

ISSN: 2516-4848

November/December 2018

Issue 5 / Volume 1



# NewSpace INTERNATIONAL

In this Issue: #Launch #Constellations #Earthobservation #Smallsatellites #LEO #MEO #Debris #Artificialmoon



Sign up for your FREE copy today at [www.newspaceinternational.com](http://www.newspaceinternational.com)



## Second Generation GaN based SSPAs/BUCs in C, X, Ku and Ka-Band



250W C-Band  
2nd Generation GaN SSPA/BUC



400W C-Band  
2nd Generation GaN SSPA/BUC



300W-400W C-Band Rackmount  
2nd Generation GaN SSPA/BUC



400W Ku-Band  
2nd Generation GaN SSPA/BUC



1,250W Ku-Band  
2nd Generation GaN SSPA/BUC





**Dr Amy Saunders**

**Editor**

“ Most of us will be able to recall a key story from the start of this year pretty well – back in January 2018, Rocket Lab achieved the second launch of its Electron vehicle, which carried to orbit a variety of small satellite payloads, alongside the Humanity Star. The small geodesic sphere, around 1 metre in diameter and constructed from carbon fibre, spun rapidly in orbit to create a flashing light of the sun’s rays reflected from its 65 highly reflective panels. Orbiting the Earth every 90 minutes, and visible from anywhere on the globe with the naked eye, the Humanity Star was designed to be ‘a bright symbol and reminder to all on Earth about our fragile place in the universe.’

This ‘shared experience for everyone on the planet’ wasn’t globally well-received; some went as far as to call it ‘space graffiti.’ During its shorter-than-expected time in orbit, the Humanity Star was the brightest object in the sky, a somewhat controversial feat given that astronomers already struggle with light pollution. Academics the world over were very vocal in their derision of the (arguable) vanity project. Columbia University’s Director of Astrobiology Caleb Scharf wrote in *Scientific American*: “Most of us would not think it cute if I stuck a big flashing strobe-light on a polar bear, or emblazoned my company slogan across the perilous upper reaches of Everest. Jamming a brilliantly glinting sphere into the heavens feels similarly abusive. It’s definitely a reminder of our fragile place in the universe, because it’s infesting the very thing that we urgently need to cherish.”

It’s now been revealed, as reported by China’s *People’s Daily Online* that the Chinese city of Chengdu plans to launch its own illumination satellite, currently known as the ‘artificial moon.’ Due for launch in 2020, Wu Chunfeng, Chairman of the Chengdu Aerospace Science and Technology Microelectronics System Research Institute Co., Ltd., the illumination satellite is designed to complement the Moon at night. Shining some eight times brighter than the Moon, the satellite will be ‘bright enough to replace street lights’ – indeed, according to some reports, this is its purpose – with a diameter of 10-80km. Testing has been ongoing for several years now, and the technology is now considered mature.

As for the Humanity Star before it, various experts have come out in droves to highlight the potential problems, including disrupting the natural rhythms of nocturnal animals, and of course, causing unnecessary light pollution, already a problem in much of the world. “The moon would significantly increase the night-time brightness of an already light-polluted city, creating problems for Chengdu’s residents who are unable to screen out the unwanted light,” John Barentine, Director of Public Policy at the International Dark Sky Association, told Forbes.

Whether we’ll see this artificial moon come to fruition in 2020 is arguable, but it’s certainly an interesting story that we’ll be keeping track of here at NewSpace International. It’s also a pleasingly symmetrical way to round out the year, allowing us to finish just as we started; with an unlikely story of an illumination satellite that will provide something for the Scrooges of the world to complain about this Christmas. ■



2018: A tale of two space graffiti

# CONTENTS

**Letter from the Editor** 3  
2018: A tale of two space graffiti

**NewsBlast** 6  
All the latest news from around the world

**Developments in satellite constellations** 14  
A bumper feature on current and planned constellation projects



**Observing the Earth from space** 20  
Satellite Vu's Anthony Baker shares his thoughts on Earth observation

**Democratizing satellite** 22  
Rafel Jorda Siquier from Open Cosmos opines on democratization

**Modernizing the launch sector** 24  
The biggest advancements in satellite launch technology in 2018

**Enhancing Earth observation technologies** 32  
Teledyne e2v's Paul Jerram discusses Earth observation projects

**Advertisers' Index / Next issue** 34



Front cover: Bangabandhu Satellite-1 Mission. Photo courtesy of SpaceX

## Editor

Amy Saunders  
amy.saunders@dsairpublications.com

## Sales Director

Chris Ayres  
chris.ayres@dsairpublications.com

## Sales Director

Sam Baird  
sam@whitehillmedia.com

## Publisher

Richard Hooper  
richard@dsairpublications.com

## Managing Director

David Shortland  
david@dsairpublications.com

No part of this publication may be transmitted, reproduced or electronically stored without the written permission from the publisher.

DS Air Publications does not give any warranty as to the context of the material appearing in the magazine, its accuracy, timeliness or fitness for any particular purpose. DS Air Publications disclaims all personal responsibility for any damages or losses in the use and dissemination of the information.

All editorial contents Copyright © 2018 DS Air Publications  
All Rights Reserved  
ISSN: 2516-4848

DS Air Publications  
1 Langhurstwood Road  
Horsham  
West Sussex  
RH12 4QD  
United Kingdom  
T: +44 1403 273 973  
F: +44 1403 273 972





## Outdoor High Power Amplifiers

- 1250W, 750W, 400W, 180W
- C, X, Ku, DBS, Ka, Q & V bands



## Indoor Touch Screen Amplifiers

- 1250W, 750W, 400W
- C, X, Ku, DBS & Ka-band
- 1:1 & 1:2 Systems



## Outdoor HPA Systems

- 1:1, 1:2 Redundant & power combined systems
- Small, lightweight
- Easy maintenance
- Quick Installation



2.5kW Ku/DBS System

1.5kW Ku/DBS System



## Outdoor SSPBs

- Ka-band 10, 20, 40W
- Ku-band 16-200W
- C-band 40-400W

Come see us at:



CABSAT

SATELLITE 2019

## Bringing HD video to the Moon via laser

LGS Innovations will be supporting NASA's Orion EM-2 Optical Communications (O2O) project by providing an optical modem that will enable broadband data communications to and from the Orion Multi-Purpose Crew Vehicle designed to take humans into lunar orbit. Laser communications can transmit data over long distances at rates up to 100 times faster than traditional radio frequency systems.

"We're proud to support yet another NASA project with advanced optical technology to help meet the ever-increasing requirements for more bandwidth and faster connections," said Kevin Kelly, LGS Innovations CEO. "Fast and reliable communications are key to the success of exploration missions and can transform the work and life of space crews."

The modem will convert the data generated on the Orion spacecraft to an optical signal, allowing it to be beamed from the vicinity of the Moon to a receiver on Earth. It will also be capable of receiving the optical signal from Earth and converting it to data for the spacecraft.



LGS Innovations was selected by MIT Lincoln Laboratory, a DoD Research and Development Laboratory that is managing the contract. LGS is expected to deliver the modem in late 2019 to help maintain NASA's Orion schedule. The advanced free space optical capability will continue to push forward space exploration and can be suitable for commercial applications such as satellite communications.

LGS Innovations is helping NASA adopt laser communications for other missions with technologies such as the first deep-space laser transmitter for the Deep Space Optical Communications project, and a free-space laser modem that will fly aboard the International Space Station as the first demonstration of a fully operational, end-to-end optical communications system. ■

## UK to develop alternative to Galileo

UK industry will benefit from a UK£92 million injection to design a national alternative to the EU's Galileo satellite system, ensuring UK security post-Brexit.

The money has been allocated from the £3 billion Brexit readiness fund announced at last year's Budget and will be rolled out over the coming months.

Satellite navigation systems like GPS are increasingly important for commercial, military and other critical applications, from guiding aircraft, ships and emergency services to helping millions of people find their way on car journeys.

A recent government study estimated that sustained disruption to satellite navigation would cost the UK economy £1 billion per day.

The government has been clear that the UK wants to remain involved in the Galileo programme, and is negotiating with the European Commission to this end. But without the assurance that UK industry can collaborate on an equal basis now and in the future, and without access to the necessary security-related information to rely on Galileo for military functions such as missile guidance, the UK would be obliged to end its participation in the project.

The UK Space Agency is leading this phase of the work to look at options for a British Global Navigation Satellite System, which would fully meet UK security requirements and support the UK's sovereign space and cryptography sectors. This significant new investment will develop specific technical proposals with the Ministry of Defence playing a full role in support.

The 18-month engineering, design and development project will deliver a detailed technical assessment and schedule of a UK global positioning system. This would provide both civilian and encrypted signals and be compatible with the US GPS system.

UK industry has been instrumental in developing Galileo technology and encryption, and this experience will be used in developing the alternative, with a number of multi-million-pound contracts available for British space companies.

"Britain is a world leader in the space industry and satellites. We are investing in an alternative option to Galileo to ensure our future security needs are met using the UK's world-leading space sector," said Business Secretary Greg Clark. "Our position on Galileo has been consistent and clear. We have repeatedly highlighted the

specialist expertise we bring to the project and the risks in time delays and cost increases that the European Commission is taking by excluding UK industry. Britain has the skills, expertise and commitment to create our own sovereign satellite system and I am determined that we take full advantage of the opportunities this brings, backed by our modern Industrial Strategy."

"The danger space poses as a new front for warfare is one of my personal priorities, and it is absolutely right that we waste no time in going it alone if we need an independent satellite system to combat those emerging threats," said Defence Secretary Gavin Williamson.

"This alternative system and the UK's very first Defence Space Strategy which I will launch later this year will be a further boost to military skills, our innovative businesses and our genuinely world-leading role which has seen us make such a key contribution to Galileo."

