036, India Tel: 09444499221  
For all magazine related enquires  
E-mail: kartikeya@futureaviation.in

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# AIRBUS FINALISES JUICE READY FOR ITS MISSION TO JUPITER



The Airbus-built JUICE (JUPITER ICy moons Explorer mission) spacecraft will shortly leave Toulouse, France, for Kourou, French Guiana, for lift-off on an Ariane 5 in April 2023. Shipment is expected in early February. The spacecraft has been at Airbus in Toulouse since August 2021 for final assembly and test. This included integration of the final instrument units and the largest solar arrays ever to fly on a planetary exploration mission, needed to power the mission at 740 million kilometres from the Sun.

“With JUICE’s departure for the launch site fast approaching, we look back at its long Earthly journey through various Airbus sites in Europe towards final integration and involving close to 500 Airbus employees who prepared the spacecraft for its eight-year cruise,” said Cyril Cavel, JUICE Project Manager at Airbus Defence and Space.

“It has been an incredible adventure, along with more than 80 companies across Europe, to bring ESA’s vision to life and ulti-

mately study Jupiter and its icy moons in fine detail.”

Today a commemorative plaque was unveiled during a press event in Toulouse as a tribute to Italian astronomer Galileo Galilei. The plaque has been mounted on the spacecraft to honour Galileo who was the first to view Jupiter and its largest moons through a telescope in 1610.

On its more than 2 billion-kilometre long journey, the 6.2 ton JUICE spacecraft will collect data on the icy moons to try to understand whether there is any possibility that these moons could host microbial life. Carrying 10 state-of-the-art scientific instruments, including cameras, spectrometers, an ice-penetrating radar, an altimeter, a radio-science experiment, and sensors, the JUICE spacecraft will complete a unique tour of the Jupiter system that will include in-depth studies of three potentially ocean-bearing moons: Ganymede, Europa and Callisto.

During its four year-long mission, JUICE will spend nine months orbiting the icy moon Ganymede analysing its nature and evolution, characterising its subsurface ocean, and investigating its potential habitability. After being selected by ESA as prime contractor in 2015 Airbus has led a pan European industrial consortium to design and build this unique spacecraft.



# NASA, DARPA WILL TEST NUCLEAR ENGINE FOR FUTURE MARS MISSIONS



DARPA and NASA have a long history of fruitful collaboration in advancing technologies for our respective goals, from the Saturn V rocket that took humans to the Moon for the first time to robotic servicing and refueling of satellites,” said Dr. Stefanie Tompkins, director, DARPA. “The space domain is critical to modern commerce, scientific discovery, and national security. The ability to accomplish leap-ahead advances in space technology through the DRACO nuclear thermal rocket program will be essential for more efficiently and quickly transporting material to the Moon and eventually, people to Mars.



NASA and the Defense Advanced Research Projects Agency (DARPA) announced a collaboration to demonstrate a nuclear thermal rocket engine in space, an enabling capability for NASA crewed missions to Mars. NASA and DARPA will partner on the Demonstration Rocket for Agile Cislunar Operations, or DRACO, program. The non-reimbursable agreement designed to benefit both agencies, outlines roles, responsibilities, and processes aimed at speeding up development efforts.

“NASA will work with our long-term partner, DARPA, to develop and demonstrate advanced nuclear thermal propulsion technology as soon as 2027. With the help of this new technology, astronauts could journey to and from deep space faster than ever – a major capability to prepare for crewed missions to Mars,” said NASA Administrator Bill Nelson. “Congratulations to both NASA and DARPA on this exciting investment, as we ignite the future, together.”

Using a nuclear thermal rocket allows for faster transit time, reducing risk for astronauts. Reducing transit time is a key component for human missions to Mars, as longer trips require more supplies and more robust systems. Maturing faster, more efficient transportation technology will help NASA meet its Moon to Mars Objectives. Other benefits to space travel include increased science payload capacity and higher power for instrumentation and communication. In a nuclear thermal

rocket engine, a fission reactor is used to generate extremely high temperatures. The engine transfers the heat produced by the reactor to a liquid propellant, which is expanded and exhausted through a nozzle to propel the spacecraft. Nuclear thermal rockets can be three or more times more efficient than conventional chemical propulsion.

“NASA has a long history of collaborating with DARPA on projects that enable our respective missions, such as in-space servicing,” said NASA Deputy Administrator Pam Melroy. “Expanding our partnership to nuclear propulsion will help drive forward NASA’s goal to send humans to Mars.”

Under the agreement, NASA’s Space Technology Mission Directorate (STMD) will lead technical development of the nuclear thermal engine to be integrated with DARPA’s experimental spacecraft. DARPA is acting as the contracting authority for the development of the entire stage and the engine, which includes the reactor. DARPA will lead the overall program including rocket systems integration and procurement, approvals, scheduling, and security, cover safety and liability, and ensure overall assembly and integration of the engine with the spacecraft. Over the course of the development, NASA and DARPA will collaborate on assembly of the engine before the in-space demonstration as early as 2027.

The last nuclear thermal rocket engine tests conducted by the United States occurred more than 50 years ago under NASA’s Nuclear Engine for Rocket Vehicle Application and Rover projects.

“With this collaboration, we will leverage our expertise gained from many previous space nuclear power and propulsion projects,” said Jim Reuter, associate administrator for STMD. “Recent aerospace materials and engineering advancements are enabling a new era for space nuclear technology, and this flight demonstration will be a major achievement toward establishing a space transportation capability for an Earth-Moon economy.”

NASA, the Department of Energy (DOE), and industry are also developing advanced space nuclear technologies for multiple initiatives to harness power for space exploration. Through NASA’s Fission Surface Power project, DOE awarded three commercial design efforts to develop nuclear power plant concepts that could be used on the surface of the Moon and, later, Mars.

NASA and DOE are working another commercial design effort to advance higher temperature fission fuels and reactor designs as part of a nuclear thermal propulsion engine. These design efforts are still under development to support a longer-range goal for increased engine performance and will not be used for the DRACO engine.



# SUCCESSFUL FLIGHT OF SMALL SATELLITE LAUNCH VEHICLE (SSLV)

**S**mall Satellite Launch Vehicle (SSLV) successfully launched three satellites into their intended orbits. In its second developmental flight, the SSLV-D2 vehicle placed EOS-07, Janus-1 and AzaadiSAT-2 satellites into their intended 450 km circular orbit with an inclination of 37 degrees. It took-off from the first launch pad at Satish Dhawan Space Centre, Sriharikota at 09:18 hours IST and took about 15 minutes to inject the satellites.

SSLV is the new small satellite launch vehicle developed by ISRO to cater the launch of small satellites up to 500 kg to Low Earth Orbits on 'launch-on-demand' basis. It is config-

ured with three solid stages 87 t, 7.7 t and 4.5 t respectively. SSLV is a 34 m tall, 2 m diameter vehicle having a lift-off mass of 120 t. A liquid propulsion-based Velocity Trimming Module (VTM) achieves desired velocity for the insertion of the satellites into the intended orbit. SSLV is capable of launching Mini, Micro, or Nanosatellites (10 to 500 kg mass) to a 500 km orbit. It provides low-cost access to Space, offers low turn-around time, facilitates flexibility in accommodating multiple satellites and demands minimal launch infrastructure.

In its first developmental flight on August 7, 2022, SSLV-D1 had marginally missed to place the satellites. SSLV-D2 implemented the recommendations made by the expert committee that analysed the shortcomings of SSLV-D1 flight.

SSLV-D2 carried EOS-07, a 153.6 kg Earth Observation Satellite realised by ISRO; Janus-1, a technology demonstration satellite weighing 10.2 kg belong ANTARIS, USA; and AzaadiSAT-2, a 8.8 kg satellite realised by Space Kidz India by integrating various scientific payloads developed by 750 girl students across India.

With today's successful launch India has got a new launch vehicle which was aimed to commercialise the small satellite launches through Industry on demand basis. ISRO looks forward for catering to the increasing global need of launching smaller satellites into Space.



Cunningham's last assignment at NASA Johnson was chief of the Skylab branch of the Flight Crew Directorate. In this capacity, he was responsible for the operational inputs for five major pieces of manned space hardware, two different launch vehicles and 56 major experiments that comprised the Skylab Program.



# Apollo Astronaut Walter Cunningham Dies at 90

Former astronaut Walter Cunningham, who flew into space on Apollo 7, the first flight with crew in NASA's Apollo Program, died early Tuesday morning in Houston. He was 90 years old.

"Walt Cunningham was a fighter pilot, physicist, and an entrepreneur – but, above all, he was an explorer. On Apollo 7, the first launch of a crewed Apollo mission, Walt and his crewmates made history, paving the way for the Artemis Generation we see today," said NASA Administrator Bill Nelson. "NASA will always remember his contributions to our nation's space program and sends our condolences to the Cunningham family."

Cunningham was born March 16, 1932, in Creston, Iowa. He graduated from Venice High School, in Venice, California, before going on to receive a Bachelor of Arts with honors in physics in 1960 and a Master of Arts with distinction in physics in 1961 from the University of California at Los Angeles. He then completed a doctorate in physics with exception of thesis at the Advanced Management Program in the Harvard Graduate School of Business in 1974.

The Cunningham family offered the following statement: "We would like to express our immense pride in the life that he lived, and our deep gratitude for the man that he was – a patriot, an explorer, pilot, astronaut, husband, brother, and father. The world has lost another true hero, and we will miss him dearly."

He joined the Navy in 1951 and served on active duty with the U.S. Marine Corps, retiring with the rank of colonel. He flew 54 missions as a night fighter pilot in Korea. He worked as a scientist for the Rand Corporation for three years. While with Rand, he worked on classified defense studies and problems related to the Earth's magnetosphere. Cunningham has accumulated more than 4,500 hours of flying time in 40 different aircraft, including more than 3,400 in jet aircraft.

Cunningham was selected as an astronaut in 1963 as part of NASA's third astronaut class.

Prior to his assignment to the Apollo 7 crew, Cunningham was on the prime crew for Apollo 2 until it was cancelled and the backup lunar module pilot for Apollo 1. Cunningham was designated the lunar module pilot for the 11-day flight of Apollo 7, which launched on Oct. 11, 1968, and was the first human flight test of the Apollo spacecraft. With Walter M. Schirra, Jr. and Donn F. Eisele, he tested maneuvers necessary for docking and lunar orbit rendezvous using the second stage of their Saturn IB rocket. The crew successfully completed eight tests, igniting the service module engine, measuring the accuracy of performance of all spacecraft systems, and providing the first live television transmission of onboard crew activities. The 263-hour, 4.5-million-mile flight splashed down Oct. 22, 1968, in the Atlantic Ocean.

“

On behalf of NASA's Johnson Space Center, we are beholden to Walt's service to our nation and dedication to the advancement of human space exploration," said Vanessa Wyche, center director. "Walt's accomplished legacy will continue to serve as an inspiration to us all.

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# SIXTH GPS III SATELLITE BUILT BY LOCKHEED MARTIN LAUNCHES AS PART OF CONSTELLATION MODERNIZATION



Lockheed Martin is incredibly proud to support the Space Force's GPS team as it continues to add world-class capabilities that underpin U.S. national security with enhanced performance and accuracy," said Andre Trotter, Lockheed Martin vice president for Navigation Systems. "With the last GPS III satellite complete and ready to launch, production of the first GPS IIIIF vehicle is underway.



The sixth Global Positioning System III (GPS III) satellite designed and built by Lockheed Martin has been launched and is propelling to its operational orbit approximately 12,550 miles above Earth, where it will contribute to the ongoing modernization of the U.S. Space Force's GPS constellation.

GPS III Space Vehicle 06 (GPS III SV06) launched from Cape Canaveral Space Force Station, Florida, aboard a SpaceX Falcon 9 rocket at 7:24 a.m. EST today. About 83 minutes after liftoff, U.S. Space Force and Lockheed Martin engineers at the company's Denver Launch & Checkout Operations Center confirmed signal acquisition of GPS III SV06 and now have the space vehicle «flying» under their control. GPS III SV06 is the 25th Military-Code satellite introduced to the constellation. The satellite will provide advanced technology to aid Space Force operators in their mission by providing positioning, navigation and timing (PNT)

data to military and civil users worldwide.

GPS is a satellite-based radio navigation system that delivers the gold standard in PNT services to America's military, U.S. allies and civil users. The satellites serve as a crucial technological foundation for internet, financial, transportation and agricultural operations, with more than 4 billion users depending on the PNT signals.

GPS III vehicles provide three times greater accuracy and eight times greater anti-jamming capability over existing satellites in the constellation. To better address mission needs and emerging threats, Lockheed Martin intentionally created GPS III with a modular design, allowing new technology and capabilities to be added in the future.

Lockheed Martin has completed production on its original GPS III SV1-10 contract, with the Space Force declaring SV10 Available for Launch on Dec. 8, 2022. GPS III SV06 will soon join SV01-05 in orbit. GPS III SV07-10 are completed and in storage at the company's facility waiting for the U.S. Space Force to call them up for launch. Lockheed Martin is also designing and building the GPS III Follow On (GPS IIIIF) for the Space Force, which will feature even more innovative capabilities than its predecessors. GPS IIIIF satellites will feature an accuracy-enhancing laser retroreflector array, a new search and rescue payload, a fully digital navigation payload and more next-generation technology. In November 2022, Space Systems Command announced it exercised the third production option valued at approximately \$744 million for the procurement of three additional GPS IIIIF satellites from Lockheed Martin, meaning the company is now contracted to build SV11-20.



# EUTELSAT RETIRES EUTELSAT 5 WEST A SATELLITE

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Eva Berneke, Eutelsat Chief Executive Officer, commented: “The impressive extended lifespan of EUTELSAT 5 West A showcases the first-rate satellite control expertise of the Eutelsat teams. The satellite provided an overall service availability of 99.999%, a figure that stands as a testament to the hard work and dedication of all the Eutelsat teams who have worked together throughout the years on this mission.

”

Initially designed for a 15-year lifetime, the EUTELSAT 5 West a satellite has retired after an impressive 20+ years of fruitful in-orbit operation. The satellite was successfully re-orbited as planned to more than 400km above the geostationary arc, the propulsion system depressurised and the electrical equipment on board passivated. The final operation to deactivate the remaining Radio Frequency source (telemetry transmitter) was performed from the Issy-les-Moulineaux Satellite Control Centre on 13 January at 09:57 UTC (10:57 Local time).

The End-of-Life activities operated by mission control teams placed the satellite in safe conditions with an orbit and configuration fully compliant with French Space Law and international Space Traffic Management recommendations.

Based on a Spacebus 3000B3 platform manufactured by the then Alcatel Alenia Space (now Thales Alenia Space), the satellite was originally built on behalf of Steliat. Shortly

after its launch in July 2002, the satellite was bought by Eutelsat and renamed Atlantic Bird-3, operating from the 5° West orbital position where it remained for its entire operational life. It was given the name EUTELSAT 5 West A in 2012 and operated in an inclined orbit since the end of 2019, which enabled an extended lifespan of the satellite.

A progressive transfer of services to the new EUTELSAT 5 West B satellite, as well as other satellites of the Eutelsat fleet, was started in January 2020, ensuring seamless continuity of operations for customers. The EUTELSAT 5 West A continued to operate until its decommissioning, notably providing maritime connectivity.

A disruptive satellite for the Group, EUTELSAT 5 West A enabled the transition to digital television, notably in France in the early 2000s, when analogue television technology was converted to and replaced by digital broadcasting.

James Matthews, Eutelsat CSR Director, added: “The decommissioning of EUTELSAT 5 West A satellite is a perfect example of our commitment to the responsible use of space, a fundamental element of the Group’s CSR mission. This operation shows how the Space Traffic Management expertise of Eutelsat is being used to mitigate the risk of space debris for both security and environmental concerns, ensuring the long-term sustainability of space for all operators”.





## AIRBUS BUILT INMARSAT-6 F2 SATELLITE ARRIVES ON BOARD AN AIRBUS BELUGA IN FLORIDA FOR LAUNCH

The second Airbus-built Inmarsat-6 geostationary telecommunications satellite (I-6 F2) has arrived on board an Airbus Beluga at the Kennedy Space Center in Florida ready for its launch in February. The second satellite of the Inmarsat-6 generation is based on Airbus' ultra-reliable Eurostar E3000 spacecraft and will be the 58th Eurostar E3000 built by Airbus. It will be the ninth Eurostar in orbit that is equipped with electric propulsion for orbit raising, reinforcing Airbus' position as the world leader in electric propulsion.

François Gaullier, Head of Telecommunications & Navigation Systems at Airbus, said: "I-6 F2, with its sophisticated digitally processed payload, will join Inmarsat-6 F1 (I-6 F1) in orbit giving Inmarsat even more flexibility, capability and capacity. This is the 10th geo-telecommunications satellite we have built for our long-term customer Inmarsat, a leading provider of global mobile satellite communication services, and with I-6 F1 the satellites will enable a step change in the capabilities and capacity for their ELERA services, and deliver significant additional capacity for their Global Xpress network."

I-6 F1 and I-6 F2 each feature a large 9m aperture L-band antenna and six multi-beam Ka-band antennas, giving a high level of flexibility and connectivity. They also carry new generation modular digital processors to provide full routing flexibility over up to 8000 channels and dynamic power allocation to over 200 spot

beams in L-band, per spacecraft. The Ka-band spot beams are steerable over the full Earth disk, with flexible channel to beam allocation.

The satellites will enable Inmarsat to further enhance its world-leading ELERA (L-band) and Global Xpress (Ka-band) networks respectively, for customers across land, sea, and air. They are also the next step in the company's plans for the world's first multi-dimensional network, Inmarsat ORCHESTRA. The 'network of networks' will build on Inmarsat's existing space-based capabilities to provide a transformational growth in capacity and new features for customers into the 2030s and beyond.

Investments made by Airbus in platform and payload technologies used on

I-6 are supported by the European Space Agency and national agencies, in particular the UK Space Agency and CNES, France's National Centre for Space Studies. I-6 F2 has a launch mass of 5.5 tons, spacecraft power of 21 kW and a design life of more than 15 years.

The first Airbus built Inmarsat-6 (I-6 F1) satellite was successfully launched in December 2021. It reached its geostationary testing location in summer 2022 and is scheduled to enter service in early 2023. I-6 F2 is set to follow after its successful launch and enter service in early 2024.

Airbus' geostationary telecommunications satellites have clocked up more than 1300 years of successful operation and are in service or being built for all of the world's leading geostationary satellite operators.





## MediaTek and Skylo Collaborate on Next-Gen 3GPP NTN Satellite Solutions on Smartphones and Wearables

Skylo, a Non-Terrestrial Network (NTN) service operator connecting anything, anywhere announced its on-going partnership with MediaTek, a leading global chipset manufacturer. With MediaTek's 3GPP NTN-standard modem and Skylo's NTN service, smartphone and IoT manufacturers are able to develop new devices, sensors, and wearables with in-built satellite connectivity. This allows OEMs to offer connectivity experiences that weren't possible before, such as being able to text without any gaps or loss in coverage resulting in deeper customer relationships.



MediaTek's 3GPP standards-based chipset with NTN is a major milestone in bringing ubiquitous connectivity to smartphones and subscribers across the globe," said Dr. Andrew Nuttall, Chief Technology Officer for Skylo. "We're honored to support MediaTek and deliver a service to their OEM customers."



"The use cases for satellite connectivity based on 3GPP NTN standard are profound, and we have just scratched the tip of the iceberg as satellite and cellular converge for the first time. Our technology provides users with a tested, viable, and consistent opportunity to contact loved ones and emergency services from remote areas," said Cliff Lin, Assistant General Manager of MediaTek. "We will continue to work with Skylo to ensure that the chipsets we manufacture are compliant with industry standards and work on its commercial-ready and capable satellite network."

MediaTek's chipsets power over two billion new consumer and enterprise products each year, and lead the industry with integration, connection, and power-efficiency. For those device manufacturers who need available chipset solution with 3GPP NTN-capabilities, MediaTek currently has that capability, making it possible to integrate cellular and satellite connectivity into the same device. Further, Skylo's NTN service is also commercially available today and has done extensive stress testing with MediaTek's 3GPP NTN chipset to ensure always-on availability when the user has access to the open sky.



## The New Iridium GO! exec Redefines Personal Off-the-Grid Connectivity

Iridium Communications unveiled the most capable, ultra-portable solution for truly global connections to all smartphones, tablets and laptops – a new class of personal satellite communication device called the Iridium GO! exec™. Built for the professional but made for everyone, the Iridium GO! exec provides a natural extension of your world off-the-grid to send and receive email, use chat or office applications, make phone calls, share pictures, post to social media or get help in an emergency.

Building upon the success of the original Iridium GO!®, introduced in 2014, the Iridium GO! exec is based on Iridium Certus® technology and provides faster data speeds at a size, weight, power and price-point unheard of in the satellite industry. Its ideal for connecting remote workers, NGO personnel, government employees, first responders, GA pilots, sailors and everyday adventurers, helping them to stay connected and productive from anywhere.

The Iridium GO! exec's ultra-portability means it can fit in a backpack, on the glare shield of a personal aircraft, be easily carried from the boat to the beach or from the jeep into the field. Multiple users can wirelessly connect their smart devices over Wi-Fi or by using the built-in ethernet port to connect wired devices to the internet.

Loaded with new features, the Iridium GO! exec can function as a standalone device to make calls using its built-in speakerphone or initiate an SOS call if the user's smart device runs out of power. It works with popular messaging, email, and other native applications well known to users. With a very capable battery, it provides extended usage on the go and can even be used as a power bank to charge a smartphone or tablet directly with a dedicated USB-C power output. The device also comes with an application manager that makes it easy to have the best experience possible by choosing what apps you want to use, prioritizing their connections and setting time and data limits to help companies and individuals stay within budget.

Custom applications can also be developed for the Iridium GO! exec using an Iridium-provided API, with developers already working on Iridium GO! exec versions of some apps popular with Iridium GO! users. An external antenna and fixed-install kit for boats and remote locations is also available to order, with additional accessories expected in the coming months.

When we launched the Iridium GO! nine years ago, our vision was to allow anyone with a smartphone to stay connected when they were off the grid," said Iridium CEO Matt Desch. "We've now turbocharged that capability with the Iridium GO! exec. There's nothing like this device for businesses, governments or consumers that want to stay productive beyond terrestrial coverage."



# US, JAPAN SIGN SPACE COLLABORATION AGREEMENT AT NASA HEADQUARTERS

During an event hosted by NASA Administrator Bill Nelson and Deputy Administrator Pam Melroy at the agency’s Headquarters in Washington, representatives from the United States and Japan gathered to sign an agreement that builds on a long history of collaboration in space exploration between the two nations. U.S. Secretary of State Antony J. Blinken and Japan’s Minister for Foreign Affairs Hayashi Yoshimasa signed the agreement on behalf of the United States and Japan, respectively.

“The future of space is collaborative,” said Blinken. “Through this agreement, our nations have strengthened our partnership in space and here on Earth. We will go farther and learn even more together.”

The signing is a highlight of Prime Minister Kishida Fumio’s visit to Washington, his first since taking office in 2021.

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This signing symbolizes not just the exploration of space, but also the partnership and the friendship between the United States and Japan,” said Emanuel. “This is a new beginning.

“I hope that Japan-U.S. space cooperation will further deepen based on this agreement, as it will benefit the future of humanity,” said Hayashi.

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“I expect this agreement to vigorously promote Japan-U.S. space cooperation and expand areas of cooperation for the Japan-U.S. alliance, which is stronger than ever before,” said Kishida.

Among the other witnesses in attendance were U.S. Ambassador to Japan Rahm Emanuel, Japanese Ambassador to the U.S. Tomita Koji, Japan Aerospace Exploration Agency President (JAXA) Yamakawa Hiroshi, and Deputy Assistant to the President and Executive Secretary of the National Space Council Chirag Parikh. NASA astronaut Anne McClain and JAXA astronaut Hoshide Akihiko also participated in the event.

“From low-Earth orbit to the Moon and beyond, Japan is one of NASA’s most significant international partners, and this latest framework agreement will allow us to further collaborate across our agencies’ broad portfolios in exploration, science, and research,” said Nelson.

Known as the “Framework Agreement between the Government of Japan and the Government of the United States of America for Cooperation in Space Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, For Peaceful Purposes,” this pact recognizes a mutual interest in peaceful exploration. It completes work from President Joe Biden’s May 2022 visit to Japan and the September 2022 visit to Tokyo of Vice President Kamala Harris, chair of the National Space Council.

Strengthening the space collaboration between the U.S. and Japan is a priority for both.

The framework covers a broad swath of joint activities between the countries, including space science, Earth science, space operations and exploration, aeronautical science and technology, space technology, space transportation, safety and mission assurance, and much more.

NASA and the Government of Japan finalized a previous agreement in November 2022 confirming Japan’s contributions to Gateway as part of a commitment to long-term lunar exploration cooperation with NASA under the Artemis program. Japan also was one of the original signatories of the Artemis Accords.



## NASA Awards Spacecraft Processing Operations Contract

NASA has selected Astrotech Space Operations, LLC of Titusville, Florida, and Space Exploration Technologies Corp. (SpaceX) of Hawthorne, California, to provide commercial payload processing services for agency missions launching from multiple locations.

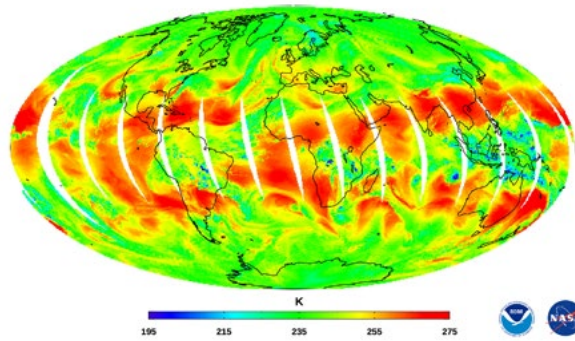
Under the Spacecraft Processing Operations Contract, NASA will issue a fixed-price, indefinite-delivery, indefinite-quantity contract that has a potential 10-year ordering period. The maximum total contract value is \$100 million across all contracts supporting operations from NASA's Kennedy Space Center in Florida, Cape Canaveral Space Force Station in Florida, as well as Vandenberg Space Force Base in California.

The contract also includes a special on-ramp provision to enable additional providers and incumbents to submit proposals introducing new commercial processing facilities and support services not available at the time of the initial award. The ordering period runs from approximately February 2023 to February 2033.

NASA will issue task orders for the facilities and services necessary to perform prelaunch processing of spacecraft and associated rocket flight hardware of the completed payload stack before being delivery to the launch pad.

NASA's Launch Services Program at Kennedy will manage the contract. The program is responsible for launching uncrewed rockets delivering spacecraft that observe the Earth, visit other planets, and explore the universe – from weather satellites to telescopes to Mars rovers and more.

NOAA-21 CrIS Sensor Brightness Temperature, 1596  $\text{cm}^{-1}$   
12 Feb 2023 Day Time



## First Global Image from NOAA-21's CrIS Instrument

Three months after the NOAA-21 satellite launched from Vandenberg Space Force Base, an instrument onboard that provides valuable weather forecasting measurements to global weather models sent back its first science data. The data from the new Cross-track Infrared Sounder (CrIS) instrument will continue the critical infrared soundings that play an important role in numerical weather prediction. The first light image in brightness temperature was captured by the NOAA-21 CrIS sensor at the 1596  $\text{cm}^{-1}$  water vapor channel on February 12, 2023. This image shows the large-scale waves of upper tropospheric water vapor and clouds over the Earth's globe. Image generated using NOAA-21 Preliminary, Non-Operational Data. The infrared map above shows water vapor in the troposphere, the lower part of the atmosphere where we live and where weather happens. The red on the map likely indicates areas of drier air, where you're seeing deeper into the atmosphere, said David Johnson, NOAA's Joint Polar Satellite System's (JPSS) CrIS instrument scientist.

"There's that red area that's over Hispaniola that's about 275 degrees Kelvin and you go north of that off the mid-Atlantic coast and it's about 240 degrees Kelvin, so that's higher up in the atmosphere," Johnson said. "That's a region where there must be more water vapor in the atmosphere, since we cannot see through it to warmer air below."

The CrIS sensor provides hyperspectral infrared observations from more than 2,211 channels with high radiometric and spectral accuracy. CrIS measures atmospheric temperature, surface temperature, and several trace gases in the atmosphere, including Carbon Dioxide ( $\text{CO}_2$ ), Ozone ( $\text{O}_3$ ), Methane ( $\text{CH}_4$ ), Sulfur Dioxide ( $\text{SO}_2$ ), Carbon Monoxide ( $\text{CO}$ ), and Nitrous Oxide ( $\text{N}_2\text{O}$ ). The CrIS sensor measures infrared spectra in three spectral bands: the long-wave IR (LWIR) band from 650 to 1095  $\text{cm}^{-1}$ , mid-wave IR (MWIR) band from 1210 to 1750  $\text{cm}^{-1}$  and short-wave IR (SWIR) band from 2155 to 2550  $\text{cm}^{-1}$ . When combined with measurements from the Advanced Technology Microwave Sounder (ATMS), these two instruments provide high quality measurements of atmospheric temperature and water vapor, which allow forecasters to predict extreme weather events like thunderstorms and atmospheric rivers, along with daily weather. These first global images are part of a series of events that includes instrument activation, intensive calibration and validation activities that occur before the satellite is declared fully operational. Together, NOAA and NASA oversee the development, launch, testing, and operation of all the satellites in the Joint Polar Satellite System program. NOAA funds and manages the program, operations, and data products. On behalf of NOAA, NASA and commercial partners develop and build the instruments, spacecraft, and ground system, and launch the satellites.

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CrIS takes detailed profiles of temperature and water vapor that forecasters use to measure atmospheric instability," said NOAA's JPSS Program Scientist, Dr. Satya Kalluri.

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## Sidus Space Announces Multi-Million-Dollar Agreement with Netherlands for Laser Communication Satellite

Sidus Space, Inc. a Space-as-a-Service company focused on commercial satellite design, manufacture, launch, and space-based data collection combined with space and defense mission critical hardware manufacturing has been awarded a multi-million dollar agreement with The Netherlands Organization for Applied Scientific Research (TNO) to deploy and test TNO's laser communications technology aboard a Sidus' LizzieSat™ satellite.

As part of the \$2.5 Million agreement, TNO will design and deliver HemiCAT, a high-efficiency miniature communications laser terminal, which Sidus will integrate into its hybrid 3D printed satellite, LizzieSat™. Sidus will manage all aspects of integration, deployment, and operations, including procuring a launch and operating HemiCAT in orbit. The in-orbit demonstration mission for laser satellite communication is part of a study of Dutch defense technology.

"This HemiCat is an important new technology and we look forward to working with Sidus to launch and test HemiCAT as a pathfinder for future laser satellite communication systems," Michiel Ringers, TNO Business Development Manager stated. "The Sidus team offered the best turnkey solution, designing, building, and deploying flight heritage hardware for demanding applications — the perfect combination of expertise and capabilities we look for in a partner."

“We are honored to be selected by TNO as its mission partner for the HemiCAT technology,” said Carol Craig, Sidus Space Founder and CEO. “This partnership will allow us to demonstrate further versatility of our LizzieSat™ platform and advance our mission of ‘Bringing Space Down to Earth’ while continuing to expand our reach into the international satellite market.”



## Lockheed Martin's First LM 400 Multi-Mission Spacecraft Completed, Ready for Final Testing

The first Lockheed Martin LM 400, a flexible, mid-sized satellite customizable for military, civil or commercial users, rolled off the company's digital factory production line and is advancing toward its planned 2023 launch.

The agile LM 400 spacecraft bus design enables one platform to support multiple missions, including remote sensing, communications, imaging, radar and persistent surveillance. Lockheed Martin invested in common satellite designs to support demand for more proliferated systems, high-rate production and affordable solutions. The LM 400 is scalable and versatile starting at the size of the average home refrigerator, with capability to grow for higher power and larger payloads and packaged to enable multiple satellites per launch. The LM 400 bus can operate in low, medium or geosynchronous earth orbits, providing greater flexibility than other buses in this class. The LM 400 space vehicle is compatible with a wide range of launch vehicles in a single, ride-share or multi-launch configuration.

For potential military applications, the LM 400 conforms to Modular Open Systems Architecture standards for interoperability with other platforms from all the services. This design helps unlock the U.S. Defense Department's vision for joint all-domain operations and joint all-domain command and control.

Each LM 400 spacecraft includes SmartSat™, Lockheed Martin's software-defined satellite architecture. SmartSat™ provides even greater mission adaptability and can perform onboard “Edge” data processing, which reduces the time it takes to get actionable data into the hands of mission operators and decision-makers on the ground. The LM 400 is already under several contracts, most recently being named as one of the satellite buses supporting U.S. Space Force's planned Missile Track Custody program in medium earth orbit.



“This resilient LM 400 satellite bus was created completely digitally, offering greater flexibility, commonality and the ability to rapidly configure to order across missions,” said Matt Mahlman, director of strategy and capture at Lockheed Martin Space's Satellite Bus Center of Excellence. “Given that, we can produce these new satellites faster and at a much lower cost to our customers.”





## Send-off ceremony of science instrument payload of NISAR held at NASA's JPL

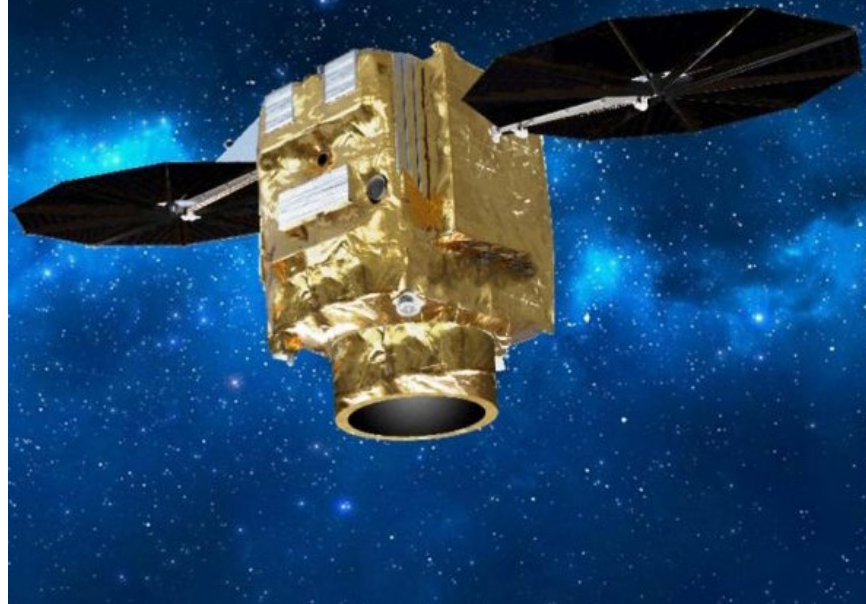
A Send-off ceremony of science instrument payload of NISAR held at NASA's Jet Propulsion Laboratory (JPL) on Feb 3, 2023. Shri S Somanath, Secretary, DOS / Chairman, ISRO, Sripriya Ranganathan, Indian Ambassador and Deputy Chief of Mission, officials from ISRO, NASA were present during the ceremony.

NASA-ISRO SAR (NISAR) is a Low Earth Orbit (LEO) observatory being jointly developed by NASA and ISRO. It carries L and S dual band Synthetic Aperture Radar (SAR), which operates with Sweep SAR technique to achieve large swath with high resolution data. The SAR payloads mounted on Integrated Radar Instrument Structure (IRIS) and the spacecraft bus are together called an observatory

The NISAR observatory carries a 12m wide deployable mesh reflector mounted onto a deployable 9m boom developed by JPL which shall be used by both-JPL-NASA developed L-Band SAR payload system and ISRO developed S-Band SAR payload.



"Today we come one step closer to fulfilling the immense scientific potential NASA and ISRO envisioned for NISAR when we joined forces more than eight years ago," Somanath said. "This mission will be a powerful demonstration of the capability of radar as a science tool and help us study Earth's dynamic land and ice surfaces in greater detail than ever before."



## Airbus to provide Poland with a very high resolution optical satellite system

Airbus Defence and Space has signed a contract with Poland to provide a geospatial intelligence system including the development, manufacture, launch and delivery in orbit of two high-performance optical Earth observation satellites. The contract also covers the associated ground segment, including Direct Receiving Station in Poland, launch services, training for the Polish team, maintenance and technical support for the space and ground systems.

Furthermore, the agreement encompasses the delivery of Very High Resolution (VHR) imagery from the Airbus Pléiades Neo constellation as early as 2023.

This contract is the first export success, achieved with the support of the French government, for the Airbus S950 VHR optical satellite which stems from the development of the Pléiades Neo constellation, already operating in orbit with two satellites since 2021. This latest generation system offers a cutting-edge performance of VHR optical capabilities accompanied by a very high agility in orbit.