"We remain confident in the strength of our space sector and look forward to working in partnership with them on the exciting prospect of a national satellite navigation system," said Dr Graham Turnock, CEO of the UK Space Agency. ■



# Kepler Communications raises US\$16 million to deliver nanosatellite data services in LEO

Kepler Communications has raised US\$16 million in a Series A round of financing led by Costanoa Ventures, with participation by Deutsche Bahn's (DB) Digital Ventures as a strategic investor. The round also included a number of returning investors, such as IA Ventures who led their Series Seed. This brings the cumulative total raised to over US\$21 million.

Rather than pursue the more typical approach of launching a constellation prior to delivering customer services, Kepler already delivers services for customers operating in the poles who are currently completely devoid of connectivity options.

Despite being the size of a breadbox, their first satellite KIPP, a 3U CubeSat, delivers upwards of 40Mbps to 60cm diameter VSAT antennas for their customers where the bulk of alternative satellite services peak around 1Mbps. This is an improvement similar to the jump from 3G to 4G data speeds. KIPP will soon be joined on orbit by its sister satellite, CASE, when the latter is launched from the Satish Dhawan Space Centre on India's Polar Satellite Launch Vehicle (PSLV) in mid-November 2018.

"We've spoken with icebreakers, oil tankers, tourism companies, maritime operators, and scientific organizations that all operate at the poles. They told us of the frustrations with the complete lack of high bandwidth coverage in these regions. This is what led us to roll out PolarConnect, the world's only high bandwidth solution designed for the poles," stated Mina Mitry, CEO of Kepler.

Demand for connectivity at the poles is poised to increase, as tourism activities flourish and ice-covered shipping lanes melt as a result of global warming. One of Kepler's early customers is F. Laeisz, one of the world's oldest shipping companies that operates an icebreaking vessel, the Polarstern, which can support over 100 crew members and spends the majority of its operational

lifetime outside of traditional satellite coverage.

"With the Kepler system, for the first time we are able to send massive files like operational data, scientific data, videos, or photos. These are bandwidth intensive and we have no other way to send the data if we used traditional systems," said Thomas Liebe, Chief Operator of the Polarstern.

Kepler's store and forward service is designed to work with a wide variety of VSATs, meaning that customers with existing Ku-band steerable antennas will be able to make use of the service without the need to install new ground antenna.

"We are uniquely excited by Kepler as compared with all the recent nanosatellite communication companies because they have demonstrated that their satellites are filling global gaps in connectivity," said Greg Sands, Founder and Managing Partner of Costanoa Ventures.

"Kepler has incredible technology, with KIPP having already demonstrated the highest data throughput ever achieved in a nanosatellite. They have strong customer traction, with early polar customers already making use of PolarConnect."

Sands will also join Kepler's board.

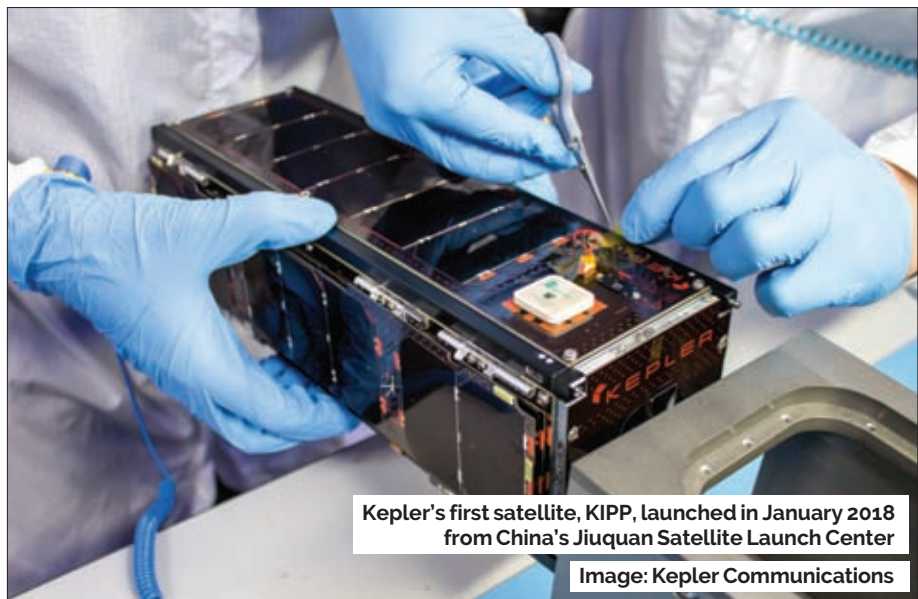
After KIPP and CASE, Kepler is planning to deploy its third satellite TARS in H2 2019 that will be used to

demonstrate their Internet of Things (IoT) connectivity service. The focus on IoT connectivity led to the strategic investment by DB Digital Ventures, who has a need for IoT connectivity amongst their business units.

"We are excited about the novel connectivity solutions that Kepler is bringing to market, and look forward to implementing their service within our business units at DB. Kepler represents a market leader for connectivity when compared to other nanosatellite connectivity options we've explored," said Boris Kühn, Managing Director at DB Digital Ventures.

Kepler will be using the new capital to grow revenues, and to launch its GEN1 constellation, which will be put into service by the end of 2020 and includes up to 15 additional nanosatellites. The focus of their GEN1 constellation will be on delivering high-capacity and affordable store-and-forward services beyond the capabilities offered by KIPP, CASE, and TARS.

Everything Kepler does is with an eye towards their ultimate goal of in-space connectivity, and Kepler is intent on doing this sustainably. The GEN1 and GEN2 constellations predominantly focus on store-and-forward and IoT services, but will have the necessary technology to lead to in-space connectivity. ■



Kepler's first satellite, KIPP, launched in January 2018 from China's Jiuquan Satellite Launch Center

Image: Kepler Communications

## Moon Express signs MoU with CSA

Moon Express has signed a Memorandum of Understanding (MOU) with the Canadian Space Agency (CSA) to explore options for collaboration with the CSA and Canada's space sector on technologies and payloads for missions to the Moon.

Under the agreement, the CSA and Moon Express will explore the possibilities of using Moon Express lunar orbiter and lander systems for potential CSA payloads and will promote possibilities for collaboration between Moon Express and the Canadian space industry and academia.

Moon Express is a US commercial space company founded in 2010 with the goal of providing low cost, frequent access to the Moon for science, exploration and commerce while seeking new resources to benefit Earth. Moon Express serves a global base of customers from its 72 Acre Space Campus headquarters at Cape Canaveral with additional facilities at the NASA Kennedy Space Center.

"Moon Express is excited to support the CSA in a new era of lunar exploration," said Moon Express Founder and CEO Bob Richards. "Successful collaborations between the CSA and private industry have put Canadian technology on the surface of Mars, and soon near asteroids. We look forward to working with the CSA to develop new opportunities for Canadian science and technology in the exploration of Earth's eighth continent, the Moon, and its vast resources." ■

## Goonhilly opens Farnborough office

Goonhilly Earth Station has opened an office at the Cody Technology Park in Farnborough, Hampshire, in support of its plans to expand its consultancy, design engineering and small-scale manufacturing capabilities. The new site gives Goonhilly more space to expand its design engineering team and attract talented engineers.

The teams in Farnborough and Goonhilly will collaborate closely. For example, while the Farnborough team will be focused on deep space antenna array design, their colleagues in Cornwall will undertake the implementation. The Farnborough office perfectly complements Goonhilly's teleport facilities in Cornwall, providing a second UK base from which to conduct electronics and systems design operations.

"With offices in both Cornwall and Farnborough, we will be able to expand and attract a wider pool of engineering talent, while the Farnborough office will also serve as a convenient meeting place for many of our customers and partners. It's an exciting time to join or work with the Goonhilly team as we focus on helping to shape the new space economy with disruptive communications technologies," said Ian Jones, CEO at Goonhilly. ■

## NASA explores LEO commercialization

NASA recently selected 13 companies to study the future of commercial human spaceflight in low Earth orbit (LEO). The study will inform NASA's strategy for enabling the commercialization of human spaceflight in LEO and NASA's long-term requirements for the ISS.

Space Adventures, the only company to have delivered private human spaceflight missions to the International Space Station (ISS), was one of the selected companies.

In December, Space Adventures will submit recommendations to NASA on how to quantify the LEO market opportunity, evaluate technical concepts for low-cost habitation, and describe a viable and sustainable business case in LEO.

"We are excited to work with NASA and to have the opportunity to provide input into the future of commercial activities in LEO and thoughtful suggestions on what the agency can do to assist in the development of the marketplace," said Tom Shelley, President of Space Adventures. "When commercial crew vehicles are providing regular access to LEO we will see a great future for space tourism; and we are excited to partner with Made in Space to further understand the in-space manufacturing and the materials processing marketplace."

"Within 20 years, in-space robotic manufacturing and assembly will be utilized to fabricate and integrate functional space systems for solar power generation, remote sensing, and communications," said Andrew Rush, CEO of Made in Space (MIS). "Space-enabled manufacturing of useful products will drive sustainable, commercial operations in LEO. Working with the Space Adventures' team on this study, MIS will conduct analysis of the price points required to meet existing addressable markets and identify break points for scaling production to larger markets where the cost must be lower to compete with terrestrially produced products."

Space Adventures has also partnered with Radiant Solutions for this project. In related news, SSL, a Maxar Technologies company (formerly MacDonald, Dettwiler and Associates Ltd.), was also for NASA's study to explore the use of commercial habitats in space as satellite manufacturing facilities.

In support of NASA's vision of a vibrant space economy, and expanded opportunities for American industry, SSL will study the feasibility of habitable space platforms for building commercial satellites and how they might unlock new capabilities and business paradigms.

"Today's focus on commercial activity in space is undoubtedly accelerating innovation," said Richard White, President of SSL Government Systems. "At SSL, we work closely with NASA to explore concepts that implement next-generation business models to stimulate private demand for commercial human spaceflight. Bringing commercial and government innovation together will be a powerful driver of capabilities." ■





PREMIUM SUPPLIER OF HIGH POWER AMPLIFIERS FOR  
SATELLITE COMMUNICATIONS

more than **300**  
**500W Ka-band**  
amplifiers shipped

**Q-band** heritage at  
**50, 120, 200W**

request a **V-band**  
**quote, meeting,**  
or **data sheet**

Comtech Xicom is a leader in the design and production of **millimeter wave TWTAs**.

We have shipped more than **2000 Ka-band amplifiers** to military and commercial customers worldwide.

**V-band** is of emerging interest due to the **vast available bandwidth** and availability of V-band hardware. Xicom is in a **leadership position** to develop V-band products.



# KA, Q, and V-BAND

## MILLIMETER WAVE LEADER

EMAIL: [info@xicomtech.com](mailto:info@xicomtech.com) | WEB: [xicomtech.com](http://xicomtech.com) | PHONE: +1-408-213-3000

# Kineis: Europe's first nanosatellite constellation

To facilitate the use of Internet of Things (IoT) technology, CLS is expanding and has created Kineis, with CNES's support. Kineis connectivity draws on a new innovative satellite constellation of 20 nanosatellites with a new communication technology tailor-made for connected objects.

CLS has entrusted the development of this constellation to Thales Alenia Space for the prime contractor of the complete system, which will rely on Nexeya for the fabrication of nanosatellite platforms and Syrlinks for its support in the design and construction of the instrument. The constellation will be in orbit in 2021.

"With French excellence in space, the unfailing support of CNES, and key accounts who will be participating in a future round table, we decided to create Kineis to make satellite geolocation and data collection accessible to as many people as possible," said Christophe Vassal, Chairman of the CLS Executive Board.

"Kineis is a satellite operator that will provide unique, universal connectivity fully dedicated to the IoT industry. Any object fitted with a Kineis modem can be located and transmit data wherever it is, whatever the conditions. Kineis connectivity is simple to integrate into third-party devices, consumes very little power and is reliable. All this will be available at a very competitive price, making it accessible to as many people as possible, so Kineis will very soon be locating and collecting data from several million connected objects, in real or near-real time. The company will become the natural partner for all entrepreneurs seeking to offer their customers an inexpensive satellite-based Internet of Things," said Alexandre Tisserant, Kineis Project Leader.

Kineis plans to work closely with terrestrial IoT operators, current satellite operators and connected object manufacturers. Kineis connectivity is positioned as an entry-level service for certain satellite operators and as a complement for terrestrial operators wishing to offer their customers worldwide coverage.

In the 1980s, CLS and CNES created the ARGOS system, laying the foundations for what would later become IoT. CLS used the ARGOS satellite system to track connected objects before GPS or Galileo existed. With Kineis, CLS and CNES are revolutionising ARGOS and democratising a system that has enabled the history of animal migration to be rewritten, marine resources to be managed sustainably, piracy to be fought and the greatest ocean races to be followed. More efficient, easier and affordable, the unique and universal connectivity offered by Kineis will soon be widely available to the general public (outdoor leisure activities, boating, etc.) and the private sector (logistics, fishing, agriculture, etc.). Kineis will enable IoT use to make the impossible, possible. ■



Kineis constellation

Image: Kineis

## IN BRIEF...

↗ AAC Clyde has won a follow-on order with Canada's Kepler Communications for a 6U machine-to-machine communications mission. The new platform, TARS, will be the third built by the company for Kepler's growing constellation, offering satellite communication services for Internet of Things (IoT) and data backhaul applications. Following on from the success of Kepler's first mission (KIPP), TARS will determine the capacity and performance required to deliver narrowband services globally, while augmenting the high-capacity store-and-forward capabilities provided by their first and second satellites, KIPP and CASE.

↗ LeoSat Enterprises, which is launching the fastest, most secure and widest coverage data network in the world via a constellation of low Earth orbit satellites, has achieved an important milestone by securing commercial agreements valued at over US\$1 billion. These pre-launch agreements span a wide range of fast-growing data and mobility sectors including, enterprise, telecoms, government and finance.

↗ OHB Group has signed a Letter of Intent for future cooperation with Blue Origin to explore the extent to which OHB, MT Aerospace and Blue Origin can work together across the Atlantic. The companies have partnered on a future Blue Moon mission to the lunar surface – Blue Origin's lunar lander capable of bringing several metric tons of cargo to the Moon. The companies will collaborate on a payload on board Blue Origin's reusable New Glenn rocket.

↗ Exotrail, a start-up company developing proprietary electric thruster technology for small satellites as well as plug-in software for the operation of satellites equipped with propulsion, has raised US\$4.1m in investment.

↗ Azercosmos OJSC and Innovation Center for Social Innovation Lab (SiL) Are launching a new NewSpace Business Accelerator to support the launch of innovative projects and products in space and facilitate their investment and finance and market access.

The program offers financial support for a development line within four months for start-ups and idea authors. ■



# Airbus tests 4G/5G defence balloon

Airbus has successfully tested stratospheric 4G/5G defence applications with a high-altitude balloon demonstration. The technology tested, an Airbus LTE AirNode, represents a key part of Airbus' secure networked airborne military communications project, Network for the Sky (NFTS).

With this new generation of long-range communications in the sky, high-altitude platforms (HAPs) such as Airbus' Zephyr will be able to create persistent, secured communication cells to relay information on a variety of different aircraft platforms including helicopters, tactical UAVs and MALE UAVs (Medium Altitude Long Endurance Unmanned Aerial Vehicles).

With the support of French and Canadian space agencies, Airbus flew and tested the communications solution in Canada at all altitudes up to 21km above the Earth's surface, using a stratospheric balloon to create a high-altitude airborne cell site. In its payload, the balloon carried an Airbus LTE AirNode, which provided a 30km-wide footprint of coverage for private and secure communications. The Airbus team, equipped with two vehicles and two drones, tracked the balloon over 200km, exchanging 4K video between the different assets – simulating an ISR mission with real-time transmission. The data was sent via a private network at speeds from 0.5-4Mbps, which is comparable to 4G/5G mobile communication.

Pushing the boundaries in delivering easily deployable communications, this capability will significantly increase

operational flexibility during air missions. An LTE AirNode allows opportunistic, secure communications between different aircraft as they fly within range of each other, where operations require permanent and powerful connectivity. It will deliver highly secure communications for airborne assets, ground or maritime-based operations for several weeks or months at a time – combining the persistence of a satellite with the flexibility of a UAV. This type of ad-hoc network can be adaptable to all users – from special forces to disaster relief scenarios.

Airbus' NFTS solution combines different communication technologies to form one resilient global mesh network, allowing aircraft to be a fully integrated part of a high-speed connected battle space. Today, individual aircraft, UAVs and helicopters continue to operate on separate networks with limited bandwidth and interoperability, and often little resilience. NFTS will integrate various technologies, such as satellite links with geostationary, medium and low Earth orbit (LEO) constellations, tactical air-to-ground, ground-to-air and air-to-air links, voice links, 5G mobile communication cells and laser connections, into a single global secure network.

NFTS is the foundation for the connected airborne battlespace, and should offer a full operational capability by 2020. The NFTS programme is part of Airbus' Future Air Power project and is fully aligned with the development of the European Future Combat Air System (FCAS). ■



Airbus LTE balloon

Image: Airbus Defence and Space

## RemoveDEBRIS nets first space junk

The RemoveDEBRIS satellite has successfully used its on-board net technology in orbit – the first demonstration in human history of active debris removal (ADR) technology. The spacecraft began the experimental phase of its mission on 16 September, when it used a net to capture a deployed target simulating a piece of space debris.

RemoveDEBRIS was designed, built and manufactured by a consortium of leading space companies and research institutions led by the Surrey Space Centre at the University of Surrey. The project is co-funded by the European Commission.

"To develop this net technology to capture space debris we spent six years testing in parabolic flights, in special drop towers and also thermal vacuum chambers. Our small team of engineers and technicians have done

an amazing job moving us one step closer to clearing up low Earth orbit," said Ingo Retat, Airbus RemoveDEBRIS project head.

In the coming months, RemoveDEBRIS will test more ADR technologies: A vision-based navigation system that uses cameras and LiDAR technology to analyse and observe potential pieces of debris; the first harpoon capture technology used in orbit; and a drag-sail that will finally bring RemoveDEBRIS into the Earth's atmosphere where it will be destroyed, bringing its mission to a close.

The US Space Surveillance Network tracks 40,000 objects and it is estimated that there are more than 7,600 tonnes of 'space junk' in and around Earth's orbit – with some moving faster than a speeding bullet, approaching speeds of 30,000 miles per hour. ■

# Space 'techpreneur' to set up over \$100 million venture unit

mu Space Corporation Founder and CEO James Yenbamroong has revealed his plan to establish a venture unit in 2019 in a move to go international and to create opportunities beyond satellite communications.

The planned venture unit will be set up in 2019 in partnership with private investors to provide funds to startups and medium-sized companies working in NewSpace and deep tech sectors.

"We'll generate \$100 million as initial fund," said Yenbamroong, adding that more funds will be raised, if needed, to support promising startups and companies. "We're now scouting for innovative startups and early-stage businesses with a potential to disrupt the current market by developing products or services that are new to the world and can help improve the lives of people. These may include, for example, artificial intelligence, robotics, space research and deep space exploration."

The venture unit will be based outside of Thailand. "It can be in any country that can offer a conducive business environment for the venture unit to grow and operate. But for now, the nearest prospect is Singapore," said Yenbamroong.

Singapore is currently home to over 100 venture units. The country's competitive business ecosystem, digital infrastructures, pro-business local policies and sufficient tech talent pool have attracted many venture units to make Singapore as their central hub for operations.