Jean-Marc Nasr, head of Space Systems at Airbus said: "This contract will provide Poland with one of the world's most sophisticated satellite Earth observation systems. It strengthens Europe and gives the Polish nation a truly sovereign space capability. We look forward to further developing our cooperation with Poland under the umbrella of the strategic partnership between France and Poland".

Following the launch of the satellites from the European Space Centre in Kourou, French Guiana, the imagery coming from the Polish satellites will be directly received in Poland by the infrastructure of the national satellite system, ensuring full autonomy.

This announcement consolidates Airbus' position as world leader in the export of Earth observation satellite systems and is a major show of confidence in the company's technology. It is also an endorsement of Airbus' strategy to invest in the Pléiades Neo constellation, the benchmark for VHR geo-information systems. The satellites' assembly, integration and tests will be carried out in Airbus' clean rooms in Toulouse and launch is planned by 2027. Starting in 2023, Poland will have access to Pléiades Neo imagery directly from Airbus.





## Stratolaunch Completes Second Captive Carry Flight with TA-0 Test Vehicle

Stratolaunch, LLC announces the completion of its second captive carry flight with the Talon-A separation test vehicle, TA-0. It was the ninth flight for the company's launch platform, Roc.

The flight set a new duration record lasting a total of six hours and reached a maximum altitude of 22,500 ft., representing another important step forward in the company's near-term goal of completing separation testing with TA-0. Primary test objectives included flight outside of the local Mojave area for the first time and evaluation of the separation environment. Roc and TA-0's onboard data systems provide critical information on the aerodynamic loads and moments prior to release of TA-0, helping to ensure safe separation of the vehicle from Roc. The flight team also practiced chase formation and communication sequencing for the upcoming separation test.

A flight data review will determine the next steps on the test timeline. Stratolaunch continues to progress toward separation test and its first hypersonic flight of TA-1 within the first half of 2023.

"The thorough evaluation of release conditions will provide data to reduce risks and ensure a clean and safe release of Talon-A during future tests," Dr. Krevor said. "We are excited for what's ahead this year as we bring our hypersonic flight test service online for our customers and the nation."



Our amazing team is continuing to make progress on our test timeline, and it is through their hard work that we grow closer than ever to safe separation and our first hypersonic flight tests," said Dr. Zachary Krevor, Chief Executive Officer and President for Stratolaunch.



## Terran Orbital Wins \$2.4Bn Contract to Build 300 Satellites for Rivada Space Networks

Terran Orbital Corporation a global leader in satellite-based solutions announced its wholly-owned subsidiary, Tyvak Nano-Satellite Systems, Inc. ("Tyvak"), has been awarded a \$2.4 billion contract to design, build, and deploy 288 low-earth orbit satellites for Rivada Space Networks. As part of the contract, Terran Orbital will also develop 12 "spare" satellites to produce a total of 300 spacecraft.

Rivada Space Networks is a wholly-owned subsidiary of Rivada Networks, Inc., a U.S.-based wireless technology company focused on open-access wholesale and the convergence of terrestrial and satellite communications. Founded by Declan Ganley, Rivada is active across North and South America as well as Europe. Rivada holds a multitude of patents relating to spectrum sharing, digital spectrum arbitrage, prioritized messaging, open access services, and other wireless communications technologies.

Terran Orbital, through its subsidiaries, is an innovative mass producer of small satellites for leading operators and major industry participants and is a preferred supplier for customers across the United States, Europe, the Middle East, and Australia.

Terran Orbital, through its subsidiary Tyvak, will act as the prime contractor to design and manufacture the approximately 500 kg satellites, integrate the communication payload, and perform the final satellite assembly, integration, and test. We will also be responsible for developing portions of the ground segment. Mission operations for the on-orbit satellites will be conducted from a state-of-the-art satellite operations control center. Rivada expects to begin deploying its constellation as early as 2025, subject to compliance with applicable regulatory requirements, with the anticipated launch of four of our satellites.

"We at Rivada see Terran Orbital as a kindred spirit of sorts. We are delighted to have the opportunity to bring this project to fruition with them," said Declan Ganley, Chairman and CEO of Rivada Networks.



"Terran Orbital is thrilled to form this new partnership with Rivada Space Networks," said Marc Bell, Co-Founder, Chairman, and Chief Executive Officer of Terran Orbital. "Our partnership will show why Terran Orbital continues to be a satellite manufacturer of choice for aerospace and defense companies worldwide. We are ecstatic to work alongside Rivada and look forward to building out their LEO constellation."





# NASA TO LAUNCH ISRAEL'S 1ST SPACE TELESCOPE

NASA will launch Israel's first space telescope mission, the Ultraviolet Transient Astronomy Satellite (ULTRASAT). ULTRASAT, an ultraviolet observatory with a large field of view, will investigate the secrets of short-duration events in the universe, such as supernova explosions and mergers of neutron stars.

Led by the Israel Space Agency and Weizmann Institute of Science, ULTRASAT is planned for launch into geostationary orbit around Earth in early 2026. In addition to providing the launch service, NASA will also participate in the mission's science program.

"We are proud to join this partnership, an international effort that will help us better understand the mysteries of the hot, transient universe," said

Mark Clampin, director of the Astrophysics Division at NASA Headquarters in Washington. "ULTRASAT will give the global science community another important capability for making new observations in the nascent field of time domain and multimessenger astrophysics programs."

ULTRASAT's wide field of view will allow it to quickly discover and capture ultraviolet light from sources in the cosmos that change on short timescales. Researchers will combine ULTRASAT's observations of these short-term events with information from a variety of other missions, including those studying gravitational waves and particles – a field known as time domain and multimessenger astronomy. The results will shed light on

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"Groundbreaking science calls for cutting-edge technology," said Uri Oron, director of the Israel Space Agency in the Ministry of Innovation, Science, and Technology. "Our requirements from ULTRASAT, such as a wide field of view, advanced ultraviolet sensitivity, and real-time data control and transfer are at the forefront of technological developments. Israel's space industry can deliver these capabilities. The Israel Space Agency is proud of the cooperation with NASA as a direct example of the strong partnership between the agencies, and of the Israeli space industry's technological effort involved in the development of the telescope."

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the workings of everything from black holes and gravitational wave sources to supernovae and active galaxies.

"This is a breakthrough project that places Israel at the forefront of global research," said Eli Waxman, astrophysicist at the Weizmann Institute of Science and ULTRASAT's head researcher. "Leading international bodies such as NASA and the DESY research institute have joined this Israeli-led project as partners, having recognized its scientific significance. They are investing considerable resources in the construction and launch of the satellite to become active participants in this mission with access to its scientific products. It's a science-driven partnership."

Through the agreement between NASA and the Israel Space Agency, NASA will provide the launch opportunity, Flight Payload Adapter, and other launch-related responsibilities for ULTRASAT. The Israel Space Agency will deliver the completed observatory to NASA's Kennedy Space Center in Florida for launch.



# OMNISPACE AND LIGADO NETWORKS TO COMBINE SATELLITE SPECTRUM FOR DIRECT-TO-DEVICE SERVICES

Omnispace and Ligado Networks announced a Memorandum of Understanding (MOU) to combine their respective licensed mobile satellite services (MSS) spectrum to enable the world's most capable space-based, direct-to-device (D2D) solutions for global voice, text and data connectivity. Utilizing large blocks of satellite spectrum in the L- and S-Bands, this agreement sets the stage for the development of multi-band, multi-orbit satellite offerings to enable ubiquitous mobile connectivity for more than 5 billion mobile subscribers in areas where terrestrial cellular coverage does not exist today.

The companies' collaboration would use portions of Ligado's 40 MHz of L-band satellite spectrum in the U.S. and Canada and Omnispace's 60 MHz of S-band satellite spectrum (3GPP 5G bands n255 and n256). The combination would bring together for the first

time the largest block of satellite spectrum dedicated to meeting a global market need for text, voice and data capability. The satellite spectrum assembled by the companies is licensed, 3GPP-standardized for non-terrestrial networks (NTN) and already in compliance with existing international ITU and U.S. regulations. Additionally, the collaboration anticipates optimizing multi-orbit geostationary (GEO) and non-geostationary (NGSO) networks to provide seamless, global coverage for D2D use cases across key markets, including consumer smartphone, automotive and Internet of Things (IoT) connectivity.

"In many ways, this spectrum combination is the last missing piece to unlocking the full promise and potential of direct-to-device connectivity and creates the necessary foundation for an exceptional voice, text and data experience," said Ram Viswanathan, President

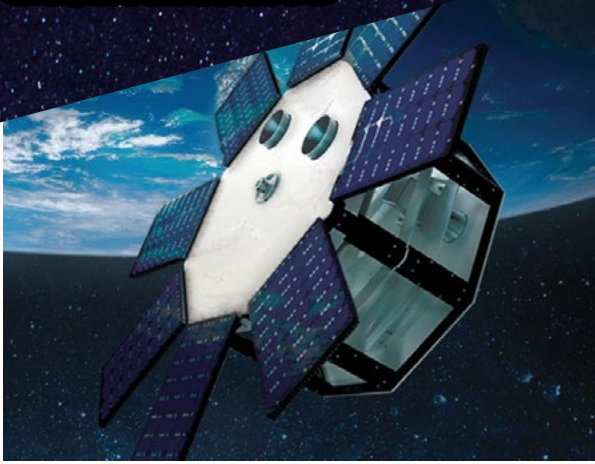
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"We are pleased to partner with Omnispace in this initiative that has the potential to accelerate enhanced 5G non-terrestrial networks globally with coverage and bandwidth to support superior direct-to-device satellite connectivity," said Doug Smith, President and CEO for Ligado Networks. "This an important step forward for Ligado's satellite business. The addition of S-band solutions to our growing L-band portfolio of satellite services brings together an unrivaled amount of licensed satellite spectrum across multiple orbits. Together we are able to establish a premier, one-stop shop global footprint for ecosystem partners and global MNOs to offer premium services for billions of mobile subscribers worldwide."

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and CEO for Omnispace. "Together with Ligado, we will bring the spectrum and technology to deliver a game-changing solution directly from space to a variety of devices that could benefit billions of mobile subscribers worldwide."

The combination of L- and S-band spectrum is a unique opportunity to expand the ecosystem of D2D applications and technologies, enhance user experience and extend service globally. For consumer smartphones, the offering will have enough bandwidth to go beyond emergency satellite texting by offering ubiquitous roaming mobile coverage with two-way voice, messaging and data capabilities. Automotive partners can leverage the service to provide customers a suite of safety, telematics and intelligent connectivity solutions that are always-on and resilient. The expansion of the ecosystem, driven by this unique combination of satellite spectrum bands, will enable greater accessibility for mission-critical IoT connectivity across industries such as agriculture, government, energy production and distribution, as well as supply chain management.



## Sidus Space Secures Additional Launches with SpaceX

Sidus Space, Inc. a Space-as-a-Service company focused on mission critical hardware manufacturing combined with commercial satellite design, manufacture, launch, and data collection, today announced it has signed an agreement with SpaceX to launch on Transporter missions manifested for 2024 and 2025.

This additional agreement further extends the Company's relationship with SpaceX, chosen in part due to their successful and reliable launch capabilities. Sidus Space expects the Maiden Flight of LizzieSat™ on SpaceX Transporter-9 later this year. Along with launching in 2023, the new agreement adds two additional flights in 2024 and two flights scheduled for launch in 2025, each of which are on upcoming Transporter missions.

Once launched, each LizzieSat™ mission is expected to be in orbit for four to five years. This timeline provides sufficient time on orbit to meet customer needs and to advance future technologies.



"We are thrilled to have signed multi-year agreements with SpaceX, establishing a regular launch cadence for Sidus and our customers", said Founder and CEO, Carol Craig. "With an expected nine LizzieSats in orbit via SpaceX launches through early 2025, we can accommodate multiple missions, offering a variety of flight opportunities to customers. This provides our customers multiple manifest options to meet their mission objectives while expanding our space data and imagery platform as part our mission of "Bringing Space Down to Earth™."



## Euclid electromagnetic compatibility tests successful

ESA's Euclid mission is undergoing the final test before launch in July 2023. Here it is standing in a special room in the Thales Alenia Space test facilities in Cannes, France, where it successfully underwent electromagnetic compatibility testing.

This kind of testing is routine for spacecraft. All electronics emit some form of electromagnetic waves that can cause interference with other devices. Think of the buzz that speakers give out right before an incoming call on a mobile phone. Spacecraft electronics can cause similar interference, but out in space such interference can have disastrous consequences, so all systems must be checked before launch.

The large test chamber at TAS, called the Compact Antenna Test Range, simulates the electromagnetic environment of deep space, being lined with cones that absorb radio signals and prevent reflections. To avoid TV or radio interference, the walls of the chamber form a steel 'Faraday cage', impenetrable to electromagnetic signals from the outside world.

In this radiation-free environment, the team studied the radio signals and electrical noise coming from the various systems on the spacecraft and checked whether they caused any electromagnetic interference with each other.

ESA's Euclid mission is designed to explore the composition and evolution of the dark Universe. The space telescope will create a great map of the large-scale structure of the Universe across space and time by observing billions of galaxies out to 10 billion light-years, across more than a third of the sky. Euclid will explore how the Universe has expanded and how structure has formed over cosmic history, revealing more about the role of gravity and the nature of dark energy and dark matter.

Euclid is a fully European mission, built and operated by ESA, with contributions from NASA. The Euclid Consortium – consisting of more than 2000 scientists from 300 institutes in 13 European countries, the US, Canada and Japan – provided the scientific instruments and scientific data analysis. ESA selected Thales Alenia Space as prime contractor for the construction of the satellite and its Service Module, with Airbus Defence and Space chosen to develop the Payload Module, including the telescope. NASA provided the near-infrared detectors of the NISP instrument.



## Sierra Space Completes Third Successful Test of Inflatable Habitat Unit Designed for First Commercial Space Station

Sierra Space, a leading, pureplay commercial space company building the first end-to-end business and technology platform in space, announced that the company's LIFE™ Habitat (Large Integrated Flexible Environment) successfully completed a third stress test – this time for duration – exceeding NASA certification requirements and demonstrating the inflatable structure's integrity for sustaining human life in space for long periods of time.

This latest assessment, called an Accelerated Systematic Creep Test, is a destructive materials testing method by which test engineers load the test unit – a subscale version of the inflatable habitat – with a sustained amount of pressure over time until it fails. The unit's "softgoods" pressure shell burst after over 150 hours, exceeding NASA's short-term, recommended creep dura-

tion target of 100 hours. High-strength softgoods materials are sewn and woven fabrics – primarily Vectran – that become rigid structures when pressurized and can provide safe and sustainable architecture for space habitation.

This latest creep test is a different kind of stress test than the two previous ones conducted in July and November, which pressurized units with increasing loads until they burst at maximum or Ultimate Burst Pressure (UBP). All three tests took place within six months, further demonstrating Sierra Space as a market leader in the development of softgoods inflatable habitat technology, a key step in facilitating extended human missions to low-Earth orbit, the moon and Mars.

"LIFE Habitat represents the essential technology developments needed to one day enable humans to live and work in space," said Sierra Space CEO Tom Vice. "Habitat units are a key element in Sierra Space's platform in space, and this crucial milestone illustrates that our team has exceeded programmatic requirements that validate critical aspects of the LIFE Habitat design. These results will propel us in 2023 as we mature the technology via full-scale development and continue toward full NASA certification."

Sierra Space, its partner ILC Dover and NASA subject matter experts performed the subscale Accelerated Systematic Creep Test in December 2022, at NASA's Marshall Space Flight Center in Huntsville, Alabama. The purpose of the test was to determine the duration of time that LIFE Habitat's pressure shell could last during its on-orbit operational mission life.

NASA designed a climate-controlled, disposable building in which the test was performed. This building was specifically built to meet two requirements: 1) to protect the test article (Sierra Space's pressure shell) during the duration of the test and 2) to be expendable once the article successfully burst upon maximum creep pressure and duration. Due to the explosive nature of the test, the team placed the sub-scale space habitat adjacent to the flame trench of the Saturn 1/1B test stand, where NASA tested rockets for the Apollo program.

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Sierra Space's LIFE Habitat pressure shell has an on-orbit performance requirement of 15 years, but with softgoods, there is a 'times four' safety requirement set by NASA, so we must ultimately prove we're viable for 60 years," said Shawn Buckley, LIFE Chief Engineer and Senior Director of Engineering at Sierra Space. "Based on data from this first subscale creep test, we well exceeded the on-orbit mission performance requirement of 60 years for inflatable structures within our current architecture.

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## Stratolaunch Creates Advanced Program Office at Discovery Park District and Collaborates with Purdue University on Hypersonic Design and Test

Stratolaunch LLC and Purdue University are pleased to announce they have established a partnership dedicated to accelerating the time required to design, build, test, and fly hypersonic vehicles.

Stratolaunch will establish the Stratolaunch Advanced Programs Office at the Convergence Center in Purdue's Discovery Park District in West Lafayette, Indiana to ensure the goals of their collaboration will be rapidly achieved. The office will be led by an experienced advanced design director with support staff that will offer opportunities for student internships.

Through their collaboration Stratolaunch and Purdue will leverage the university's world class multi-disciplinary hypersonic design methods, ground test facilities, faculty, staff, and students to anchor ground simulations. By combining this capability with Stratolaunch's rapid prototyping fabrication, flight test service, as well as hypersonic flight test data from the Talon-A, the

integrated team will develop methodologies to accelerate the design to fly time of hypersonic systems.

Stratolaunch recently funded a one-year collaborative research project with four Purdue faculty experts and their graduate students to explore and establish a foundation of best-in-class computational and experimental capabilities, which can be used to create the most comprehensive suite of flight-validated air vehicle design optimization tools.

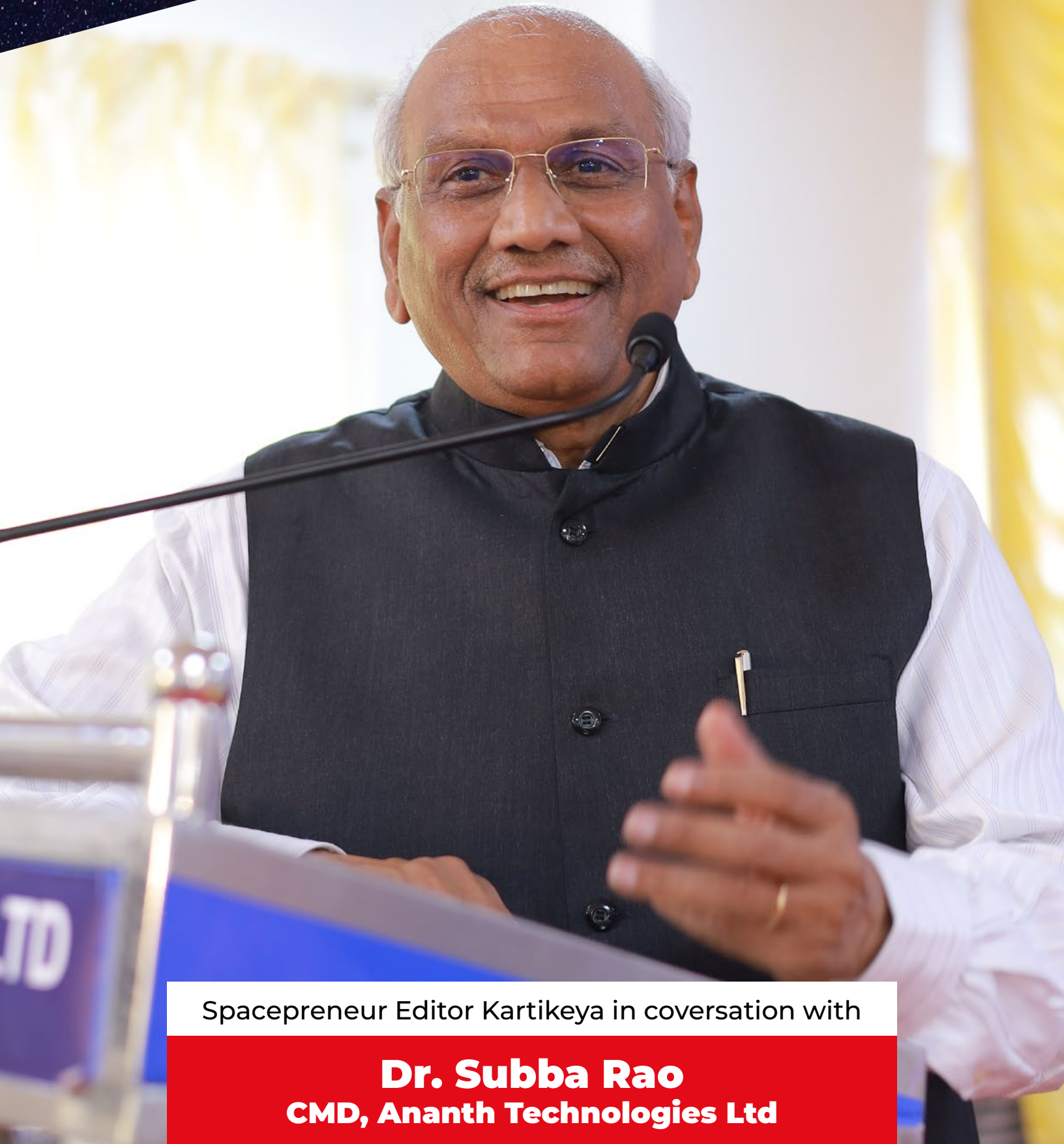
"I'm excited for our partnership with Purdue because of the positive implications it has for streamlining our nation's hypersonic design capabilities," said Dr. Zachary Krevor, CEO and president at Stratolaunch. "Reducing development and test timelines of hypersonic vehicles is paramount to achieving critical leap-ahead technologies."

"Stratolaunch's unique capacities to provide access to flight data in long-duration hypersonic conditions complements Purdue's advanced hypersonics laboratories and the cutting-edge research by our faculty to advance these technologies while providing our students with real-world learning experiences," Purdue President Mung Chiang said. «Stratolaunch's office at Discovery Park District further strengthens Purdue as an epicenter of hypersonic research and testing in the country.

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Any effort to increase the speed of 'continuous learning' in hypersonic systems design and deployment is a major win for our nation's defense," said Dan DeLaurentis, vice president for Discovery Park District institutes. "The world-class Purdue computational and ground test research capabilities, combined with a premier hypersonics flight test capability of Stratolaunch, is exactly such an effort, and yet another new avenue for developing and retaining the best talent so desperately needed in this domain.

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Spacepreneur Editor Kartikeya in conversation with

**Dr. Subba Rao**  
**CMD, Ananth Technologies Ltd**



**Q Can you describe your journey from the beginning days of your career to becoming a supplier of products to big players in Aerospace sector?**

**A** As I was working in Indian Space Programme of ISRO, I realised the importance commercialisation of Space related products and resigned my good job and started Ananth Technologies to work on Launch vehicle products, satellite products and satellite applications - in all sectors of Indian Space programme. That is why developed Centres in Hyderabad, Bangalore and Thiruvananthapuram. Similarly working for defence research programmes like LCA etc. The aerospace products are related to Avionics, Navigation, Electro mechanical related, mechanical products. Thus working for Satellite programme - so far contributed extensively to 90 Satellites and 70 launch Vehicles.

**Q What are the Aerospace sectors that Ananth Technologies is serving currently?**

**A** working for satellite programmes of Low Earth Orbits (LEOS), Medium Earth Orbits (MEOs), Geosynchronous Orbits (GEOS) for Earth observation Satellites (EOS), Navigation Satellites and Communication satellites. Also working for helicopters and LCA.

**Q Give us an insight into your collaborations with multiple companies? What are the prospects achieved so far?**

**A** Ananth has built cooperation's with Airbus, Antaris, Nexeya, Israel companies etc for manufacturing of Satellites in our facility in Bangalore. My goal is to make India "Spacecraft Manufacturing Hub" - for global needs.

**Q In general, what are the major challenges the sector is facing today and how is the road ahead? Is PPP the only way to boost India's space business?**

**A** Since reforms were announced by Hon Narendra Modi , Prime Minister , that

opened opportunity for private sector to grow on its own globally. Space economy in India and globally is huge. Particularly India gets various inputs from Space in to developing its economy fast. Space sector contributes immensely for economy.

**Q How did the outbreak of pandemic Covid-19 effect your operations? How did you overcome them?**

**A** Pandemic did effect operations nationally and internationally. As a result all projects were delayed. We are working hard to compensate for the time lost to the extent possible.

**Q What is your level of participation in 'Make in India' Initiative? How is it helping in expanding Ananth Technologies operations in India?**

**A** The government of India pushing "Make in India "under "AATMA NIRBHAR Bharat "is a great boon to Indian industry. As a result,





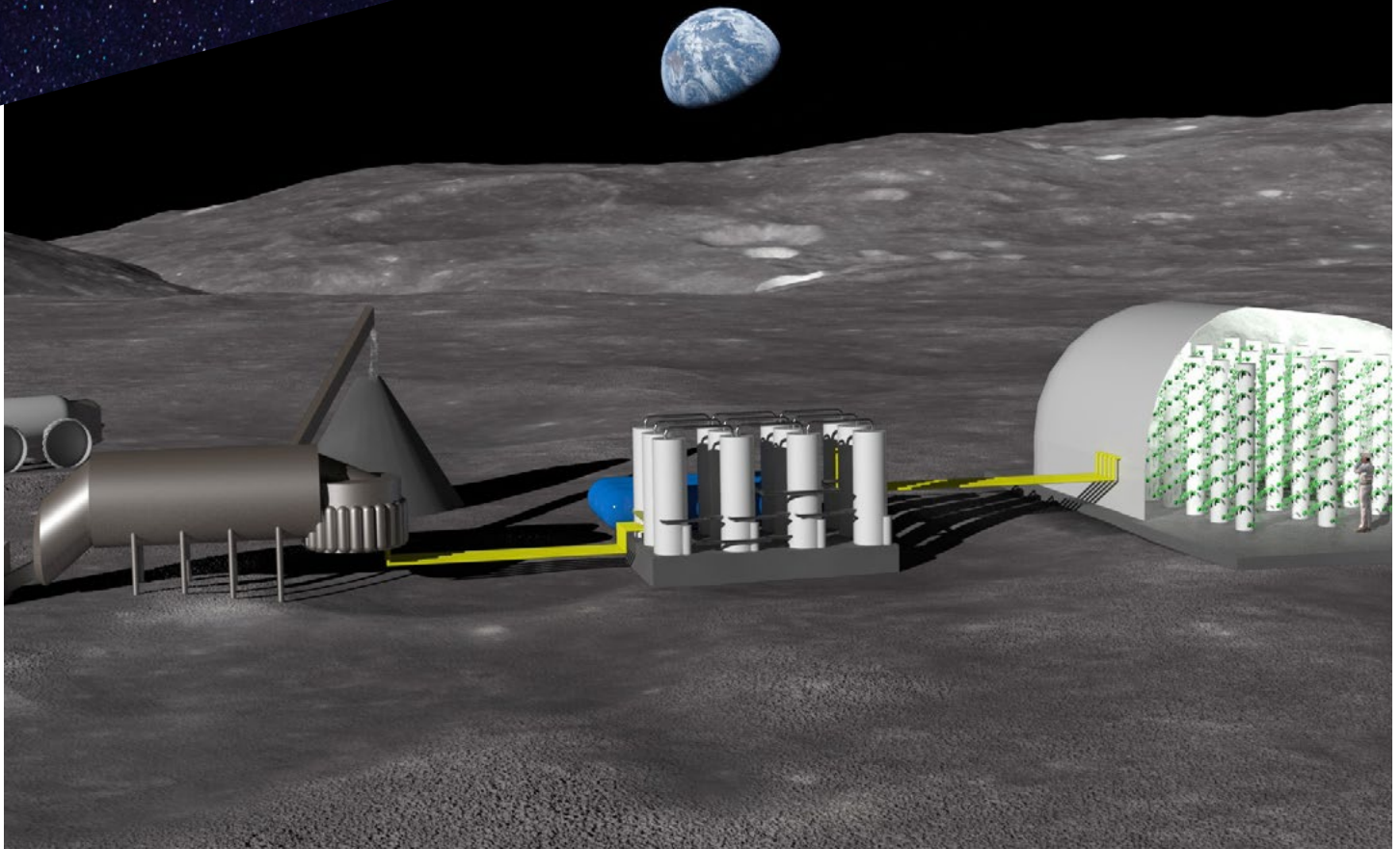
imports from various OEMS from abroad are restricted with a rider that they must collaborate with Indian industry and manufacture those subsystems and platforms. This resulted in to huge manufacturing opportunities to Indian industries. Now foreign OEMS are also realising that India can work with them from design, development, and manufacturing to testing with best quality processes and economical products. This gives raise to deployment of large scale expertise from Indian side. Thanks to PMs Initiative in this

direction.

**Q** What is your vision for Indian space market in the coming decade?

**A** Indian Space market is huge - for Earth observation satellites coming with high resolution and more revisit time helps collect larger inputs needed for development in various sectors like water resources sector, environmental sector, infrastructure sector etc to name few. In communication sector, satellites in LEOS, MEOS, and GEOs are

undergoing larger technological changes towards higher band widths per transponder, low latency and becoming more economical. Satellites small and large contribution for Defence sector too in the areas of surveillance, detailed mapping etc. Therefore, my vision is to make "India satellite manufacturing hub ". Since we are also involved in launch vehicle area; we endeavour to make launches from India more economical - and thus entire Space eco system shall be in place soon in India for India and for globe.



# Farming on the Moon

Sooner or later, settlers on the Moon will have to become farmers. A new ESA Discovery project led by Norway's Solsys Mining is looking into the treatment of lunar soil to create fertiliser for growing plants.

The good news is that analysis of lunar samples returned to Earth in the past by Moonwalkers and robots shows sufficient essential minerals are available for plant growth, apart from nitrogen compounds. The bad news is that lunar soil (or 'regolith') compacts in the presence of water, creating problems for plant germination and root growth.

Hydroponic farming therefore offers a practical alternative; this type of agriculture involves feeding plant roots directly with nutrient-rich water, without the need for soil. The potential is still there however to put lunar regolith to work, on the basis of 'in-situ resource utilisation' – or living off the land.

The 'Enabling Lunar In-Situ Agriculture by Producing Fertilizer from Beneficiated Regolith' project, led by Solsys Mining with

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This work is essential for future long-term lunar exploration,” comments ESA materials and processes engineer Malgorzata Holynska. “Achieving a sustainable presence on the Moon will involve using local resources and gaining access to nutrients present in lunar regolith with the potential to help cultivate plants. The current study represents a proof of principle using available lunar regolith simulants, opening the way to more detailed research in future.

”

Norway's Geotechnical Institute (NGI) and Centre for Interdisciplinary Research in Space (CIRiS), involves studying a combination of mechanical, chemical and biological processes to extract mineral nutrients from the regolith. Valuable elements might need concentrating before use, while undesirable ones would be removed.

The left of this artist's impression shows a mechanical sorting area for the regolith, passing through to the central module for more advanced processing, such as chemical leaching. Finally extracted nutrients would be dissolved in water to be pumped to the hydroponic garden, right.

The Solsys Mining team is optimistic, having already cultivated beans using simulated lunar highland regolith as a nutrient source. The project came about as an idea submitted through ESA's Open Space Innovation Platform, seeking out promising new ideas for space research. It is now being funded by the Discovery element of ESA's Basic Activities.



# Eyes on Hera: Asteroid Mission's Cameras Ready

ESA's Hera asteroid mission for planetary defence is about to gain its sight. Two complete and fully tested Asteroid Framing Cameras have reached OHB in Germany for integration aboard Hera's payload module. This instrument will provide the very first star-like view of Hera's target for the mission to steer towards the Dimorphos asteroid, which last year had its orbit altered by an impact with NASA's DART mission.

"It is a huge milestone to have the very first Hera payload ready for integration onto the spacecraft," comments Hannah Goldberg, Hera system engineer. "And the Asteroid Framing Camera, AFC, is not only our first payload, but also the most important, since by itself it can obtain all the mission's core goals. Hera payloads are arranged with core and opportunity objectives in mind – based firstly on the data we have to acquire, then the secondary results we seek to obtain whenever possible.

"Our October 2024 launch date is creeping ever closer, but the mission subsystems are beginning to come together as planned. So the next time

we'll see these cameras will be aboard the complete Hera flight model when overall spacecraft testing begins this autumn."

Hera is Europe's contribution to an international planetary defence experiment. Following the DART mission's impact with the Dimorphos asteroid last year – modifying its orbit and sending a plume of debris thousands of kilometres out into space – Hera will return to Dimorphos to perform a close-up survey of the crater left by DART. The mission will also measure Dimorphos' mass and make-up, along with that of the larger Didymos asteroid that Dimorphos orbits around.

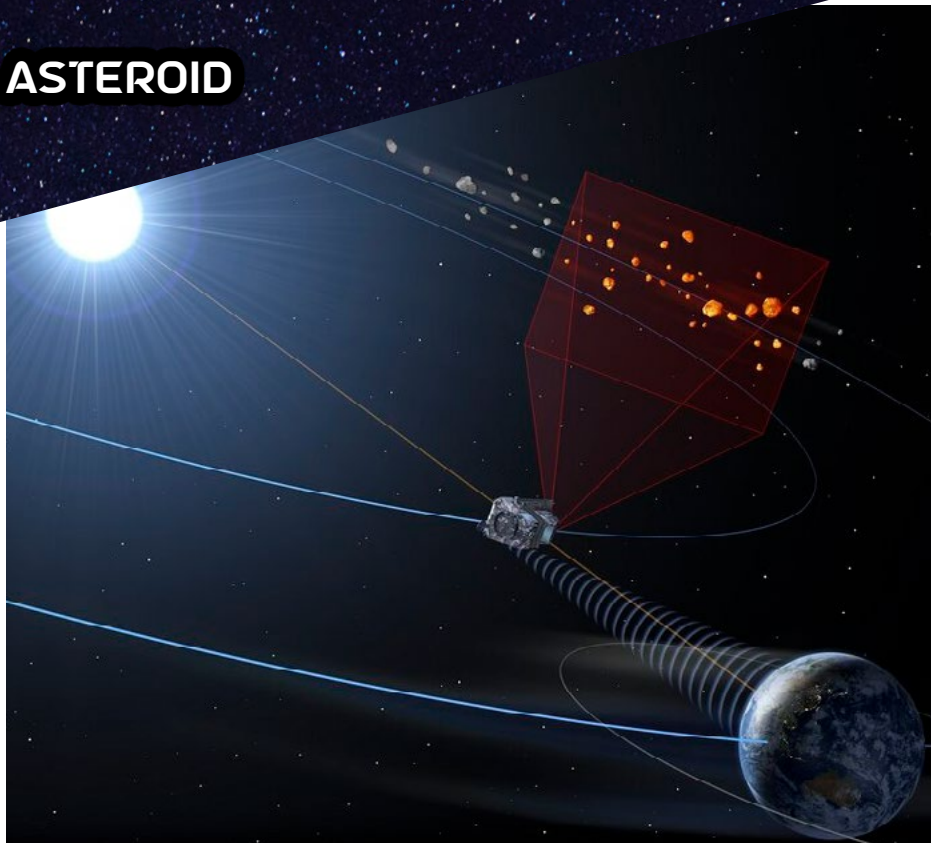
Operated on a redundant basis – meaning one unit will be kept in reserve in case of failure – the AFC will play a pivotal role in Hera's mission. As well as acquiring detailed views of the surface of Dimorphos for scientific analysis, including the crater left by the DART impact, the AFC will also be used for guidance, navigation and control. The AFC will home in on Dimorphos when it is still a single point of light in the sky – seen in conjunction with the larger asteroid Didymos. The AFC will then transition to close-up navigation, utilising edge detection to keep the asteroid centered in its field of view while tracking surface features to derive Hera's exact position from the asteroid in a similar manner to self-driving car software.

Around the same size and shape as a household vase, the 1.3 kg AFC has been designed, manufactured and tested by Jena-Optronik in Germany. The compact design with its long baffle to protect the camera's optics from sunglare shares heritage with the startracker units that Jena-Optronik specialises in – utilised to map the stars around a spacecraft in order to pinpoint its position in space.

Steffen Schwarz, Head of Marketing & Sales at Jena-Optronik, comments: "Hera is a prestigious mission and we at Jena-Optronik are looking forward to make a decisive contribution to its success through our camera." Possessing a 5.5 degree field of view, the monochromatic AFC acquires images using complementary metal-oxide-semiconductor active pixel sensor (CMOS APS) technology – an advanced, rad-hardened version of the imaging used in modern smartphone cameras – the FaintStar2 detector chip marketed by Caeleste in Belgium, initially designed for startrackers through a project in ESA's General Support Technology Programme.