The establishment of Yenbamroong's planned venture unit comes at a time when investment in space-related activities is skyrocketing.

According to a report from investment firm Space Angels, about US\$3.9 billion of private funds worldwide have been invested in 2017 in commercial space companies. Of that investment, venture capital fund accounted for 40 percent or US\$1.56 billion.

The report also found that over 120

venture capital firms made investments in the space industry last year, a big jump from about 80 in 2016.

"Entrepreneurial space age shows no sign of slowing down. 2017 was a positive year for the space industry, and the momentum continues to 2018, with nearly one billion US dollars in private funds invested in this year's first quarter alone," commented Yenbamroong.

"We're extremely optimistic about the sustained growth of the space industry. Without a doubt, the market potential for space-related activities is going up and there's no stopping right now. We'll definitely see the rise of new startups and businesses in the future focusing on commercial space flights, space tourism and in-space manufacturing," said the Founder and CEO of mu Space Corp.

He added: "The moon is our next explorable colony beyond Earth. So we set a goal to be there in the next 10 years, there along with 100 humans." ■

## Rocket Lab unveils new production facility

Rocket Lab has unveiled a new 7,500sq/m production facility that rethinks the way orbital rockets are built. The facility in Auckland is designed for rapid mass production of the Electron rocket. Adding to Rocket Lab's existing production facility and headquarters in Huntington Beach, California, the new facility brings Rocket Lab's manufacturing footprint to more than 4.5 acres and enables the company to build an Electron rocket every week.

"Every detail of the Rocket Lab launch system has been designed to provide small satellites with rapid and reliable access to space. This requires the ability to manufacture launch vehicles at an unprecedented rate, so we've expanded our global

production capability to build and launch an Electron rocket to orbit every week," said Beck. "We have the team, the industry-leading launch vehicle, the global production facilities and the launch sites to liberate the small satellite market. Rocket Lab has opened access to orbit."

Electron launch vehicles undergo final assembly at the new Auckland facility, where all parts go through a streamlined process for testing and integration into the rocket before launch from Rocket Lab's private orbital launch pad, Launch Complex 1, on the Mahia Peninsula.

All Electron launches, including those from Rocket Lab's USA launch site, currently undergoing final selection, will be commanded from the new Mission Control at the Auckland facility.

The new production facility will house more than 200 of Rocket Lab's growing team of 330 people. Rocket Lab is actively recruiting new personnel to support monthly launches in 2019, scaling to weekly launches by the end of 2020. ■



Rocket Lab's new production facility

Image: Rocket Lab





**CABSAT**

**12 - 14 MAR 2019**  
DUBAI WORLD TRADE CENTRE

**CABSAT.COM**

## **POWER TO CREATE** **INSPIRATION - ACTION - REACTION**

With a rapidly evolving media and entertainment industry, are you thriving in the face of disruption?

As the MENA region's leading broadcast, satellite and content event, CABSAT 2019 gathers the global players in media creation, production and distribution together to power your growth in the rapidly changing digital economy.

***Over US\$ 64 billion will be invested by Saudi Arabia alone on its entertainment industry as part of the Kingdom's Vision 2030 programme\****

Want to grab your slice? Head over to learn how at CABSAT and network with visitor communities from the media & entertainment industry including **TV & Film | Audio | Satellite | Digital Media | Photography | Esports**

\*Source: Saudi General Entertainment Authority (GEA) Announcement - Feb 2018

**CABSAT OFFERS BUSINESS OPPORTUNITIES ACROSS THE  
CONTENT CREATION, PRODUCTION & DISTRIBUTION CHAIN**

To book your stand, contact the CABSAT Team on +971 4 308 6552/6433 or email [CABSAT@DWTC.COM](mailto:CABSAT@DWTC.COM)

Organised by



مركز دبي للتجارة العالمية  
DUBAI WORLD TRADE CENTRE

FOLLOW US     #CABSAT2019



# Developments in satellite constellations

Satellite constellations are big business right now. Gone are the days when constellations were strictly for Earth observation or telephony services, today's newcomers plan to bring broadband Internet connectivity to the masses, bridging the digital divide, or deliver high-quality, enterprise-grade connectivity services with unparalleled security.

Constellations of small satellites have proven extremely newsworthy in recent years as several private companies have decided to get in on the action. The attraction is clear; medium Earth orbit (MEO) or low Earth orbit (LEO) satellites can be launched in series to provide ubiquitous, global coverage of the Earth, offering fibre-like connectivity speeds and lower latency than traditional GEO satellites.

We talk about satellite constellations with the same reverence as 5G, 4K and reusable launch vehicles, but they're not really that new. The Global Positioning System (GPS), Galileo and GLONASS constellations have all been providing essential services for some time now, while the Iridium and Globalstar constellations have been utilised for years to provide telephony services.

Today's new wave of constellations are more of a concept revival than a brand new innovation. A rebranding, if you will. We're moving on from essential services, with most of the latest constellations focusing instead upon delivering next generation fibre-like services from space; Internet for everyone, connecting the unconnected, is the main focus.

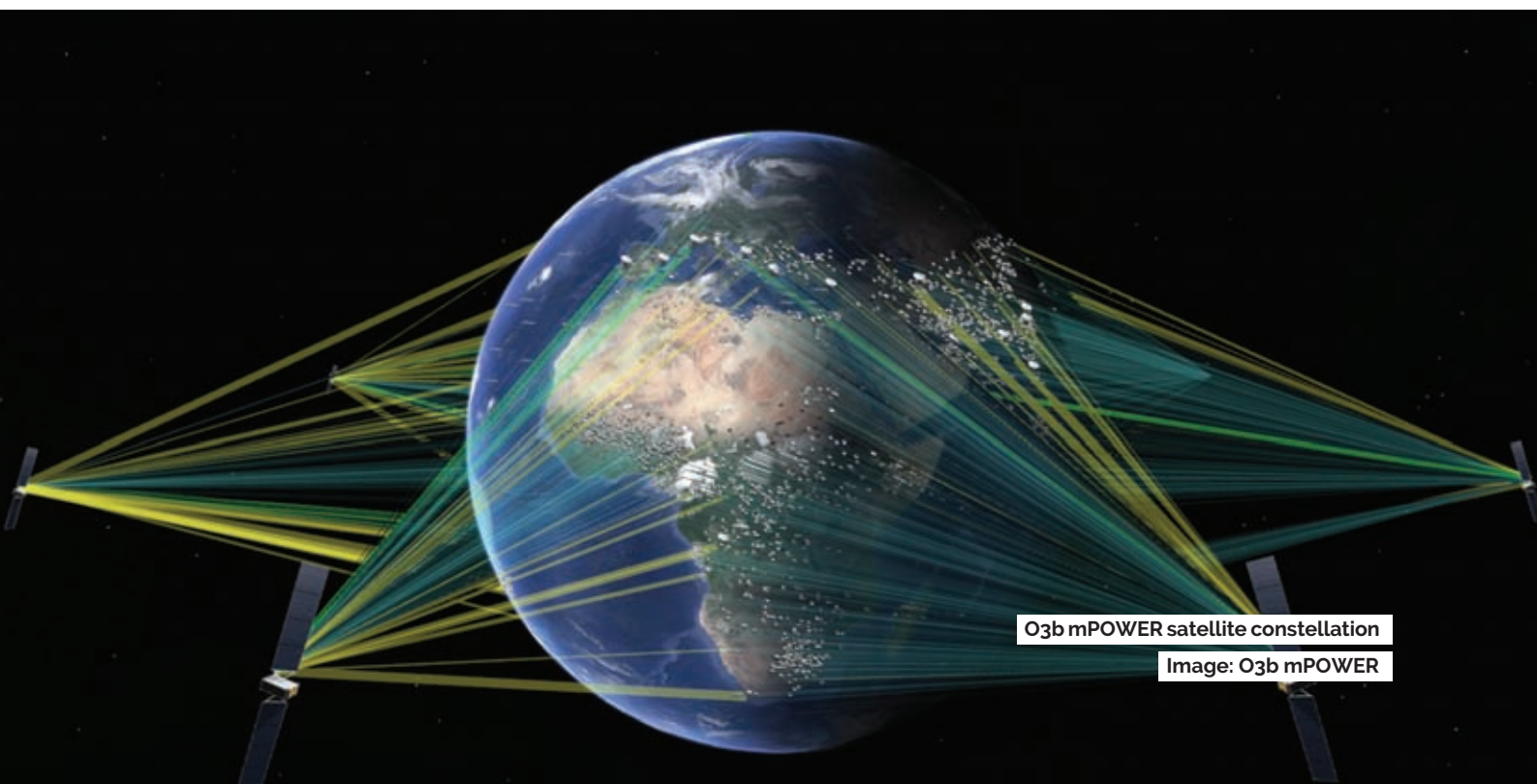
MEO and LEO constellations offer a number of advantages over GEO satellites. The main advantage, the one that everyone seems to have a very definite opinion on, is latency. With GEO satellites, latency is around 125ms, compared with about 1-4ms (in theory) for LEO satellites. Supporters believe that this lower latency, delivering 'terrestrial connectivity from the sky' will be absolutely vital for certain services going

forwards, such as banking, betting, and military applications. On the other hand, naysayers argue that latency is a red herring, that it is unimportant for most applications. Whatever your point of view, there's no denying that there is a significant latency difference.

On the flip side, LEO constellations are much more complex operationally speaking. Near-global coverage can be provided by three GEO satellites, whereas for LEO satellites, tens are required to deliver the same coverage. Of course, with more satellites and smaller beams, more handovers are required, and more technologically-advanced antennas and tracking capabilities are an absolute must to enable these constellations.