Other Hera subsystems are currently being finalised: Hera's laser-based PALT (Planetary Altimeter) coming from Portugal; the HyperScout2 imager from the Netherlands; the Milani CubeSat from Italy and the Juventas CubeSat from Luxembourg; and the TIRI thermal imager contributed by Japan.

“The images we will see from the AFC will resemble those returned by DART before its impact,” adds Hannah. “For example, the picture we saw of the two asteroids together in DART’s field of view, and then later on the boulder-strewn surface of Dimorphos as DART was about to collide. “The AFC’s images will be complemented by colour images from other instruments, including Hera’s HyperScout instrument which will see in 25 different colours and the ASPECT hyperspectral imager aboard the Milani CubeSat, whose vision will extend beyond visible light into the infrared.”



## NEOMIR: finding risky asteroids outshone by Sun

**I**n brief: Asteroids, like stars, only come out at night. Hidden in the glare of our Sun are an unknown number of asteroids on paths we cannot track, many of which could be heading for Earth, and we just don't know it.

ESA's planned NEOMIR mission will be located between Earth and the Sun and will act as an early warning system for asteroids 20 metres and larger that cannot be seen from the ground.

In-depth Predicting Chelyabinsk: No one saw the Chelyabinsk meteor of 15 February 2013 coming. Just after sunrise on a calm and sunny winter's day, a 20-metre asteroid struck the atmosphere over the Ural Mountains in Russia, at a speed of more than 18 km/s.

The relatively small rock approached Earth from very near the direction of the Sun, exploding in the atmosphere and creating a shockwave that damaged thousands of buildings, breaking windows and injuring roughly 1500 people from flying shards of glass. It was the largest asteroid to strike Earth in over a century.

Statistically, asteroids this size strike Earth about once every 50-100 years. Larger asteroids are far less common but – just ask the dinosaurs – do a great deal more damage. These are, fortunately, much easier to detect.

In fact, we have discovered almost all aster-

oids larger than 1 km in size. Small and medium-sized asteroids are more common, and can still do great damage, but warning times of a few days can be enough for local authorities to notify the public to keep away from windows or even to evacuate a local area.

With NEOMIR, we'll be prepared whether it's preparing for a mission to deflect a large asteroid years in advance or providing the data for local authorities to keep communities informed of airbursts weeks ahead, ESA's NEOMIR will fill a gap in our current asteroid detection capabilities.

Asteroids are visible because they reflect the Sun's light, which we can detect from Earth. However, the closer they get to the Sun, the harder they are to see. Asteroids crossing the face of the Sun are particularly difficult to detect, but from Earth we are also blind to asteroids near the Sun as they are outshone by its glare.

ESA's upcoming NEOMIR mission will be launched into orbit around the first Lagrange point (L1) between the Sun and Earth, remaining in the same position relative to the two bodies. This will give the telescope a constant view of asteroids that may come towards the Earth from the direction of the Sun.

Being situated outside of Earth's distorting atmosphere and with a telescope observing in

### CURRENT STATUS

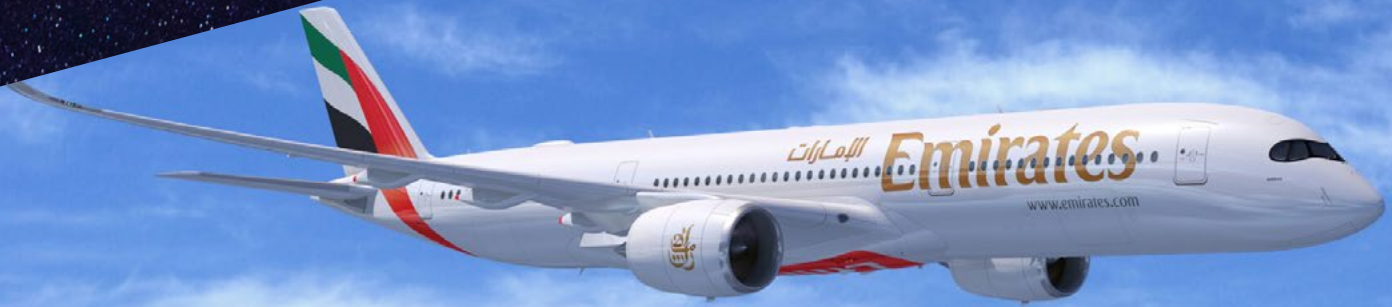
Details of the Space Safety Programme's NEOMIR mission are currently being fleshed out and it is planned to be launched around 2030 with an Ariane 6-2 rocket. An initial study to assess the feasibility of the NEOMIR mission was conducted by ESA's Concurrent Design Facility in the Netherlands, in 2021. The study focused on defining a mission that would complement NASA's NEO Surveyor mission. The US-funded mission should fulfil the US Congress mandate to discover 90% of near-Earth objects larger than 140-metres in diameter, while NEOMIR is designed to focus on imminent impactors of any size.

infrared light, NEOMIR will monitor a close ring around the Sun that is impossible to observe from the ground. The mission will detect asteroids passing between Earth and the Sun – any that pose a threat and that we cannot currently see will have to pass through this ring.

By making observations in the infrared part of the light spectrum, NEOMIR will detect the heat emitted by asteroids themselves, which isn't drowned out by sunlight. This thermal emission is absorbed by Earth's atmosphere, but from space NEOMIR will be able to see closer to the Sun than we can currently from Earth. Asteroids 20 metres and larger that are heading toward Earth should be detected by NEOMIR at least three weeks in advance. In the worst-case scenario, in which the asteroid is spotted passing near the spacecraft, we would get a minimum of three days' warning – the fastest the asteroid could move from L1 to Earth.

NEOMIR is currently early mission study phase. It will require a half-metre telescope with a large, corrected focal plane, as well as two infrared channels covering light in the 5-10 micrometre waveband. The required detector technologies and associated electronics for this novel mission are currently under development. Industrial research and development projects are planned as supporting activities in parallel.

The requirements will be to deliver a similar performance to the 'NEO Surveyor detectors', i.e., Teledyne's HxRG, which are in use in the James Webb Space Telescope (NIRSpec) and ESA's Euclid (NISF) and Ariel missions, although at shorter wavelengths.



# EMIRATES TAPS INMARSAT FOR A MAJOR NEW IFC DEAL



GX Aviation is well positioned to meet growing passenger expectations around a digital onboard experience, offering high-speed connectivity with uninterrupted global coverage across all flight routes, even over the Arctic. We look forward to working closely with Emirates on the rollout and other exciting innovations that build on its excellent track record of providing a best-in-class passenger experience.



Emirates has selected Inmarsat as the inflight connectivity provider for its incoming fleet of Airbus A350s, as part of a commitment by the United Arab Emirates airline to ensure passengers ‘fly better’.

The milestone agreement marks an expansion of the long-standing partnership between Emirates and Inmarsat. It will enable the airline to provide advanced, high-speed inflight broadband using Inmarsat’s award-winning GX Aviation solution on-board 50 Airbus A350s, which enter service from 2024. As a result, passengers will be able to stay connected with family and friends, browse the internet, and enjoy social media, all from the comfort of their seat.

The Airbus A350s will be the first Emirates aircraft to take advantage of Inmarsat’s Global Xpress (GX) satellite network, which powers the world’s first and only globally available high-speed broadband network, ensuring passengers can enjoy uninterrupted global connectivity, no matter their destination.

The GX network currently consists of five Ka-band satellites and will be further enhanced with the addition of seven more satellite payloads as part of Inmarsat’s fully funded technology roadmap. This includes two Inmarsat-6s, the most sophisticated commercial communications satellites ever built, both of which are scheduled to enter service this year.

These will be followed by three additional satellites in geostationary orbit – adding speed, capacity, and resilience – and two in highly elliptical orbit, which launch later this year and enter service next year, enabling the world’s only commercial mobile broadband service for aircraft flying in higher elevations and across the Arctic, such as routes between the Middle East and North America.

William Huot-Marchand, Inmarsat Aviation’s Senior Vice President of Inflight Connectivity, said “We are delighted that Emirates has joined the GX Aviation family. This will be the first fleet with Emirates to be equipped with our highly advanced GX Aviation solution.

Adel al Redha, Emirates’ Chief Operating Officer, said “Delivering a world-class onboard experience has always been paramount to Emirates and we understand the importance of being connected during flights. Over the years, we have worked closely with Inmarsat and our supplier partners to ensure all our aircraft offer Wi-Fi connectivity. We look forward to finding ways and options to improve the connectivity on-board our aircraft by utilising GX Aviation for our Airbus A350 fleet. The advanced capabilities being introduced by the forthcoming satellites are particularly important, as this will boost capacity across our global network, including aircraft flying over the Arctic for routes between the Middle East and America.”



# GAPSAT ACQUIRES QBX, INCLUDING ITU FILINGS FOR A GEO CONSTELLATION



Gregg Daffner, CEO of GapSat, said, "Given the rapid expansion of satellite communications in recent years, especially for HTS and UHTS, scarcity of spectrum has become a critical issue and satellite operators have been steadily moving up the spectrum ladder to higher frequencies. We have seen the move from C-band to Ku-band and to Ka-band and more recently, an interest in developing Q and V-bands. With the acquisition of QBX providing us with high priority orbital slot filings and patents to develop a global geostationary satellite constellation, GapSat is now ideally placed to meet the growing demands of the communications infrastructure sector.



GapSat Development Group Limited a BVI company that provides satellite operators with on-orbit, GEO communications satellites on an interim basis, has acquired QBX Limited, an Isle of Man based satellite solutions and consulting services company with a portfolio of satellite radio frequency spectrum and intellectual property.

Satellite spectrum and associated geostationary orbit slots are a finite resource and increasingly regarded as key strategic assets for the telecom and data communications industry, in the same way as patents are for emerging high technology industries. With wireless and mobile broadband playing an essential role in bringing high-speed, low-cost communications to the developing and developed world, the demand for mission-critical, orbit spectrum resources is increasing and a so-called 'race for space' is emerging.

The assets comprise a patent for radically new techniques to improve in-flight safety and communications for geostationary, aero-mobility services and a suite of three ITU geostationary satellite slot filings using conveniently placed orbital locations to provide for full global coverage/service from the resulting geostationary constellation,

using the Ka-, Q-/V- and E-/W-bands for long-term spectrum future-proofing.

With a strong background in developing existing on-orbit satellites for sale or lease, and the addition of this new portfolio of radio frequency spectrum and intellectual property, GapSat is currently seeking potential partners that could be existing satellite fleet operators, aero systems integrators, aero instrumentation manufacturers or financial investors, to develop the assets for data services in the marine and aero mobility sectors.

Mark Posen, Managing Director and Principal Consultant at RPC Telecommunications Ltd, said, "These filings have good ITU priority in parts of the geostationary arc where it is almost impossible to make usable new filings. Development of innovative approaches to leverage existing satellite spectrum is critical for satellite operators to address this increasing scarcity and complement their existing infrastructure and reach."

Katherine Gizinski, Chief Executive Officer, ManSat Limited, said, "We are excited to be part of this project which we see as a unique and valuable opportunity to develop key orbital resources with mid-ocean coverage to address marine and aero mobility needs worldwide."



Spacepreneur Special Editor Prof D.Vivekananda coversation with

**Dr.Kirankumar A.S.**

**Chair of ISRO's Committee of Earth Observation Satellites [CEO]**



OMPR / ISRO HQ

**Q** You have had excellent exposure and, thereby, opportunities to work on 'INDIGENOUSNESS' as an objective to make ISRO on its own. What made you think along these lines, i.e., Cost-effectiveness or affordability OR knowing the Strengths & Country's R & D Capabilities?

**A** If we look at today, we are all aware of how disruptive technologies impact people's lives, the global environment, etc. Yet, back in 1957, when the first object entered space, we observe that space technology was already a hugely disruptive innovation since it allowed humans to take objects beyond Earth for the first time and carry out operations from space. As a result, when this technology became accessible, the great scientist of our nation, Dr. Vikram Sarabhai, examined how a young democracy, which was only 10 years into independence, may use this new technology to address many of the problems staring in the face of the nation.

Dr. Sarabhai had a clear vision of using space technology to enable India address problems of communication broadcasting, weather monitoring and education. So, the entire space technology effort at that time was also highly innovative. Also, because this space technology was a result of intense military rivalry between two super powers of the day, they would not be readily available. But even so, he saw that we needed to get started and that the entire method that he embraced was that whatever was available at the time should be introduced into the nation, made familiar to the populace, and used to solve specific issues we were having and find solutions.

Hence, in this context, it is clear that long-term indigenous competence in taking objects to space and using space for various solutions was the primary effort. So in that framework, Dr. Sarabhai could envision a programme through which India conducted

one of the world's largest socio technological experiment SITE (Satellite Instructional Television Experiment) of demonstrating effectively the reach a broadcasting satellite from GEO platform could provide to the remote corners of our nation. This mission made use of America's (ATS-F) Advanced Technology Satellite borrowed and moved over to Indian Longitude for one year during 1975- 1976.

**Q** Your High Profile shows your inclination [since your Academic days] always to be a PHYSICIST showing your direction towards Physics and, thereby, Philosophy, always by CHOICE and not by CHANCE. Can you share a few insights?

**A** One of the things we discover when we begin working, especially in space programme and pushing objects beyond earth an important realization is the insignificance of ourselves as individuals in the





larger scheme of the cosmos. It is where understanding physics also plays a role. It refers to dimensionality because when we learn more about the immensity of the cosmos, another window is opened, making it clear how little we know. And it is in this philosophical frame of mind that one begins to understand what has to be done on a personal level to increase the accessibility of technology tools for humanity to survive on this planet and lead better lives.

Furthermore, physics and philosophy are the only things

that can help you. Many insights are coming to me. Indian satellite Aryabhata was our nation's first satellite launched in April 1975 as part of an Indo-Soviet cooperative program. And I was completing my stint at the Indian Institute of Science for my M.Tech degree then and an advertisement for a research associate position for the Satellite for Earth Observation (SEO) at Ahmedabad attracted my attention. I had applied for this post and got selected for the same in the year 1975

Your career Began at SPACE APPLICATION CENTER, Ahmadabad, making way to become the Director. Can you elaborate on the journey, working with Senior Scientists as you joined? Later, working with Experienced Scientists of various Streams & becoming Head of the Electro-Optical Systems Group. I was thus beginning work on a

project that was the follow-up to the Aryabhata satellite for Earth Observation when I joined the Space Application Center. As part of the friendship agreement between India and the USSR, Moscow planned to launch this new satellite, a combination of two spacecraft. I had the chance to work on this new satellite for the earth observation project. And that's how my career in creating one of the cutting-edge sensors for the satellite began. Hence, when I began my career I had some advantages since I had completed a course at IISc called physical engineering (M.Tech in Physical Engineering), an interdepartmental program designed by the Institute to bridge the knowledge gap

between scientists and engineers. My experience in several technical and scientific fields and my exposure at the Institute offered me a clear advantage over colleagues.

**Q Was there any chance of Forums beyond the Country inviting and offering to be part of their Commercial Activity?**

**A** As we began working on IRS1A, 1B, and 1C, we had already developed the capacity to provide photographs from space with a resolution that was similar to or useful on a global scale. Hence, rather than other people trying to provide us with an opportunity in their business, we could leverage what we had created and make it available to the worldwide community in remote sensing. Our satellites sent data to almost 18 ground stations worldwide in the mid-1990s. Many other nations utilized this data, including Russia, Germany, Europe, and the United States.



Hence, despite many limitations or constraints on the available Technology, ISRO and the Department of Space attempted to market what they had built and bring whatever revenue we could obtain through this process. In that sense, certain commercial operations were taking place, but we could also collaborate with other space organizations and contribute data in various ways. And we continually sought to maximize the value of existing capabilities and potential for financial gain through commercial endeavors.

**Q Can you share the feelings of the day you were asked to head ISRO?**

**A** Given the contribution of ISRO to the nation and the preminent position it had in the country an opportunity to

lead ISRO was indeed a matter of great Honour, privilege and responsibility. In addition, the ISRO was encouraged to utilize space technology to solve the nation's issues since it was ingrained in the ISRO's ethos. One of the most important things that existed was the chance to lead a group that had already made a name for itself and demonstrated to the nation and the world that we could make a difference despite obstacles and resource restrictions and contribute to the development of the nation. The true sentiment at the time was that there was a chance to advance the present situation, advance things, and enable the nation to profit from whatever space technology operations were underway. The thought process at that period was what can be done, which can genuinely assure, so whatever capability is there,

how to take it to the next level? At that time, the main focus had to be on streamlining all of the initiatives we were working on and letting people know that we had, in a sense, demonstrated our capability and the need was to build capacity in the country to ensure use of space technology.

**Q What were your priorities at ISRO to sail through the vision and mission?**

**A** We had just surpassed one of the technical breakthroughs at the time. Hence, streamlining every project already underway and accelerating the completion rate became the top goal. Even the sector of the economy that accounted for over 80% of launch vehicle fabrication activity was feeling the pressure. If they have made efforts in terms of money and investment resources, they also need to see a return on those efforts. So, the nation needed to go from exhibiting capability to demonstrating or using capacity and increasing the number of space-based systems running. So, it was evident that streamlining operations, increasing the number of launches, and then developing expanded capacity in space activities were the top priorities for addressing the many issues of a strong or one of the world's fastest-growing economies.

Additionally, the fastest-growing economies need a lot of inputs for planning, monitoring, and geopolitical situations. It also calls for different kinds of observation of your surroundings, your nation's visibility abroad, signs from space and beyond, and a desire to stay current in the Committee of Nations. These were the actual problems that needed to be solved. Therefore, during those few years, the focus was on stepping up both in terms



of launch vehicle production and increasing the number of launches each year in all types of vehicles, as well as on building navigation satellite series, putting it into operation, and attempting to utilize its services for a variety of applications.

Sir, looking at the trends in advancements of technology to elevate the living standards of human beings, there are also threats, and thereby, technology's focus to overcome this is a challenge. Please comment on this from the SPACE Science and Tech Applications perse.

It is a constant struggle for humanity since whenever a new technological capacity is made accessible, individuals always want to use it to further their power to rule others, whether in small groups, nations, or larger entities. Some want to profit from the new technical

capacity, others want to exploit it economically, and some want to utilize it to improve living circumstances and deal with particular issues related to life on Earth. And then, throughout time, we've also observed that any technology capacity frequently results in several other issues due to the rapidity or speed at which you want to implement a solution. Hence, this is always a challenge. We must ensure that each of these new technical skills, whatever they may be, has a greater emphasis placed on its solutions for the benefit of all humankind and the sustainability of life on Earth. In the private sector, there is money available. The private sector outside the borders of national nations is making these actions. Therefore there are a lot of difficulties. The ideals of sustainability are brought to this by nations like India, one of the oldest civilizations.

**Q Could you foresee any Bottlenecks in design and deployment from not only Technology but from Regulatory issues also?**

**A** The fact that someone physically controls every territory on Earth is undoubtedly one of the significant difference between terrestrial activities and space based activities. Hence, the entity exercising physical control have power over whatever physical events occur in that region. Yet as we can already see, communication has made it feasible for people to connect everywhere in the world. Moreover, the world is changing quickly due to the availability of portable devices. It is one situation where the ever-evolving issues of spectrum management, airwave regulation, etc., come into play. Unlike on earth space poses many challenges. Space is considered common heritage



of mankind. So, in this situation, it is vital to deal with regulatory bottlenecks and other issues collaboratively. Yet the actual difficulty lies in this. The United Nations has agreed that space is the shared inheritance of humanity. Hence all must work together to ensure space activity remains sustainable for humans on planet earth to benefit from activities in Space.

**Q** The facilities of ISRO are also open to Private SPACEPREUNERS. Can you describe the New Draft Space Policy 2022's amendments opening the Public and Private segments to pitch into R&D, Manufacturing, and System Processes potential to take our

### country to the top slot in SPACETECH?

**A** The country aspires to increase its economic power from the sixth-largest economy to the third and eventually higher. It needs more and more domains where economic development occurs. That's what the government is currently attempting to do, for instance, by making sure that there is a significant increase in participation of Indian private entities who can become significant players in the growing space economy ( a global market of trillion Dollars in the coming years).India which has built a significant capability of realising launch vehicles, satellites and its applications for a host of national

activities needs to now leverage this to be a very important player in the space economy . Towards this entities like INSPACE and NSIL along with Dept. of Space are working to change the operating environment in the country. A lot of work is being done, and we can already see the results of these changes. We saw the launch of 36 One-web satellites launched using LVM-3, one private company successfully testing its first stage (Prarambh) , another company testing its 3D printed semicryo engine and yet another company launching its satellite. The space which is considered the fourth frontier for humanity is beckoning India to be a significant player in the coming era.



# CESIUMASTRO ACQUIRES TXMISSION, A UNITED KINGDOM-BASED SMALLSAT COMMUNICATIONS COMPANY

CesiumAstro Inc., an industry leader in active phased array communications technology for space and airborne systems, announced it has acquired TXMission Ltd., a United Kingdom-based communications company that develops software-defined radios and modems for satellites, ground stations, HAPS (high-altitude platform systems), and airborne platforms. Financial terms of the transaction were not disclosed.

Founded in 2018, TXMission (pronounced “transmission”) has a rich portfolio of field-proven communications waveforms and hardware products that will complement CesiumAstro’s product lines, including their Quest™ and Connect™ software-defined radios built for the satellite and

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“TXMission’s modem capabilities are unrivaled, and together we can build a stronger end-to-end communications solution for our customers,” said Shey Sabripour, founder and CEO of CesiumAstro. “Acquiring TXMission provides a foundation for establishing an office in the United Kingdom, where we are investing to grow our presence.”

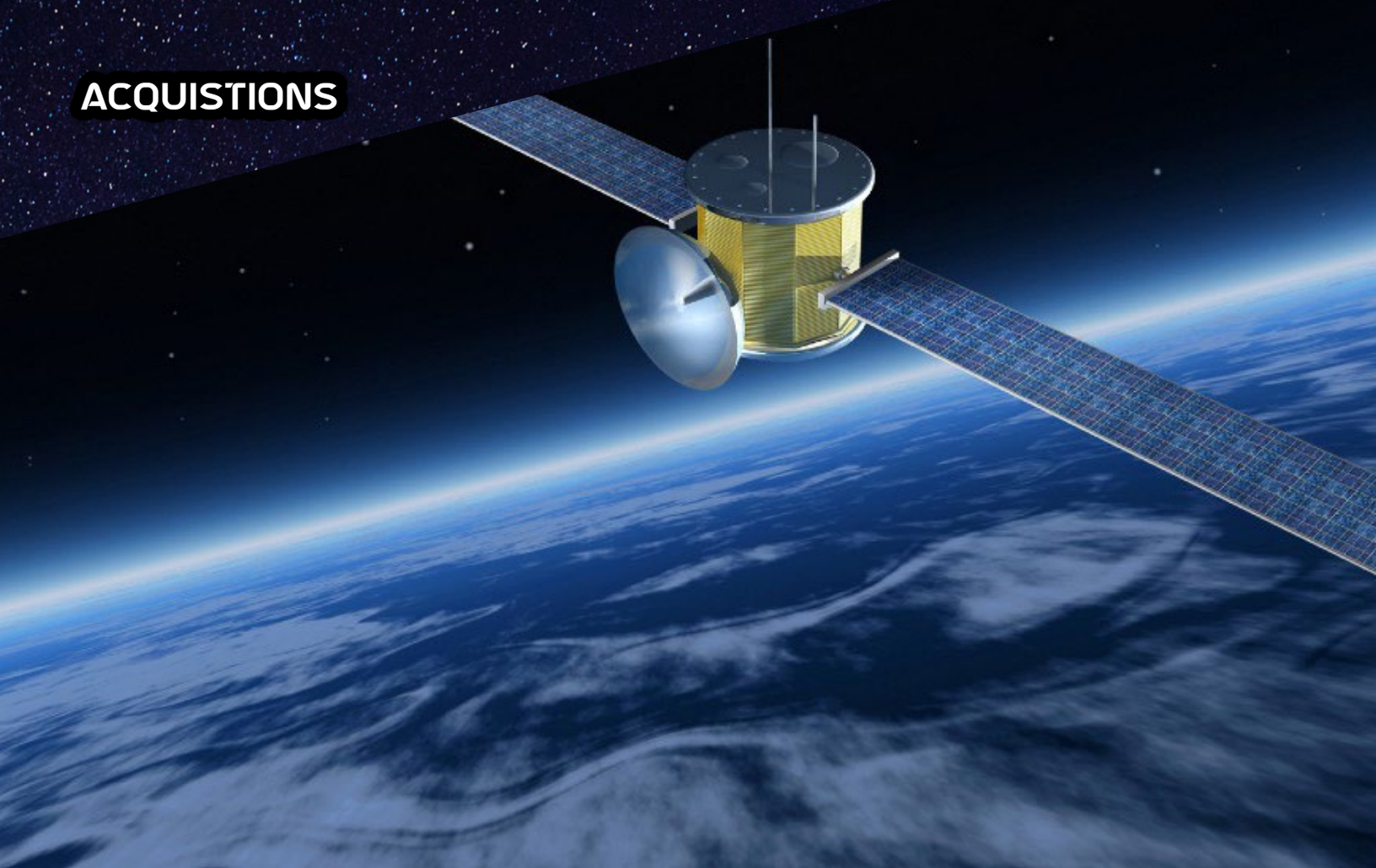
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ground station markets.

TXMission will become CesiumAstro’s first office in the United Kingdom, expanding the company’s ability to deliver mission-critical solutions to its European customers while gaining access to high-skill talent and manufacturing capability in the region.

“We are delighted to join CesiumAstro,” said TXMission’s CEO and Vice President of Engineering, Gianni Nannetti. “This is a mutually beneficial opportunity allowing us to grow our team, expand our capabilities, and continue building high-performance communications systems for our customers.”

Optimal Counsel LLP acted as legal advisor to CesiumAstro.



# BOECORE ACQUIRES SPACE SOFTWARE FIRM ORBIT LOGIC

Boecore has announced its acquisition of Orbit Logic. As a result, Orbit Logic will bring over two decades of experience providing operationally proven and highly configurable software products that support their customers' complex mission objectives in a rapidly evolving space environment. With this acquisition, the Company strengthens its software development and specialized mission operations capabilities and brings new product offerings to serve its customers better.

Speaking on the acquisition, Tom Dickson, President of Boecore, said the partnership with Orbit Logic helps Boecore expand its "product and technical capabilities, and it broadens our relationships and mission expertise within the space domain. The Orbit Logic team has built an outstanding business and has

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Likewise, Thomas Young, Principal at Enlightenment Capital, added, "with the addition of this product suite and the talented team of software developers and engineers at Orbit Logic, Boecore can continue providing its customers with the critical solutions they need to advance and maintain space superiority."

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a proven ability to develop and deliver advanced software products to its space customers. We are excited to welcome the Orbit Logic employees to the Boecore family and to continue driving innovation together."

Orbit Logic's Alex Herz also added that the Company was glad to join the Boecore platform and continue developing mission-critical products to help its customers deliver on complex space missions. The Co-Founder and President of Orbit Logic added, "Our cultures are a great fit, with both companies dedicated to innovation supporting our customers' missions. This partnership will only make our combined solutions more impactful to the space and defense communities while offering greater opportunities and support to our employees."



# CARNIVAL CORPORATION EXPANDS NEXT-GENERATION WI-FI CONNECTIVITY WITH SPACEX'S STARLINK

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High-speed, low-latency broadband internet is critical in our modern age, and we're excited to provide Carnival Cruise Line and AIDA's guests an internet experience that makes their travel even more enjoyable," said Jonathan Hofeller, vice president of Starlink sales for SpaceX. "In even the most remote waters, guest's onboard Carnival Corporation ships will be able to share real-time updates with friends and family.

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Carnival Corporation & plc, the world's largest cruise company announced an agreement for the next-generation of internet connectivity across its global fleet, the latest in a series of moves that have nearly tripled ship bandwidth since 2019. The company has signed a new agreement with SpaceX's Starlink, the leader in Low Earth Orbit (LEO) satellite technology, to provide faster service, greater capacity and more reliable Wi-Fi on a global scale.

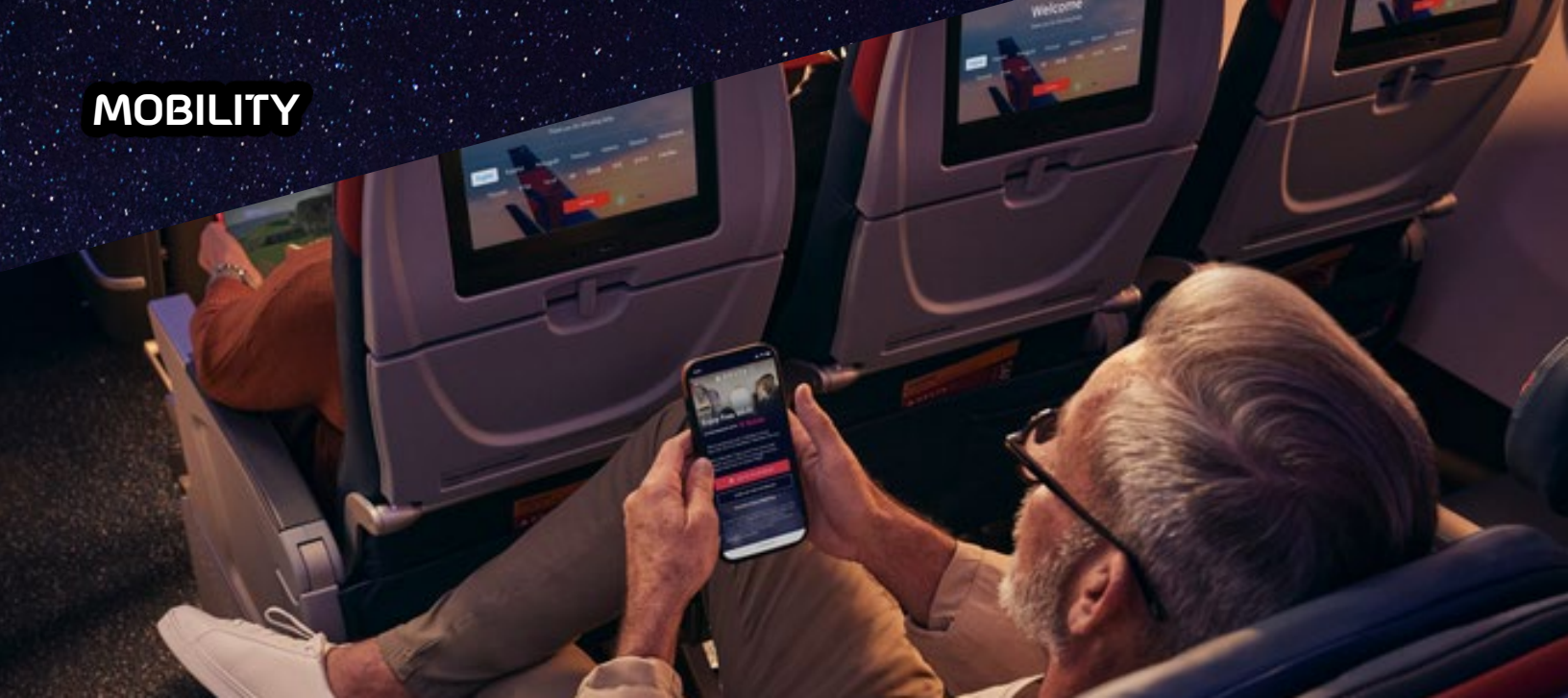
Fleet roll-out of Starlink began in December 2022 with Carnival Cruise Line and AIDA Cruises ships, with plans to expand Starlink to several of the company's other world-class cruise brands, which include Princess Cruises, Holland America Line, Seabourn, P&O Cruises (Australia), Costa Cruises, P&O Cruises (UK) and Cunard.

Rivaling on-land connectivity experiences, Starlink greatly advances Carnival Corporation's focus on providing the best available Wi-Fi experience for its guests to stay connected while on vacation, including sharing photos and videos, streaming movies and live sporting events, and enjoy-

ing other content onboard with a reliable connection at even faster speeds.

"For many of our guests, it has become more and more important to maintain the type of connectivity at sea that they've become accustomed to at home, and of course to share the unforgettable experiences of their cruise with friends and family," said Josh Weinstein, CEO of Carnival Corporation. "We are in the business of delivering happiness, and Starlink makes it as easy as possible for our guests to share all their great moments and memories, giving them even more joy out of their cruise vacation."

According to Weinstein, "The added bandwidth will give the brands the capabilities and flexibility to introduce new guest services and features, as well as help boost operational functions like onboard equipment monitoring and real-time communications between ship and shore teams. And importantly, adding Starlink's innovative technology to the company's existing connectivity platform will also help our amazing crew stay in touch with friends and loved ones."



# DELTA WILL START OFFERING FREE WI-FI ON ITS PLANES THIS YEAR

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Viasat’s system – from the satellites to how we manage bandwidth – has been designed over many years to enable consistent, high-quality Wi-Fi at scale for customers like Delta, so those traveling on Viasat-equipped Delta aircraft can enjoy their favorite content—similar to how they would at home,” said Don Buchman, general manager of the company’s commercial aviation business.

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Delta Airlines said it would begin offering free in-flight Wi-Fi to rewards-member passengers on most domestic mainline aircraft starting next month. That news may have travelled under the radar in San Diego amid the deluge of announcements at CES. But it involved a local company — Carlsbad-based Viasat, the satellite Internet provider that supplies in-flight Wi-Fi connectivity for a growing portion of Delta’s domestic fleet. The airline will offer the free service for SkyMiles members on most Delta flights with Viasat Wi-Fi within the U.S. starting Feb. 1. It will be offered on more than 700 Delta aircraft by the end of 2023.

“At work, at home and everywhere in between, connectivity is essential to daily life, and your journey on Delta should be no different,” said Delta Chief Executive Ed Bastian in a statement. “Our vision has long been to deliver an experience at 30,000 feet that feels similar to what our customers have available on the ground.”

Working with engineers from Viasat, Delta tested the system with an eye toward rolling out the free program on a larger number of additional routes by the end of 2024. “It is imperative all customers on board can enjoy their favorite content just as they would at home, and we’ve put this system through meticulous tests to make that possible,” said Bastian.

Delta isn’t the first U.S. airline to offer free Wi-Fi to passengers. JetBlue, one of Viasat’s early in-flight connectivity customers, also offers it at no

charge. Being able to deliver the Internet connectivity economically enough to allow airlines to offer it to passengers at low cost or for free has long been touted as a possibility by Viasat executives.

Delta’s move comes as Viasat is facing increased competition in the in-flight connectivity market from newcomers including SpaceX’s Starlink Aviation, which is working with Hawaiian Airlines, JSX and others to deliver in-flight Internet from its low-earth orbit satellite constellation. Viasat’s current fleet of high-orbit, geostationary satellites are nearly full. To increase capacity, the company is expected to launch its next-generation satellite, ViaSat-3, before the end of March. It will deliver an additional terabit of targeted bandwidth to Viasat’s network. This first satellite will cover the Americas. Six months later, a second ViaSat-3 is expected to blast off, providing coverage over Europe, the Middle East and Africa. The third satellite in the constellation, which will deliver bandwidth to the Asia-Pacific region, is forecast to launch less than a year later.

“With ViaSat-3, we believe Viasat still will have the lowest cost per bit in a market where demand far exceeds supply,” said Mike Crawford, an analyst with B. Riley Securities, a member of the Discovery Group. “But we do acknowledge there are a lot more existing and future bits to be consumed, including from SpaceX’s Starlink constellation, not to mention a nearly-deployed OneWeb constellation and a soon-to-be-launched Kuiper from Amazon.”





Air, our sister airline, in early 2024 and roll out across our regional jet fleet, including on our partner SkyWest, over a two-year period. With nearly all our mainline fleet set to feature satellite Wi-Fi by this April – also installed by Intelsat – we’re on track to provide consistent streaming-fast Wi-Fi across our entire fleet by 2026.

Intelsat’s state-of-the-art satellite Wi-Fi equipment will be the first commercial application of an electronically steered antenna that communicates with both low Earth orbit and geostationary satellites located 22,000 miles from Earth. With LEO at just 300 miles from the Earth’s surface, thousands of small satellites circling the planet ensure stronger connectivity with lower latency, or delay in telecommunications. Being closer to Earth provides a benefit of a shorter delay time as data moves from the ground to satellites to aircraft and back. This unique combination of using both LEO and GEO satellites enables higher speeds and more coverage, particularly across remote areas in the state of Alaska.

With satellite Wi-Fi, you can stream, browse and chat on board using the internet much like you’re used to when you’re on the ground. You can enjoy content on your personal devices from your favorite services such as Netflix, Hulu, YouTube and TikTok. Or jump online if you need connectivity to get some work done. Another bonus: On our aircraft enabled with satellite Wi-Fi, you can connect from the moment you board instead of waiting for the connection to kick in after the boarding door closes – it’s seamless connectivity from gate to gate.