Launch opportunities are another significant challenge. While several small satellites can be launched simultaneously on the same vehicle, with more than 5,000 small satellites expected for launch in the next few years, launch providers are currently unable to meet demand. Additionally, MEO and LEO satellites have much higher refresh rates - we're talking about 1-5 year lifetimes per satellite, compared with 15-20 years for GEO satellites, placing further pressure on launch providers.

There's also the known unknowns. A number of experts have voiced concerns over the 'shielding effects' of LEO constellations. In a world where satellite interference remains a constant challenge, no one is really too sure how the introduction of thousands of small satellites into MEO and LEO will affect existing GEO



O3b mPOWER satellite constellation

Image: O3b mPOWER



satellites. Concerns over signal shielding and interference have been raised, but accurate modelling of these potential challenges has yet to be completed.

It's true that bringing new MEO and LEO constellations into operations is no simple project. However, that hasn't put off today's group of intrepid satellite operators from making plans.

### O3b Networks prepares for mPOWER

O3b Networks Ltd. is a unique MEO satellite constellation, and the only modern-day small satellite constellation currently operational. O3b ('the Other 3 Billion') aims to deliver voice and data communications to mobile operators and Internet service providers, helping bridge the digital divide. The company was acquired by SES back in 2016.

The most recent four Ka-band O3b satellites were launched to augment the existing constellation in March, bringing the total number of satellites up to 16. The addition has added 38 percent more capacity across the globe, helping to grow O3b's market from +/- 45 to +/- 50 degrees latitude. Like all the other O3b satellites before them, the newest four satellites were built by Thales Alenia Space, and are now orbiting some 8,062km above the Earth. The next four satellites are expected to augment the constellation in the first half of 2019.

In March, ALCAN, Isotropic Systems and Viasat were introduced as new technology partners for SES' upcoming next-generation O3b mPOWER constellation. The three companies have been contracted to develop smart, high-throughput terminal solutions, a building block in the system's ground infrastructure innovation roadmap.

The unique O3b mPOWER system, announced in 2017, will be based around seven 'super-powered' MEO satellites, with more than 30,000 dynamic, electronically-generated fully-shapeable and steerable beams that can be shifted and switched in real time. Delivering multiple Terabits of throughput globally, the Boeing-built fleet is scheduled for launch in 2021 and is scalable to multiple terabits of throughput globally, providing coverage to an area of nearly 400 million square kilometres.

Developed with leading technology partners, O3b mPOWER Customer Edge Terminals (CET) will combine innovative steerable antenna technology with functionality spanning modem, networking and edge compute capabilities. The O3b mPOWER CET will deliver advanced network capability in form factors optimized for market specific cost, performance and power that are quick and simple to install.

"O3b mPOWER is designed to provide cloud-scale connectivity through a 'virtual fibre' network for application-aware services on a global scale," said John-Paul Hemingway, Executive Vice President of Product, Marketing and Strategy for SES Networks. "We believe that working closely with partners like ALCAN, Isotropic Systems and Viasat in a robust development ecosystem will enable us to introduce the latest innovations and greatest cost-efficiencies across multiple market segments at great scale."

Further expanding O3b's reach, in June, SES was granted authorization to serve the US market using a significantly expanded O3b fleet in MEO by the FCC. The FCC grant opens significant additional frequencies for

use in SES' NGSO constellation and enables it to deploy O3b mPOWER satellites into inclined and equatorial orbits, delivering full global pole-to-pole coverage. A total of 26 new O3b satellites are authorized, in addition to the 16 satellites already operational and in orbit. The grant allows SES to add four satellites to its existing O3b constellation, which are scheduled for launch next year, and provides the framework for SES to triple its next-generation O3b mPOWER fleet by giving US market access for another 22 super-powered satellites.

"This important FCC grant provides SES with the means to grow and scale our network, connecting the planet and delivering world class solutions to our customers globally," said Steve Collar, President and CEO of SES. "With the first seven O3b mPOWER satellites, we will deliver a paradigm shift in performance, bandwidth and service. The FCC grant provides the platform to exponentially scale the network in response to surging demand for global data connectivity."

### OneWeb ramps up preparations for first launches

OneWeb Satellites, a joint venture between OneWeb and Airbus Defence and Space, will see the installation of a constellation of LEO satellites to provide a global broadband Internet service to consumers starting in 2019. The joint venture aims to bring affordable broadband to millions of households, schools and other end users around the world; with more than half of the world still lacking access to affordable, reliable Internet, OneWeb's service is demonstrative of its commitment to bridging the digital divide.

The constellation will consist of around 882 Ku-band satellites orbiting some 1,200km above the Earth, at an estimated cost of US\$3 billion. According to reports, most of the capacity on the initial 648 satellites has already been sold. Launch of the first satellites for the constellation were expected to start in 2018, with services starting up in every rural home in Alaska 2019.

Back in June 2017, OneWeb made history with the launch of its assembly line in Toulouse, to begin end-to-end validation, testing, and integration of its first satellites. The 4,600 square meters Toulouse facility will serve to validate the production methods necessary to manufacture high-performance satellites at a scale never achieved before, de-risk any potential issues, and lay the framework for the larger multi-line OneWeb Satellites factory near the Kennedy Space Center, Florida. The initial 10 pilot and Toulouse-built satellites, after having undergone a comprehensive set of tests, will become the first of OneWeb's fleet.

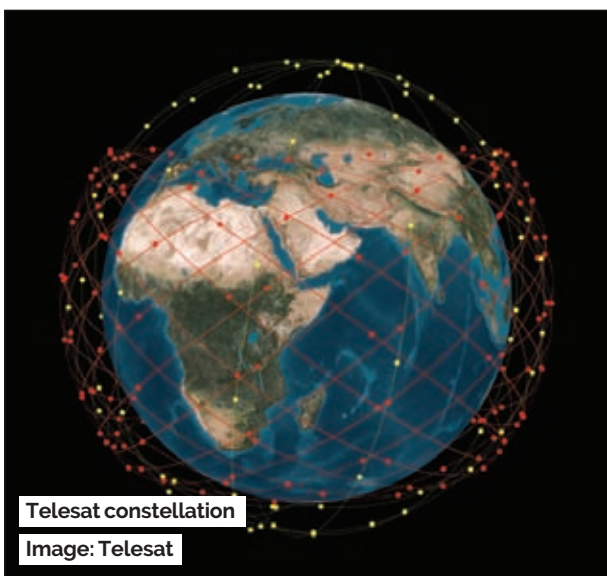
The assembly line includes state-of-the-art automation, test equipment and data acquisition capabilities to shorten assembly times and provide means to analyze factory performance and process improvements. The satellites will provide valuable in-orbit data to confirm the design of the spacecraft and proceed with fine tune adjustments if necessary. They will also enable nearly real-time detection and correction of any anomalies in the manufacturing process.

"We have just about nine months until the first of our fleet launches into orbit," said Greg Wyler, Founder and Chairman of OneWeb. "Then, if all goes well, we will begin the world's largest launch campaign, sending new satellites up every 21 days, and building not just a fleet but a digital bridge to enable affordable broadband



Telesat satellite

Image: SSTL



Telesat constellation

Image: Telesat

access for the billions of unconnected around the world."

As well as building the fleet of satellites, OneWeb Satellites will provide customized versions of these ultra-high-performance satellites, platforms and core technologies to Airbus to support their third party sales to other commercial and government operators globally. The mini satellites, coming from the huge production line, will enable new cost and performance paradigms for those looking to benefit from the advantages satellites can bring to Earth observation, sensor and telecommunications markets.

In December 2017, Hughes Network Systems, LLC signed a US\$190 million contract with OneWeb for the production of a ground network system to support OneWeb's satellite constellation. The contract builds on the original system development agreement between the companies signed in June 2015, bringing the total value of both to more than US\$300 million. It includes production of the gateway sites each with multiple tracking satellite access points to support operation and handoff of high-speed user traffic between satellites.

"Designing a ground system capable of supporting hundreds of LEOs with seamless handoff of broadband traffic between satellites presented a significant

challenge," said John Corrigan, Senior Vice President of Engineering for Hughes. "But our team was up to the task, and we are proud to be partnering with OneWeb on realizing this revolutionary satellite communications system to close the global digital divide."

Later in March, the shipment of the first gateways was reported. The Gateways feature multiple tracking antennas to support operation and handoff of high-speed user traffic to and from the LEO satellites, as well as a custom switching complex, outdoor modems and power amplifiers. Each gateway will handle up to 10,000 seamless terminal hand-offs per second, a technological and engineering breakthrough.

### Telesat takes first steps in bringing constellation to life

Telesat is developing a global LEO constellation that will, according to the company, revolutionize broadband communications services. Telesat's state-of-the-art LEO constellation will combine the company's global spectrum rights in Ka-band, granted by the FCC in November 2017, with Telesat's proprietary LEO architecture to transform global communications. Telesat LEO will offer an unsurpassed combination of capacity, speed, security, resiliency and low cost with latency that is as good as, or better than, the most advanced terrestrial networks. The company aims to accelerate 5G expansion, bridge the digital divide with fibre-like high speed services into rural and remote communities, and set new levels of performance for commercial and government broadband on land, sea and in the air. The initial constellation will consist of approximately 120 satellites by 2021 and Telesat is evaluating options to expand its system beyond this initial configuration.

Telesat's first LEO satellite, Telesat Phase 1, was transported to the Vostochny Cosmodrome in Eastern Russia for launch on board a Soyuz-2 vehicle in November 2017. However, towards the end of the month, the SSL-built satellite's launch vehicle failed. Indeed, it wasn't until January when Telesat was able to get started with the launch of its first Telesat Phase 1 LEO satellite on board a Polar Satellite Launch Vehicle (PSLV) with the Indian Space Research Organisation (ISRO). The company's Phase 1 testing will demonstrate key features of Telesat's LEO system design, in particular the capability of the satellite and customer terminals to deliver a low-latency broadband experience that MEO and GEO satellites reportedly cannot provide. Telesat has installed ground infrastructure at its teleport in Allan Park in Canada to support testing and has customers in growing enterprise segments who will be participating in trials during 2018.