When you’re airborne, staying entertained is important – and that doesn’t mean you need to connect to the internet to do that. We continue to invest in our massive library of entertainment for free streaming to personal computers, tablets and phones. We offer more than 800 movies and TV shows with more to come. And don’t forget about free texting on board.

Alaska is a member of the oneworld global alliance. With oneworld and our additional airline partners, our guests can earn and redeem miles with our highly acclaimed Mileage Plan program to fly on more than 20 oneworld and partner airlines all around the globe. Elite status on Alaska automatically matches tier status in oneworld right away and all the benefits that come with it.

## ALASKA AIRLINES PLANS STREAMING-FAST SATELLITE WI-FI UPGRADES TO OUR E175 REGIONAL JETS

As Alaska Airlines elevates its regional flying experience with an all-jet fleet, we’re excited to become the first major airline to announce plans to offer streaming-fast satellite Wi-Fi on a regional jet aircraft. We have selected Intelsat’s newest satellite Wi-Fi technology to make that happen.

Intelsat’s new system closely aligns with Alaska’s needs for our regional fleet. The new, faster service will utilize an electronically steered array (ESA) which is a small, lighter weight antenna with no moving parts – making it easier to maintain in the unique regional environment. In an industry first, Intelsat’s new system will communicate with both traditional geostationary (GEO) satellites and new low Earth orbit (LEO) satellites. With an additional \$25 million investment, this upgrade represents a major step forward in the travel experience for our guests, enabling higher speeds and more coverage in the air, particularly across areas in the state of Alaska.

The new system will debut on Horizon

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Bringing a streaming-fast satellite Wi-Fi solution to our regional jets is another key investment in modernizing our fleet, emphasizing innovation and taking care of our guests changing needs,” said Sangita

Woerner, senior vice president of marketing and guest experience for Alaska Airlines. “With the growth in remote work, we know staying connected at 34,000 feet is more important than ever. Intelsat’s new system will give our guests the peace of mind that no matter whether it’s a short flight or longer journey, there will be reliable, affordable and convenient Wi-Fi. It’s just another way we show care in the air.

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## APPOINTMENTS



### **NASA's Joe Acaba to Serve as Agency's Chief Astronaut**

NASA has selected veteran astronaut Joe Acaba as chief of the Astronaut Office at the agency's Johnson Space Center in Houston. A decorated veteran of multiple spaceflights, as well as a former U.S. Marine and former educator, Acaba is the first person of Hispanic heritage selected to lead the office. Acaba takes the place of NASA astronaut Drew Feustel, who spent two years as deputy chief and has been acting chief of the office since NASA astronaut Reid Wiseman left the post late last year.

"Congratulations to Joe Acaba on being named the new chief of the astronaut office! Joe is an experienced space flyer and a proven leader, and he will undoubtedly inspire the next generation of NASA astronauts. As we build on the International Space Station's unparalleled success in low-Earth orbit with our eyes on the Moon and then Mars, Joe will play an integral role in ensuring our NASA astronauts are prepared for the challenges ahead," said NASA Administrator Bill Nelson. "I also want to thank Reid Wiseman for his steady leadership, and to Drew Feustel for jumping in to continue the office's long legacy of excellence and integrity."

In his new role, Acaba will be responsible for managing astronaut resources and operations. He also will help develop astronaut flight crew operation concepts and make crew assignments for future spaceflight missions, including astronauts

assigned to fly on Artemis missions. "Our Johnson Space Center team congratulates Joe Acaba on his selection to chief of the Astronaut Office. We wish him well as he takes on this new and exciting leadership role," said NASA Johnson Space Center Director Vanessa Wyche. "I extend my sincerest thanks to Reid Wiseman for his dedicated service to the Astronaut Office, as he completed the tremendous task of preparing our astronaut corps for daring missions to and from the International Space Station, and integrating their expertise and space knowledge to develop and test future technologies, software, and procedures, making space travel safer, reliable, comfortable, and attainable for our nation's explorers. A special thank you to Drew Feustel for stepping in to lead our astronaut corps following Reid's transition. I appreciate his willingness to step in and help prepare our nation's astronauts to explore space for the benefit of humanity."

A veteran of three spaceflights, Acaba was born in Inglewood, California. He earned a bachelor's degree in geology at University of California in Santa Barbara, one master's degree in geology from the University of Arizona, and one in education, curriculum and instruction from Texas Tech University, Lubbock. Before his selection as an astronaut candidate in 2004, Acaba spent time in the U.S. Marine Corps Reserves and the Peace Corps, worked as a hydrogeologist, and taught high school and middle school.

"Joe is an excellent leader who brings a wealth of experience to the Astronaut Office," said NASA's Director of Flight Operations Norm Knight, who made the selection. "Knowing the significance of this position and the integrity of those who have previously served, I am confident Joe will be an outstanding chief for the Astronaut Office who will successfully lead our astronauts through an exciting future."

### **Steven Rutgers is appointed the Chief Commercial Officer at Arianespace**



Arianespace has appointed Steven Rutgers to serve as its next Chief Commercial Officer. Steven Rutgers began his career in the space industry over two decades ago, working his way progressively through the ranks – initially as the international market and account manager with Inmarsat distributor Xantic in the Netherlands. He subsequently worked in Hong Kong, Dubai and Singapore with Stratos and Inmarsat, negotiating complex bids and supporting commercial development. His career has spanned the globe, from Europe to the Middle East, Asia and the Americas, where he has conducted business with multiple sectors – including satellite operators and the government, telecommunications, oil and gas, mining, logistics and fisheries industries.

Prior to joining Arianespace, Rutgers was the Vice President of Sales with the IoT (Internet of Things) company Hiber, where he successfully executed deals with large customers served by the satellite industry.

Rutgers holds a Bachelor's degree from the International School of Economics and Management, Rotterdam.

Stéphane Israël, the Chief Executive Officer of Arianespace, stated: "I am delighted to welcome Steven

## APPOINTMENTS

Rutgers to Arianespace as our Chief Commercial Officer, succeeding Emmanuel Franc, who has opted for an external opportunity after a 2022 record year in terms of order intake, and whom I warmly thank for his contribution. With over 20 years of global satellite commercial leadership experience, Steven is a strong addition to Arianespace's Executive Committee and to our commercial team. His international experience will definitely serve and strengthen our commercial ambitions and the long-term success of Ariane 6 and Vega C on the institutional and commercial markets."

### **Momentum Welcomes Chris Kinman as Chief Commercial Officer and Dennis Mahoney as Interim Chief Financial Officer**



Momentum Inc. a U.S. commercial space company that offers transportation and other in-space infrastructure services announced that Chris Kinman will join Momentum as Chief Commercial Officer effective January 9 and Dennis Mahoney will serve as Interim Chief Financial Officer effective January 7.

"Chris and Dennis' careers show a track record of results in energizing growth and building trusted relationships with key government, civil, and commercial customers," said Momentum Chief Executive Officer John Rood. "Their expertise will guide our sales and financial teams as the Company seeks to meet the growing demand for in-space transportation and infrastructure services and create value for our shareholders."

Kinman brings more than 30 years of

experience in business development, engineering, program management, capture management, and driving growth in the defense and civil government and commercial space sectors. Most recently, Kinman served as a Senior Business Development Executive for Northrop Grumman's Space Sector. In this role, he led the business development team in the capture of Intelligence Community and DoD space opportunities, working directly with USG end users, including the Space Development Agency, Space Force, and U.S. Army. He successfully led and helped capture multiple satellite and payload opportunities at Northrop, valued at several billion dollars in total contract value.

"I am both delighted and honored to join the Momentum team during such an exciting time for the Company with the continued growth in the space infrastructure services market," said Kinman. "I look forward to applying my expertise in the space and government sectors to develop innovative solutions for our customer base and meet Momentum's growth vision to make space sustainable for future generations."

Mahoney is a seasoned professional with over 40 years of experience, including serving as CFO or senior financial executive of six public companies listed on the NYSE, NASDAQ, and ASX. He has negotiated and closed four acquisitions in the United States and Europe, and one company sale. Mahoney has deep experience in defining financial strategy, scaling operations, and driving profitable growth across a spectrum of companies in the technology, semiconductor, pharmaceutical, and medical device industries, including startups through organizations with \$1.5 billion in revenue. In these roles, Mahoney has enabled international expansions, led operations, licensed products, led government compliance, and defined global tax strategy. He has closed over \$450 million in equity

and debt financing, including IPOs and private equity. Mahoney is the founder and CEO of SequoiaCFO, where he provides executive financial consulting services to global clients. In this role, he has helped a range of tech companies grow and expand internationally.

"I am honored and pleased to be joining the extraordinary team at Momentum in its critical mission of providing transportation and other in-space infrastructure services to support a thriving space economy," said Mahoney. "Momentum is a company with great potential impact. I look forward to helping the Momentum team in every way that I can as interim CFO to advance its mission in advancing how the world operates in space."

### **NASA Names New Agency-Wide Chief Technologist**



A.C. Charania is NASA's new chief technologist, serving as principal advisor to Administrator Bill Nelson on technology policy and programs at the agency's Headquarters in Washington. He will lead technology innovation. The chief technologist aligns NASA's agencywide technology investments with mission needs across six mission directorates and

oversees technology collaboration with other federal agencies, the private sector, and external stakeholders. The position works within NASA's Office for Technology, Policy, and Strategy.

"Technology plays a vital role in every NASA mission. Making sure that we're pursuing the best policy objectives allows this agency to continue to serve as a global leader in innovation," said Bhavya Lal, NASA associate administrator for technology, policy, and strategy. "A.C. is an experienced leader in managing large, rapidly shifting technology portfolios. I am eager for him to apply his knowledge and enthusiasm at NASA."

Lal served as acting chief technologist prior to the appointment of Charania, whose first day working at NASA Headquarters was Jan. 3.

"The rate of advancement we seek in the 21st century is dependent upon selecting and maturing a portfolio of technologies into systems to execute our missions," said Charania. "With this in mind, there are incredible opportunities in partnerships within and outside of NASA. I now look forward to the opportunity to work with the entire community to increase the rate of space and aviation progress."

Before joining NASA, Charania served as vice president of product strategy at Reliable Robotics, a firm that is working to bring certified autonomous vehicles to commercial aviation. His previous experience also includes working at Blue Origin to mature its lunar permanence strategy, Blue Moon lunar lander program, and multiple technology initiatives with NASA.

He previously worked in strategy and business development for the Virgin Galactic (now Virgin Orbit) LauncherOne small satellite launch vehicle program. He also served in multiple management and technology roles at SpaceWorks

Enterprises, including helping to incubate two startups, Generation Orbit and Terminal Velocity Aerospace.

## **Astroscale Ltd. Appoints Andrew Faiola as Commercial Director**



Astroscale Ltd., the UK and European subsidiary of Astroscale Holdings Inc. the market leader in satellite servicing and long-term orbital sustainability, announces Andrew Faiola as Commercial Director, effective immediately.

"I am delighted to welcome Andrew as Commercial Director," said Nick Shave, Astroscale Ltd. Managing Director. "With his broad commercial experience and understanding of the challenges satellite operators face across all orbits, he brings a unique perspective to the cutting-edge solutions we are developing for the in-orbit servicing, satellite end-of-life services and the active debris removal markets."

Based in the UK, Faiola is

responsible for leading Astroscale Ltd.'s commercial sales, business development and marketing activities as the company aims towards making in-orbit servicing, including debris removal, routine by 2030.

"I am so excited to join Astroscale at this amazing period in its development, at a time when it is clear for all to see how critical it is to protect and improve the space environment," Faiola said. "Without access to space-based positioning, communications and Earth observation, many of the services that we take for granted to enhance our lives every day simply would not be possible. I look forward to leveraging my satellite industry experience and passion for space to work with our broad customer base to overcome our collective challenges and meet Astroscale's bold vision to make space sustainable for future generations."

Faiola joins Astroscale Ltd. with more than 20 years' experience in commercial sales and market development roles with a focus on delivering connectivity and access to information to remote locations on land, air and sea. Prior to joining Astroscale Ltd., he held leadership positions at a number of the most recognisable companies across the satellite communications ecosystem, including ALLSPACE Ltd., ST Engineering iDirect, Newtec, Intelsat, SES (formerly NewSkies Satellites), and Esatel Communications. Earlier in his career he performed research and project development work at the Center for Strategic & International Studies (CSIS), the Embassy of Mexico in Washington, DC, and at NASA, which involved the provision of internet service and remote sensing for environmental monitoring.

Faiola holds a bachelor's in economics from Washington University in St. Louis, and a master's in international affairs from The George Washington University in Washington, DC. He is also a distinguished alumnus of Space Camp.

## APPOINTMENTS



### **NASA Selects Shawn Quinn to Lead Exploration Ground Systems Program**

NASA has selected Shawn Quinn as manager of the Exploration Ground Systems program based at the agency's Kennedy Space Center in Florida, effective Sunday, Jan. 15. In this role, Quinn will lead the team responsible for developing and operating the systems necessary to process and launch NASA's Space Launch System (SLS) rocket and Orion spacecraft on Artemis Moon missions.

Quinn succeeds Mike Bolger, who retired from the agency in December 2022 after 35 years of service following the successful Artemis I mission.

"The work done on the ground at Kennedy to prepare for missions to the Moon is essential to the success of Artemis," said Kennedy Space Center Director Janet Petro. "Across several roles at Kennedy, Shawn has demonstrated outstanding leadership, mentoring, and technical skills, and will be a tremendous asset in his new role supporting Artemis and humanity's return to the Moon." Quinn brings more than 35 years of NASA experience to the role. Since 2018, he served as the director of engineering at Kennedy's spaceport, where he led a large organization of engineers from multiple disciplines in the design, development, and operations of spaceflight hardware and ground systems in support of programs and projects assigned to Kennedy, including commercial crew, launch services, ground

systems, and the International Space Station.

He has previous experience with the Exploration Ground Systems Program, serving as the associate program manager. In that position, he was responsible for ground systems development activities, including design, development, integration, fabrication, construction, activation, and verification and validation of facilities, systems, ground support equipment, and operations planning and execution activities leading to NASA's exploration missions.

Prior to that role, Quinn was the Vehicle Integration and Launch Integration Product team manager. He was responsible for the operations and development of systems at Kennedy's Launch Complex 39, including the launch pads, the mobile launcher, crawler transporter and the Vehicle Assembly Building. In the role, Quinn oversaw the overall planning and implementation of modifications of Launch Complex 39 systems to support the processing and launch of SLS and Orion. He first joined NASA in 1985 in the Engineering Cooperative Education Program at Kennedy supporting the Space Shuttle Program as a design engineer while studying for his bachelor's degree.

### **Intelsat Appoints Gaurav Kharod as the Regional Vice President of Asia Pacific**

Intelsat, operator of one of the world's largest integrated satellite and terrestrial networks and leading provider of inflight connectivity (IFC) announced the appointment of Gaurav Kharod as the regional vice president for its Asia Pacific (APAC) region. Kharod comes from Intelsat's India office, where he served as the managing sales director of South Asia and India.

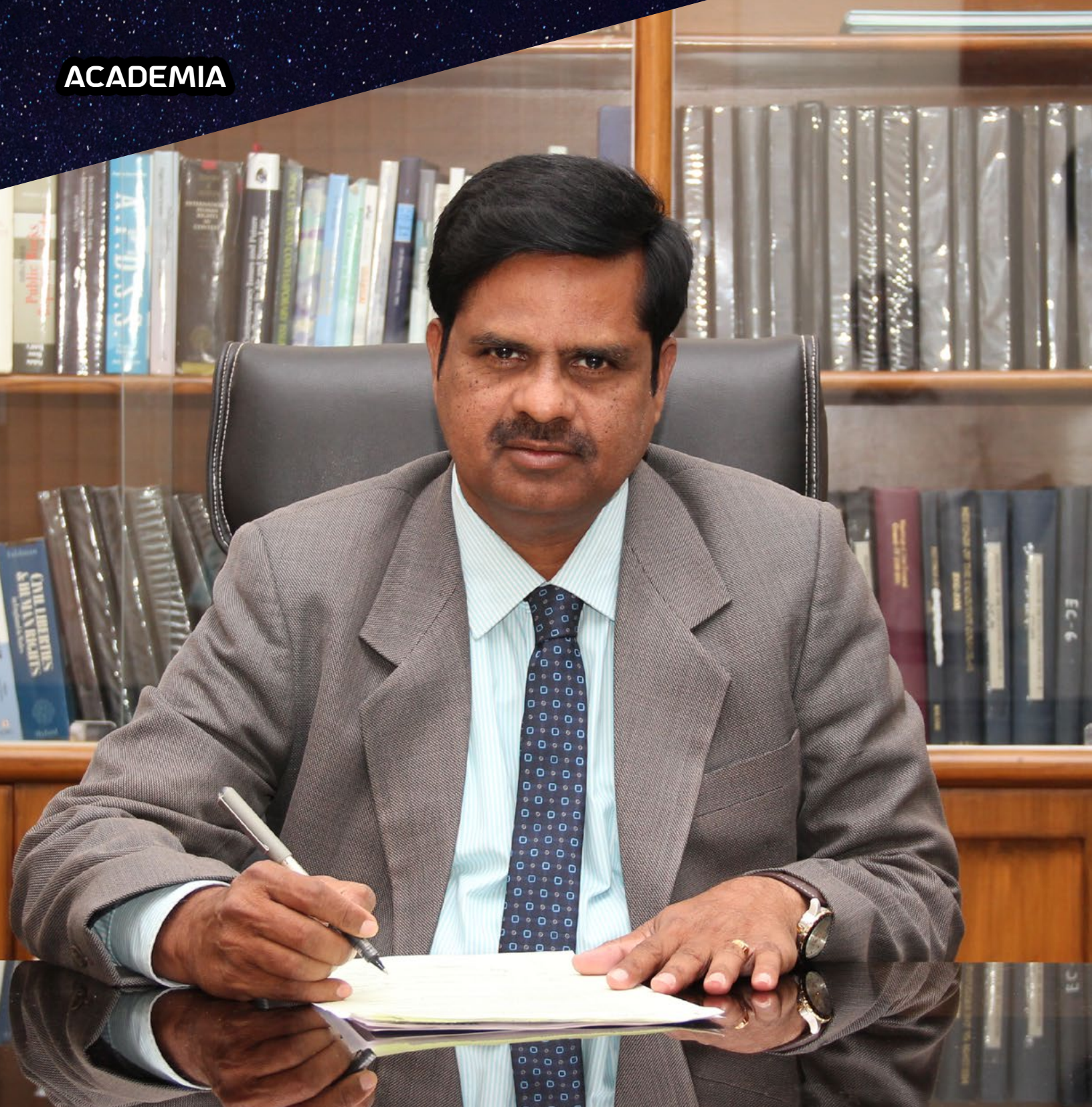


Kharod will assume the responsibilities from Terry Bleakley, who previously led the APAC team. Bleakley will transition on April 1 to a part-time senior advisory role at Intelsat and will continue to support key growth opportunities in the region.