"Telesat has a long record of industry firsts that have brought major satellite innovations to market and our LEO constellation will be another breakthrough that transforms global communications," said Dan Goldberg, Telesat's President and CEO. "The launch of our Phase 1 satellite is the starting point in making our next generation LEO system a reality and we thank SSTL and ISRO for the success of the mission to date. Telesat is uniquely positioned to deliver the world's most advanced and capable LEO constellation given our deep technical expertise, strong track record of innovation, senior spectrum rights, and laser-like focus on customer service and support. We look forward to beginning customer trials on Telesat LEO and continuing to



collaborate with industrial partners as we work to deploy a state-of-the-art, high capacity network that will deliver transformative, low latency, fibre-like broadband to commercial and government users throughout the world."

Several companies took part in the testing of the Telesat Phase 1 satellite. OmniAccess and Optus both came on board for the trials to test whether the ultra-low latency and high speeds could be successfully incorporated into their existing infrastructure. In March, Telesat announced that it had completed its orbit raising and payload testing for the Phase 1 satellite.

"Telesat is pleased to have signed a number of highly respected, industry leaders who are eager to participate in live trials on Telesat's Phase 1 LEO satellite," said Dave Wendling, Telesat's Chief Technical Officer. "We're equally pleased to begin Phase 1 LEO testing and demonstrate the transformative capabilities that Telesat's LEO constellation will deliver, including far higher data rates with superior latency at low cost. Not only will the broadband experience of Telesat's LEO system be on par with advanced terrestrial networks but, for the first time ever, it will enable the availability of high performing broadband on a global basis. We look forward to beginning customer trials and continuing to collaborate with industrial partners in optimizing our space and ground capabilities as we work to deploy a high capacity network that will deliver low latency, fibre-like broadband to commercial and government users throughout the world."

Later in May, Telesat and Global Eagle Entertainment agreed to collaborate in optimizing the capabilities of Telesat's LEO constellation to serve growing broadband requirements of maritime and aeronautical markets. The collaboration will include user terminal development, service-offering design, marketing, in-flight testing and at-sea performance testing. Telesat and Global Eagle will work together on design and testing activities for Telesat's planned LEO constellation using Telesat's recently launched Phase 1 LEO satellite. The parties will focus on airline and large cruise ship applications in polar and high-latitude regions, and passenger use-cases globally that leverage sub-50ms latency for data-intensive applications. For aviation, Global Eagle will be testing its newly-developed Ka-band antenna.

More recently in August, Telesat entered into an agreement with Airbus Defence and Space to further develop the system design for Telesat's LEO constellation. This followed closely on Telesat's July announcement that it has signed the consortium of Thales Alenia Space and Maxar to undertake a similar scope of work on Telesat's LEO program. Telesat now has two separate teams, comprised of industry leading satellite manufacturing companies, which will work in close cooperation with Telesat over the following months in a series of engineering activities and technical reviews. These efforts will culminate in each team submitting a firm proposal for final design and manufacture of Telesat's LEO satellites and ground system infrastructure. Telesat anticipates deciding by mid-2019 on a prime contractor for Telesat's LEO program – space segment, ground segment and system integration.

"Airbus has built a tremendous record in satellite manufacturing and Telesat is pleased to have concluded this agreement that will result in Airbus further

developing their design and submitting a final proposal for Telesat's full LEO system, both space and ground segment," said Erwin Hudson, Vice President of Telesat LEO. "We now have two outstanding teams – Airbus and Thales Alenia Space-Maxar – supporting Telesat LEO. Each brings a broad range of technical skills and experience along with a strong belief in the project and a commitment to its success. Telesat looks forward to this next phase of the program and to selecting a prime contractor to develop our LEO space and ground infrastructure."

#### LeoSat Enterprises gains global support

LeoSat Enterprises is another start-up company planning to launch a constellation of small satellites in LEO. Unlike other LEO constellations, LeoSat's system will feature a unique architecture utilizing inter-satellite laser links to connect the satellites, creating fibre-like symmetry at Gigabit speeds, while providing total security as the data is encrypted and secured from end-to-end across the network, with no terrestrial touch points.

"We believe that what we're doing makes sense because we're trying to replicate what's happening on the ground, in space. We're taking switches, routers, and putting them into space. That's so unique in this industry that I'm sometimes surprised to find out that we continue to be the only ones taking that approach. We're taking routers into space, and we're doing all the packet switching up there – we're essentially combining the good things of fibre with the good parts of satellites and turning that into something that I think will be a game-changer in this transition period. It's a technology that is relevant for data, and that opens a whole new market for satellite that the industry has been struggling to get



into," said Ronald van der Breggen, Chief Commercial Officer at LeoSat.

LeoSat is currently working with Thales Alenia Space to finalize the manufacturing plan for the production and deployment of the entire constellation. According to van der Breggen, the constellation will consist of 78 satellites, divided into six polar orbits 20 degree apart. Each orbit will have 13 satellites in it, 12 functioning and one spare – that's 84 satellites in total. Each satellite can handle almost 30Gbps of full duplex data. "The reason we're working in duplex is because if you want to be relevant to any terrestrial advancements, you need to be providing full duplex synchronous capacity," explained van der Breggen. The full constellation is expected to provide about 2Tbps of capacity. Launches are expected to begin in 2021 and be completed in 2022.

Despite still working on its Round A funding, LeoSat has secured two extremely respectable investors. The first came back in May 2017, when it was announced that SKY Perfect JSAT Corporation (SJC), Asia's largest satellite operator, had invested in LeoSat, making it the first Asian operator investing in LEO capabilities. The investment in LeoSat and the agreement to jointly market this new system allows SJC to pursue new business opportunities in the data and mobility markets in sectors such as telecommunications, multinational enterprise, maritime and government services by providing previously unavailable levels of network performance combined with worldwide reach and allows the company to further study the additional applications of LEO communications in pursuit of its global ambitions.

"SJC sees the strategic importance of aggressively participating in the LEO/HTS business and we see the LeoSat solution as a key opportunity to opening up new markets and delivering business growth. With the current and future growth of data traffic and the unique nature of the LeoSat system and its focus on the business market, we believe there will be very strong demand for the LeoSat solution. This investment and development partnership with LeoSat will allow SJC to expand and complement our existing GEO satellite services and beyond by enabling us to respond to customer needs which are not being met by today's technology," said Koki Koyama, Senior Managing Executive Officer of SJC.

.....  
LeoSat has distinguishing features from the other constellations that makes it especially interesting: High capacity, low latency, high security and a meshed network that simplifies its architecture  
.....

The second investment came in July 2018, when Spanish satellite operator Hispasat announced plans to invest in LeoSat in order to future-proof its communications solutions through the development of LEO capabilities. With the investment in LeoSat, Hispasat finds a perfect complement for its geostationary fleet

and expands its scope significantly towards new verticals that will define the data market over the next years. The investment in LeoSat underlines its firm belief in the unique attributes of LeoSat's new LEO network architecture to ensure further growth in the future. Hispasat will work with LeoSat to accelerate a number of key activities including, vendor selections for customer premise equipment and ground operations, as well as further optimization of the satellite platform.

"With the current and future growth of data traffic, we see the strategic importance of investing in new infrastructure to enable our existing and future customers to substantially increase their communications capabilities," said Carlos Espinós, CEO of Hispasat. "LeoSat has distinguishing features from the other constellations that makes it especially interesting: High capacity, low latency, high security and a meshed network that simplifies its architecture. LeoSat's system design, combining satellite and networking technology to provide a network in space, is a departure from existing solutions today and we see this as a key opportunity for us to open-up new markets and deliver business growth. This investment in LeoSat demonstrates our belief that there will be very strong demand for LeoSat as it is the best solution to address the enterprise market. It will allow Hispasat to strengthen and expand our existing GEO satellite services and position the company at the forefront of the new digital infrastructure."

Considering that LeoSat has yet to make the first steps in launching its constellation, the company has an impressive number of deals already lined up.

LeoSat has entered into a strategic agreement with Supernet, Pakistan's leading satellite network service provider and systems integrator specializing in end-to-end satellite-based GSM backhaul and enterprise networks. Through this agreement, LeoSat will provide Supernet with over 3Gbps of capacity on its unique LEO network infrastructure, enabling Supernet to offer a full portfolio of local to global integrated communications solutions to facilitate the key business processes of corporate, SME and individual customers.

In December 2017, meanwhile, LeoSat entered into an agreement with DCS Telecom, a leading telecoms provider of satellite and networking solutions in the Middle East, Africa and Asia, to upgrade its existing satellite solutions, giving customers access to a unique low-latency network which is expected to revolutionize data connectivity. For DCS' enterprise customers, the key attributes of the LeoSat system can be used for a number of applications, for example, to give banks secured networks with their foreign offices, provide enormous uploading bandwidth for oil and gas exploration, enable seamless connectivity for shipping and fleet management or provide the only native 4G and 5G satellite backhaul connectivity for cellular operators. LeoSat can not only offer competitive advantage in existing satellite services markets in the MENA region and beyond, it will help expand these markets by enabling new opportunities through previously unavailable levels of performance combined with worldwide reach.

In the same month, LeoSat signed a Memorandum of Understanding (MoU) with Globecom Systems Inc., which provides global connectivity services to the



enterprise, oil and gas, maritime and government markets. "We strongly believe in offering the smartest connectivity solutions to our customers, and with capabilities beyond satellite and fibre, LeoSat represents the next generation of high-performance communications networks," said Chief Commercial Officer Bryan McGuirk of Globecom.

Another interesting deal was announced in March, when Phasor and LeoSat announced their entry into a milestone agreement to serve a broad range of mission-critical enterprise network markets with an ultra-high throughput, low latency network infrastructure solution. As part of the collaborative alliance, Phasor will develop a powerful Ka-band, Non-Geosynchronous (NGSO) – ready version of its breakthrough low-profile electronically steerable antenna (ESA), scalable to virtually any use-case requirement.

"This landmark agreement between LeoSat and Phasor opens the door to a whole new level of high-powered communications networks capable of unleashing unprecedented connectivity for enterprise network markets around the world," explained David Helfgott, Phasor CEO. "Phasor's electronically-steered antenna technology is incredibly versatile and scalable – a perfect match for LeoSat's constellation in meeting diverse demands for big data and high-speed connectivity."

In the same month, network solutions provider Signahorn and LeoSat entered into yet another impressive services agreement. "At Signahorn we believe in doing everything we can to make the network solutions we offer to our customers better. This drive for excellence fuels our choice of products and we are therefore delighted to add LeoSat's next generation architecture to our existing portfolio of innovative communications solutions. By combining the best of satellite with the attributes of terrestrial networks we see a whole host of new opportunities for our customers," said Michael Biederer, VP Operations & Customer Care of Signahorn.

#### SpaceX launches Starlink demonstration satellites

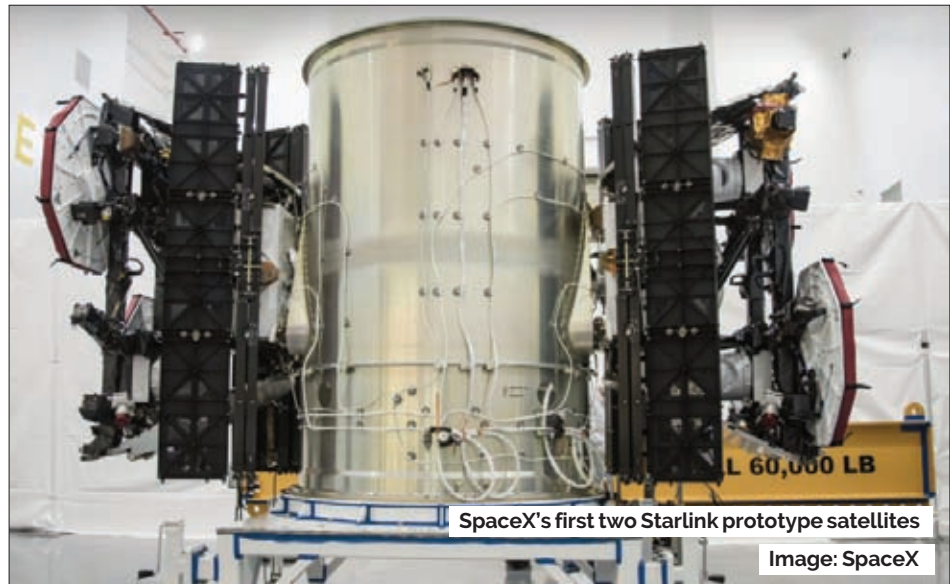
Never one to be left behind when it comes to the next 'big thing,' SpaceX too is getting in on the small satellite constellation action. The company announced plans for its Starlink constellation back in 2015, and more details have emerged over the years.

In 2017, SpaceX submitted regulatory filings for the launch of almost 12,000 satellites into orbit by the mid-2020's. This 12,000 included 4,425 satellites for the Starlink constellation, to orbit at around 1,200km above the Earth, and an additional 7,500 V-band satellites, to orbit at around 340km above the Earth, to provide communications services.

Starlink's raison d'être is to support a low-cost,

satellite-based broadband network capable of delivering Internet access to the entire world, costing around US\$10 billion in total. Like LeoSat, SpaceX plans to utilize inter-satellite links between its Ka and Ku-band Starlink satellites, in addition to phased array beam forming technologies. Latencies of 25-35ms are expected for the so-called 'mega-constellation.' SpaceX Founder and CEO Elon Musk has previously commented that Starlink's services will help raise funds to support his longer-term mission to Mars.

In February, SpaceX successfully launched Tintin A and Tintin B, the first two demonstration satellites for the Starlink constellation. Launched on the Falcon 9 vehicle, Tintin A and B are expected to orbit for 6-12 months, communicating with three testing ground stations in Washington and California. Following the demonstration, in March, the FCC approved the official request for the Starlink constellation, with some conditions. SpaceX also has yet to gain separate approval from the ITU.



#### Rumours of Facebook's Athena constellation confirmed

Another company keen not to be left behind, and now talking about planning its own constellation, is Facebook. In July, Facebook announced plans for its first constellation of LEO satellites, called Athena.

In response to a Freedom of Information Act request filed by American technology magazine WIRED, Facebook's plans to launch Athena were confirmed. The constellation is designed to 'efficiently provide broadband access to unserved and underserved areas throughout the world,' according to an application filed by Facebook with the FCC. Responding directly to a request for further details from WIRED, a Facebook person stated: "While we have nothing to share about specific projects at this time, we believe satellite technology will be an important enabler of the next generation of broadband infrastructure, making it possible to bring broadband connectivity to rural regions where internet connectivity is lacking or non-existent."

To date, no further information has been reported, so we'll have to wait and see what Facebook is cooking up.

# Observing the Earth from space



NewSpace pioneer Satellite Vu was recently launched to apply new technological developments to monitor plastic, pollution and pirates from space. In the last decade, humans have produced more plastic than in the entire 20th century and plastic constitutes approximately 90 percent of all waste floating on the ocean surface. By 2050, there could be more plastic in the world's waters than fish, measured by weight. This is just one of the challenges Satellite Vu means to meet, as CEO, Anthony Baker, explains.

**Question: Can you provide an overview of Satellite Vu's capabilities and expertise?**

**Anthony Baker:** Satellite Vu is developing a small satellite fleet which will eventually comprise seven satellites. These satellites will be capable of delivering constant, near real-time information on target sites over a 24 hour period, day and night.

Typically, current satellite technology allows a target re-visit of just once per day, often around mid-morning, and therefore you only get that snapshot for a very restricted time period. If you want to carry out pattern of life analysis – things that are going on all day and all night – you must have remote sensing capability that can deliver consistent, reliable frequent data. Plus, if you are capturing this imagery every hour, you have to deliver that information in a way that is meaningful to your customers. Satellite Vu has developed unique

algorithms that help us to analyse data in a timely way. We are harvesting billions of pixels from thousands of locations - and this all needs to be analysed. We will use machine learning and automation to enable us to process it. The human element is important too, but we need help to process the data into trends so that we can look at activity and changes in trends to help us to alert customers when a change is anomalous.

Satellite Vu will offer activity-based intelligence which looks at the pattern of life, so we are trying to determine the economic activity by looking at stationary pictures. This data must then be converted into something that end users understand, particularly if you're looking at the stock market or commodity brokers, for example that need to determine what's going on, on the ground and give it some economic value.

**Question: What are the benefits of Satellite Vu's technology compared with other satellite operators, or competing technologies?**

**Anthony Baker:** As I mentioned, as it stands today, Earth observation (EO) satellites typically re-visit a location just once a day, mid-morning when the air tends to be clearer and the shadows prominent. These observations cannot deliver the temporal pattern of life insights that Satellite Vu can deliver. It is the constant stream of information that is required to gain understanding of changes that are happening on the ground. Furthermore, our use of algorithms and automation to help to process the data and bring insights to end users is a real differentiating factor. We can also overlay this data on existing data to provide even more meaningful insights dedicated to specific customer requirements. If the information is rapid, precise, very clear and therefore actionable, it has a greater commercial value. That is the most important aspect of what we do – delivering information that is useful to the user in a timely manner.

**Question: What can you tell us about Satellite Vu's funding arrangements? We understand you've looked at crowdfunding?**

**Anthony Baker:** We did look into crowdfunding, but it's a lot more effort than we expected; to make a success of it we would need to dedicate considerable effort on PR and managing the expectations of the potential investors. To make a meaningful difference, we would likely need several hundred investors which would become a significant task in itself. We need to focus our energy on our technology and more importantly our customers requirements.

Currently, we are funded by seed funds, but we anticipate that we will close on a grant and a large revenue generating contract this year, thereafter we will seek new investors probably early next year.

**Question: Why is Earth observation so important in the modern world?**

**Anthony Baker:** There is no better way to look at the world as from space. EO data provides vital information on even the most minute changes that happen here on Earth, which means that these changes can be



monitored and acted upon if necessary. Nothing else can give the same perspective, and the developments in EO capabilities over the last few years alone have been phenomenal. Resolution has got much higher so that we can see features in great detail and the sensors on board the satellites have become ever more sophisticated. Algorithms take the Big Data produced by the satellites and convert this into meaningful information that can be used by a plethora of industries and sectors from environmental, agricultural all the way down to businesses such as insurance companies.

The other important trend in the EO sector to point out is that the cost to manufacture an EO satellite has dropped. This is due to the advent of NewSpace innovations. Small satellite technology has skyrocketed in popularity and is at the centre of a paradigm shift in the EO market which has lowered the cost and time taken to manufacture spacecraft. This transformation is significant because it is making space accessible to all and is giving less developed countries the opportunity to tackle some of their greatest problems. Satellites can now be built in just 6-12 months, yet can give excellent resolution in comparison with their large counterparts. Small EO spacecraft can produce imagery down to one metre, and in the best cases, up to 30cm resolution.

Earth Observation has a huge amount to offer the modern world, but challenges still remain to provide night and day vision, and to optimise the latency of information in order to make EO information relevant to more users; Satellite Vu is addressing these challenges.

**Question: Looking at the problem of plastic pollution specifically, how can Satellite Vu take a role in meeting this global environmental challenge?**

**Anthony Baker:** Plastic is a massive problem. The value of plastic pollution is reportedly US\$139 billion per year. This is the main area of focus for us at the moment.