"Intelsat is on an ambitious growth trajectory in the APAC market, and Gaurav brings with him the expertise that will help us achieve these goals," said Senior Vice President, Global Sales, Network and Media, Jean-Philippe Gillet. "I look forward to achieving many milestones under Gaurav's leadership in the region."

In Kharod's last assignment, he led the Media business sales team, driving the organization's strategy in the region. Kharod also implemented a successful entry strategy for Intelsat's high throughput satellite (HTS) IS-33e in the Indian market. This created a roadmap for the growth of all the different business verticals of Intelsat, including Media, Networks, FlexMaritime, and Commercial Aviation, to be fully represented in the Indian and South Asia markets. Before joining Intelsat, Kharod held leadership roles at Hughes India and Viasat Inc. in the satellite domain, along with a stint at Conax AS in the media industry. He brings a mix of expertise across sales, product management, business development, regulatory and policy affairs.

Kharod holds an MBA and a bachelor's degree in electronics engineering as part of his college education in Gujarat, India.



Spacepreneur Editor Kartikeya in conversation with

**Prof. V. Balakista Reddy**  
**Head-Centre for Aerospace and Defense**  
**laws, NALSAR University of law**



**Q** How best can you describe the Space journey since its humble beginnings to where it is now?

**A** One of the significant achievements of man in the 20th century was his ability to leaving this planet, the Earth and having complete view from space. This was only result of efforts through generations to take flight of fantasy into outer space through mythology, poetry, fiction etc...Scientists predicated the theoretical possibility of space voyages by 16th century, but it became possible only with the successful launch of the first Sputnik by former Soviet Union on 4th October, 1957. Yuri Gagarin became first man in space on 12th April 1961, and within a decade Neil Armstrong and Edwin Aldrin landed on the Moon on 16th July, 1969. Now new developments including Space stations, space hotels, space tourism, Space colonization, buying and selling of pots in space etc. With all these developments now we have entered new era---- the era of solving the problems of the earth from using space technology.

**Q** What is the Philosophy of Indian Space Programme?

**A** It is very Interesting question. I always start my discussions with famous quotation of Dr. Vikram Sarabhai, father of India Space Programme "There are some who question the relevance of space activities in a developing nation. To us, there is no ambiguity of purpose. We do not have the fantasy of competing with the economically advanced nations in the explorations of the moon or planets or manned space flights. But we are convinced that if we are to play a meaningful role nationally and in the comity of nations, we must be second to none in the application of advanced technologies to problems of man and society, which we find in our country." Dr. Vikram Sarabhai I happy to say that today Indian Space programme went behind the expectations of Dr. Sarabhai in many respects.

**Q** With the Central government allowing private players in the space arena, how does absence of space legislation impact India?

**A** In the Indian legal system, the role of judge is limited to interpreting already existing laws of the nation. In the absence of specific law, how will the judges decide upon such matters? Advancement of technology is so rapid that the legislation and the judiciary are unable to keep pace. Space Law being a super specialised area, the vacuum of not having a space legislation is strongly going to be felt now more than ever before, with the advent of private players in the space arena. The remedy lies in quickly enacting the domestic Space Legislation and ensuring that the rights and liabilities of all parties are protected by a national legislation enforceable by the Courts of India. There is a lack of clarity as to how the private parties would respond to the opportunities available, due to the absence of enabling specific laws in the area of Space. A robust ecosystem needs to be created, wherein there is a set of rules and regulations in place, on matters of space related activities for private parties to be ready to invest. This will surely bring in a positive change and this needs to be initiated by taking experiences

from many other space faring nations.

**Q What are the most common legal issues foreseen in this strategic sector?**

**A** With growing urgency for enacting new domestic law and integrating divergent regulations dealing with space and space related matters, such law should define governmental and non-governmental agencies in space, procedure for adoption and implementation of space programmes, regulation of safety of space flights, the question of liability, insurance, protection of Intellectual Property, spin off benefits and above all implementation of international obligations. Further, it should also incorporate the objectives of India's Space Policy, reiterating our country's commitment to peaceful uses of outer space and international cooperation. What are the biggest challenges facing developing countries that want to enter space? One is finance. There are huge financial requirements. There, developing countries are not

doing well because they don't have finances. One thing is that we can cooperate with developed countries. For instance, the success of India's space programme depends on cooperation with developed countries. We got help from the USA, Russia, and other countries. Now we are developing our own. The developing countries should start. They cannot think that they cannot do it. They have to start.

**Q How different is the Space Activities Bill from the US Commercial Space Launch Competitiveness Act? Are there any gaps that need to be filled?**

**A** This is a very good question. Regarding the 1st question, there are many powerful countries like the United States of America, who are in the forefront of space implementation, mainly due to back up of many space related legislations they already have in place. They promote private sector to venture into ultra-modern activities, though they are bound by the theory of Global Commons and Common Heritage of Mankind principles. They are able to initiate many

futuristic activities by taking advantage of exploring other horizons, which legally speaking they may not even have a right to. But in the absence of law, India cannot, right now even think of venturing into these areas. Regarding the 2nd part of the question, the answer is in the affirmative. Yes, definitely there are gaps that require to be filled. There is no proper international legal regime to control many space related activities like mining in space, owning of space objects, space debris, removal of defunct space objects, space security etc. That's why few countries are taking advantage of the scenario. Since the outer space belongs to everybody all countries and entire mankind need to benefit out of it. Also, this becomes a disadvantage to many of the new space faring countries. Hence, if India wants to be in the game, these issues to be addressed at the outset itself. Bringing in appropriate legislation is essential for that.

**Q Is there a need to have an independent regulatory body/authority to govern space activities in India?**





**A** Yes. There has to be differentiation between the government as a service provider and user on one hand and the corporates as stakeholders on the other hand, need an independent body which can regulate the activities.

**Q** **What opportunities and challenges do you foresee in the aerospace and defence industry ten years from now?**

**A** India is still at a nascent stage as far as developments in this industry is concerned. The 21st century belongs to Asian nations, especially in the area of aerospace and defence activities. The western countries, we can safely say, have reached a sort of saturation point. In India, the population we have is an advantage. Out of this, only 1% of the population use sectors like rail, road, ship to air transport India needs 700 to 8000 aircrafts and many new airports. Unfortunately, even now, India does not have proper facilities like MRO. Same goes for the defence

industry. Even today, we import more than 60% of our defence equipment. However, recent initiatives like Make in India, Made in India, Start-up India, Stand-up up India, Digital India, Skill India etc., have lot of Impact on Aerospace and Defence sectors. Now is the right time to bring in reforms in these sectors. With the Make In India campaign, we need to seriously implement changes in the domestic arena, so that huge sums of money can be saved and a major boost to employment opportunities are created. India has a lot of potential especially in the aerospace and defence industry, and this needs to be tapped to the fullest.

**Q** **What is the relevance of Aerospace and Defence education in India?**

**A** Object of Aerospace and Defence research and education in India started at NALSAR. The objective is to bring education to the doorsteps of those looking for an opportunity with affordable cost. I am happy to share with you that CADL for

the last one and half decades produced 15 Ph D scholars while offering various other programs which are very popular. NALSAR, Hyderabad offers many Masters and Diploma courses other than the conventional LLB and LLM programmes. The aero-space related studies alone, have produced around 1000 students in this field.

The NALSAR University of Law established the advanced Center for Air and Space law (CASL) in 2005. Since then, CASL has conducted various National and International Conferences, Workshops and Published Newsletters, Books and Articles in Aerospace Law Field. As a Head of CASL, Dr. Reddy initiated many new activities which included the launching a very futuristic Master's Degree and Post-Graduate Diploma in Aerospace and Defence Laws. Prof. Reddy has been also a pioneer and Especially, from a developing country perspective, where people are not aware of the significance of this emerging field of law or subject per se. It is important to bring in awareness and contribute to the growth of knowledge base and talent pool. This branch of law assumes great significance both politically and economically on an international scale in the increasingly globalized world. In future, India (globally) will be confronted with many legal battles in this emerging field of law. Therefore, there is an urgent need for teachers and lawyers and other stakeholders to equip themselves with aerospace specialization in order to effectively face the emerging challenges in this field of law, which may have the potential to turn into catastrophic in nature if proper and timely initiatives not taken.

**Q** **Are courses offered through Directorate of**

### Distance Education (DDE) at NALSAR recognized?

**A** Yes, NALSAR University has been graded as Category-I University by the UGC and as per the clause 4.10 of the Categorization of the University under [Categorization of Universities (only) for Grant of Graded Autonomy] Regulations, 2018. The Courses have also been recognized by the United Nations (UN) under “Education Opportunities in Space Law: A Directory” as notified by the Secretariat of the United Nations on March 23, 2017 in document “A/AC.105 /C.2/2017/CRP.10”.

### Q What employment opportunities will the students have after the completion of these courses? Whether NALSAR will provide job guarantee or job assistance?

**A** Aerospace and defence sectors being truly international in nature do not confine themselves to Indian borders. Students pursuing these courses will be able to enter the global market and boost their

career profiles. Students can expect employment as Managers (Airline Managers, Safety and Security Managers, Operations Managers, International Relations Manager (Handling, Bilateral and Traffic Rights), Legal and Financial Consultants. Job opportunities are also available in Government Organizations such as the DGCA, AAI and various defence, Space and Maritime Organizations including Private entities in the subject area. NALSAR being a Government Institution cannot guarantee you a job, we will provide you with assistance and guidance to students who are looking for jobs after completing the course by encouraging smooth interaction between students and prospective employers.

### Q How will these programmes help various stakeholders in Aerospace and Defence industries in India?

**A** Indian Aerospace and Defence sectors are the fastest growing industries among the world. These programmes will be beneficial for the Serving members of the Aerospace and

defence industries, policy makers and stakeholders working in the government departments, public sector undertakings, negotiators and diplomats who represent the country in the negotiations for various defence procurements, Aerospace Engineers/Students pursuing Aerospace Engineering, Law Graduates desiring specialization in aerospace and defence Laws, M.B.A students and Graduates undergoing various aerospace, defence and strategic studies related Programmes. Also, there is a high demand for law professionals with expertise in aerospace and defence laws. With the help of these programmes, the candidates can be well prepared for roles in international institutions, government departments (ministries of foreign affairs, defence, justice, home affairs and development), non-governmental organisations, law firms and also in private sectors (aerospace and defence companies). Prof. V. Balakista Reddy, Former Vice-Chancellor and Registrar and Currently Director, Centre for Aerospace and Defence Laws (CADL) NALSAR University of Law, Hyderabad.



Spacepreneur Editor Kartikeya in conversation with

## **Pawan Kumar Chandana and Naga Bharath Daka Co - Founders of Skyroot Aerospace**

**Q** Before we talk about business, how best can you describe the journey of skyroot aerospace since its humble beginnings to where it is now?

**A** It was in 2018 that we conceived the thought, at a time when the space sector was just about to burgeon globally. With a view that India can soon become a leading player in the global space landscape, we established Skyroot to be a part of the shift. As it came, the decision of the government of India under the guidance of our Prime Minister to encourage and develop the private space sector in India led by ISRO through IN-SPACE helped us in aligning

our mission to the aspiration of India. We thus responded to the opportunity that arose, and to our credit, were quick to move, thus becoming the first private space company to sign MoU with ISRO, and our strong pursuit of our first launch success bore fruition in the form of Vikram-S on 18 November 2022. When we reflect on our journey so far, we think it was nothing short of breath-taking. Lot of things have happened during this exciting short journey, and it has been an absolutely engaging and enjoyable roller-coaster ride.

**Q** What are the challenges & opportunities you see in the space industry?

**A** The government has led the transformation of the Indian space sector from the front, but the ecosystem still takes time to develop, and for now, the supply and value chains spreads across the world with cross-border dependencies on cutting-edge technologies, like the ones we employ. This dependency adds temporally to the development and launch schedules, and so it becomes imperative to have a water-tight hold on the supply chain to ensure that the deviations are minimal and does not have a domino effect. But we believe with the kind of interest among startups who are increasingly getting attracted to the domain, the gaps will soon be filled and Indian space will be in



a much more stronger position in the near future with the private space establishing themselves as independent players capable of end-to-end space activities. As about opportunities, it is galore. India, despite being one among a few spacefaring nations in the world, accounts for only about 2% of the space economy, even as it accounts for close to 18% of the world population. While the private sector has gained prominence in many spacefaring countries, till recently, India's private space companies had limited role as vendors and suppliers to government. It was against this backdrop that the announcement of space reforms by the government in 2020, opening it up to facilitate private participation, has given a new fillip to India's space program. This paradigm shift in policy has the potential to have a multiplier effect and contribute 5X growth in India's share of the global space market in the next few years. It

beckons a new era. And going by the signs, it has indeed started.

### **Q** How will Vikram-S encourage private players in space field?

**A** As the 1st private space launch by the Indian private space sector, the Vikram S has garnered a lot of attention and interest from Indian and global space enthusiasts and fraternity. It's a big win for the country as well, as the successful launch happened within just 2 years of the Government of India opening the space sector up for private participation. Over the last 2 years, we have seen policy development occur at a very rapid pace. Vikram S success stands testimony of the strong support and encouragement that private space receives from ISRO and IN-SPACE as the mentor and regulator of the Indian space sector.

Throughout the conception, preparation and execution of the Vikram-S, IN-SPACE has helped us in authorizing the launch and ISRO has helped us with all the infrastructure for undertaking several tests and integration activities plus provision of the launch facilities. With necessary policy frameworks and institutions such as INSPACE established and operational and highly responsive, the private players have a strong guidance and support system to back their operational and policy parameters, and so they can focus more on innovation and conceptual disruption of the domain.

### **Q** Are you seeking any support from government for upcoming missions?

**A** Support from the government is integral for the establishment and success of private space, and the synergy that can result from the innovation that happens and the end-to-end value chain capabilities that the private space can build can take Indian space to be a global leader soon. The upcoming space policy of India will be an important milestone with regard to the empowerment of the private space, and this is something which we are keen to look forward to. Our major orbital launch mission, the Vikram 1 is scheduled for the fourth quarter of 2023, and as South Asia's first orbital launch mission, it holds much importance for us. Various tests, developments and preparations for the same are underway, for which we are engaging few government facilities and infrastructure.

### **Q** Can you talk about the small satellite-launch market? How is it looking for players like you?



**A** We see considerable growth potential in the small satellite launch segment. According to a recent market survey, the global space launch services market is projected to double in size from \$14.21 billion in 2022 to \$31.9 billion by 2029, growing at a CAGR of 12.25%. Over the last decade, we have seen average satellite sizes reduce from close to 3000kgs to under ~400kgs. Moreover, the market is increasingly being led by constellations of smaller satellites in Low Earth Orbit. These customers want their satellites and constellations to be up and operational as soon as they are ready and delivered into precise destinations in space. Hence, there is an increasing need, especially among small-sat constellation builders for launch vehicle availability, greater control over launch schedule, high frequency launch capability, and last-mile satellite delivery to their target orbital destinations.

Small launch service providers such as us can cater to this need effectively. Presently, there are 4 small launch players in the global market that have reached orbit successfully. Out of these 4, 3 have just entered the market in 2021-22. We expect to enter the orbital market with our Vikram I launch vehicle next year.

**Q** **Would you associate with government projects, including in the defence sector? What are the advantages of such an association?**

**A** Though many of the technologies we possess and can develop can fulfil defence sector innovation, we are currently focused on the aerospace domain, where we believe we have a lot to accomplish with the next five years promising to be a very interesting phase for us as we are fast expanding our global reach

and acclaim. We are however open to engaging with the government at various levels and across domains if an opportunity arises.

**Q** **What is your message to youngsters who wish to become as spacepreneur?**

**A** We are excited to see the overwhelming response we receive from the youngsters of the country, who have noticed the historic milestone that the Indian private space has achieved through Vikram S. We have several programs within the organisation through which we connect, inform, engage, inspire and recruit STEM subject talents from various institutions, and this is part of our social and community commitment to ensure that the space domain goes the same trajectory that the IT sector once did for India, through which India established itself as the thought leader in the technology domain. Our message to youngsters who are looking at the space domain is that it is definitely the next frontier for India, and the domain needs more brains and brawn to fortify itself and expand outwards into the world. But we need to also caution that it will not be a cakewalk, as the private domain is new, and with various countries also pursuing expansion of their private industries, the competition globally is set to intensify.

**Q** **What is your ultimate goal in next 5-10 years?**

**A** Our goal is led by our vision of Opening Space for all, and we believe the next 5 years will see us achieving several milestones in pursuit of this, which would also set our course in becoming one of the top aerospace companies in the world.

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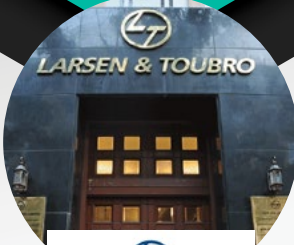


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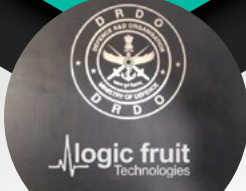


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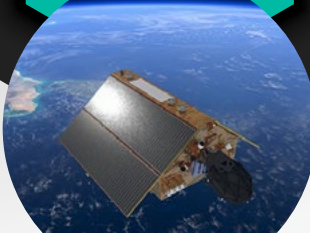
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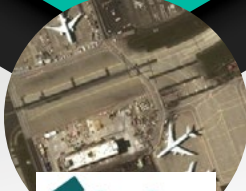


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# AERO-CET 2023

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# CAREER IN AVIATION AND SPACE ENGINEERING

### Undergraduate Courses

B.Tech Aerospace Engineering

B.Tech Avionics Engineering

B.Tech Aeronautical Engineering

Duration  
4  
Years

### Dual Program

Aircraft Maintenance  
Engineering with Degree in  
Aeronautics

Duration  
3  
Years

### Dual Degree Program

B.Tech + M.Tech Aerospace  
Engineering

Duration  
5  
Years

### Postgraduate Program

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Engineering

Duration  
2  
Years

### Diploma Program in Aviation

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Months

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Months

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 +919822013633, +919922508671, +919607950658, +919011036204