The technology offered by Satellite Vu significantly decreases the time in which it takes to measure the plastics problem. We are looking at reducing the process from years to weeks. If we can enable rapid identification of where the plastic is located and where it is originating from, governments and organisations can act. This is where our rapid re-visit times are so critical, because we build up a real-time picture of where the plastic is becoming built up, we can track it as it happens.

Measuring the distribution of plastics is also essential in enabling us to tackle it. We will provide direct multispectral measurement of the plastic contamination providing actual, rather than simulated data therefore giving the true scale of the problem. Infrared sensors, that will be built into the Satellite Vu payload, are able to detect the presence of floating debris and ultimately the type of plastic.

Then there is the data analysis. If the data is not processed quickly and precisely, the problem is simply allowed to grow, costing economies even more and resulting in wasted efforts. Satellite Vu offers both speed and precision, helping users to better identify the source. This early detection aids in more accurate localisation of the plastic before it drifts away. Our fast and reliable data processing will provide accurate and actionable data that speeds up decision-making and the delivery of solutions that can help to tackle what is a huge task for humanity. If we start this process now, we can do something about it. We can turn it around.

**Question: In June, Satellite Vu won first prize in the European Space Agency's (ESA) Ocean x Space competition. What can you tell us about the competition, and this achievement?**

**Anthony Baker:** The competition was held during the 8th edition of ESA's annual Business Applications Conference, held in Stavanger from 22-24 May, which brought together companies, users, experts, entrepreneurs and investors to foster partnerships and new ideas. The Ocean x Space competition invited small companies of 50 employees or less, to submit ideas for innovative, space-enabled services in the maritime sector. Amongst other criteria, the judges were looking for clarity of value proposition, the problem to be tackled, the use of space assets, technical feasibility and the maturity of the idea.

The award is very important to Satellite Vu as it reinforces the importance of what we are doing and striving to achieve. Plastic pollution is a massive challenge for the maritime environment and our solution provides a means to tackle it rapidly and affordably. Gaining recognition from ESA meant a great deal to us and further validates what we are doing.

**Question: What do you expect Satellite Vu to achieve in 2019 and beyond?**

**Anthony Baker:** 2019 will be a pivotal year for Satellite Vu. We aim to have our platform operational, we will be generating revenue and our future satellite sensor will be in the final stages of completion. It is set to be an exciting and ambitious year and the team is very much looking forward to making it a success and seeing our technology doing good things for the planet. ■



Plastic pollution

Image: Adobe Stock



Turtle with plastic pollution

Image: Adobe Stock

# Democratizing satellite

Open Cosmos was founded as a result of the prestigious Entrepreneur First incubator programme in 2015. Located in the ESA Business Incubator in Harwell Campus near Oxford, UK, Open Cosmos plans to democratize satellites in the same way that computers were democratized after their initial rollout in the 1960s. Founder and CEO, Rafel Jorda Siquier, outlines Open Cosmos' vision for success as well as the company's recent business developments.



Rafel Jorda Siquier

Image: Open Cosmos

**Question: Can you provide an overview of the services Open Cosmos offers and your vision for the company's future?**

**Rafel Jorda Siquier:** Open Cosmos provides simple and affordable small satellite missions to help solve the world's biggest challenges. We believe it is time to reduce the three main barriers in the space sector: Complex technology, consuming paperwork and extreme costs. This is achieved with a set of tools and services such as beeReady and beeOrbital that support the development, qualification and validation of all kind of space applications and technologies with full end-to-end mission services. We are democratizing access to space with mass customisation of space missions so that everyone can use space as a tool.

**Question: What can you tell us about your facilities and capabilities for satellite manufacturing and launch?**

**Rafel Jorda Siquier:** By providing a one-stop-shop solution to orbit, we are reducing time-consuming processes and money.

Customers can focus on developing their technologies with beeKit, our hardware development platform, run simulations with beeApp, our software platform, and then send it over to us to integrate them in our satellite platform beeSat. We take care of the entire process using our new lab with a clean room and other facilities available at Harwell Campus. The satellite is then delivered to our launching partners, so they can put it into orbit. Once in orbit, we continue to provide support and assistance, operating the satellites for our customers so they can concentrate on what they need: Space data for their applications.

**Question: We understand you've signed a PIONEER contract with ESA: Can you provide us with some of the details?**

**Rafel Jorda Siquier:** The ARTES Pioneer programme aims to facilitate the demonstration of new and advanced technologies, systems, services and applications in a representative space environment. Following the increasing demand of the space sector

to send assets into orbit in a faster, simpler and more cost-effective way, our objective during the upcoming years is to contribute having a world empowered by actionable information from space.

**Question: Why do you feel the satellite sector needs democratizing?**

**Rafel Jorda Siquier:** Democratizing satellites is the same way that computers were democratized in the 60s. First computers were expensive and huge, there were only a few of them in the world and they were predominantly used by big organizations.

Then a few intrepid entrepreneurs in Silicon Valley made them portable, affordable, and disrupted the whole industry. Thanks to that, everyone now uses computers on a daily basis. At first, they didn't know what they would be using them for, but now we all have indispensable applications in our pockets. The space industry is ripe for the same disruption. We believe that our end-to-end service based on smaller, more affordable and more accessible satellites will enable new applications to emerge.

The satellites have many uses. They can be used to collect images of vessels and track the transportation of commodities, pirates, or illegal fishing. They can also gather images of natural resources to optimize agrotech production, efficient use of water, sustainable mining, deforestation control, spillages, and contamination. They can also be used to provide telecommunications to networks of connected devices. Open Cosmos' satellites follow a standardized modular design that makes it easy to integrate almost any payload, sensor or experiment. Space agencies, corporates, and entrepreneurs can now use Open Cosmos set of tools and services to demonstrate new technologies, carry out research, or provide services to their own customers.

**Question: In March, Open Cosmos announced the signature of two space mission contracts with e2E. What can you tell us about Open Cosmos' first Simple-o customer, and what you hope to achieve together?**

**Rafel Jorda Siquier:** This contract with e2E enables us



to expand the building blocks of our one-stop-shop to orbit capabilities while demonstrating execution and delivery of a full space mission in a simple and affordable way. The combination of in-house manufacturing capabilities and an ecosystem of partners allows us to be the single point of contact for satellite service providers, whether in the telecommunication, AIS, or remote sensing verticals. It is what enables us to deliver on our vision for simple and affordable access to space. We are delighted to have e2E as our first Simple-o programme customer and look forward to delivering their missions.

**Question: It was reported in April that Open Cosmos had raised US\$7 million in its Series A funding round. What are your plans for the money, and what's next in terms of funding?**

**Rafel Jorda Siquier:** We have secured enough investment to scale up the number of missions. In the following short term, we are aiming at having between 30 and 50 satellites manufactured per year. Putting a satellite into space has traditionally cost several millions, wait for years and jump through many hoops, but Open Cosmos is offering entire missions that start from £500,000 and can be delivered in less than a year.

**Question: In June, Open Cosmos was contracted by Satellite Applications Catapult to provide its space mission service to the In-Orbit Demonstration programme (IOD-6). What can you tell us about the deal?**

**Rafel Jorda Siquier:** The IOD-6 mission offers companies the opportunity to trial their service using a larger 6U CubeSat platform in a diverse range of orbit options.

By demonstrating the operational capability of their service through IOD-6, companies are in a stronger position to secure investment and customers. Successful candidates will be able to design, develop and launch their IOD-6 mission within 18 months and we will work alongside the successful candidate to integrate the payload and simulate the mission performance on our beeKit and beeApp.

Once the payload is validated, we provide a one-stop-shop mission service integrating the payload in a 6U beeSat multipurpose nanosatellite, performing full functional and environmental tests, procuring the launch and enabling the successful candidate to operate the payload in orbit through their beeApp mission control software.

We are obsessed with making space accessible so that organizations of all sizes and industries can solve the world's biggest challenges.

We are delighted that the IOD-6 Programme has contracted our space mission services to bring to orbit the most competitive service-oriented space technologies.

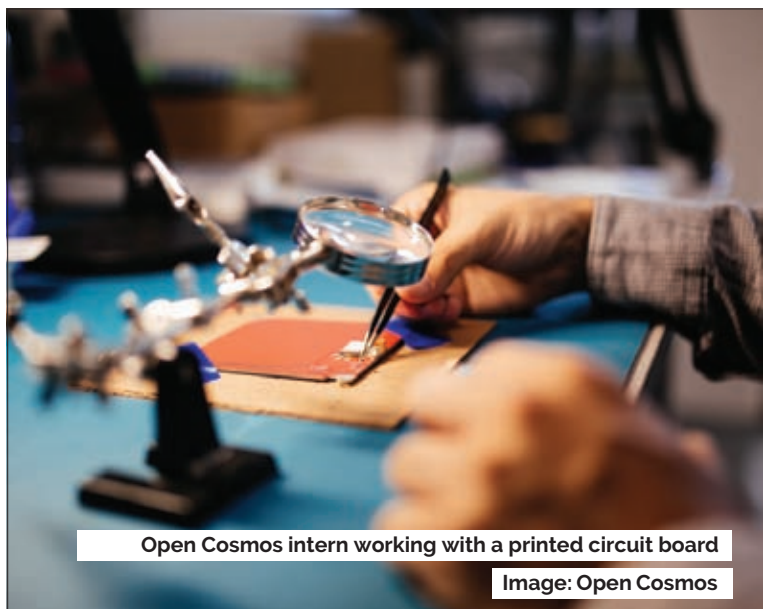
**Question: What are your expectations for Open Cosmos in 2019?**

**Rafel Jorda Siquier:** In 2019, Open Cosmos will consolidate its mission to deliver effective satellite-based solutions for global challenges. We will massively increase the distribution of our set of tools and services already being used to a broader audience. Our tools and services will be easily accessible with opportunities like 'Call To Orbit.'



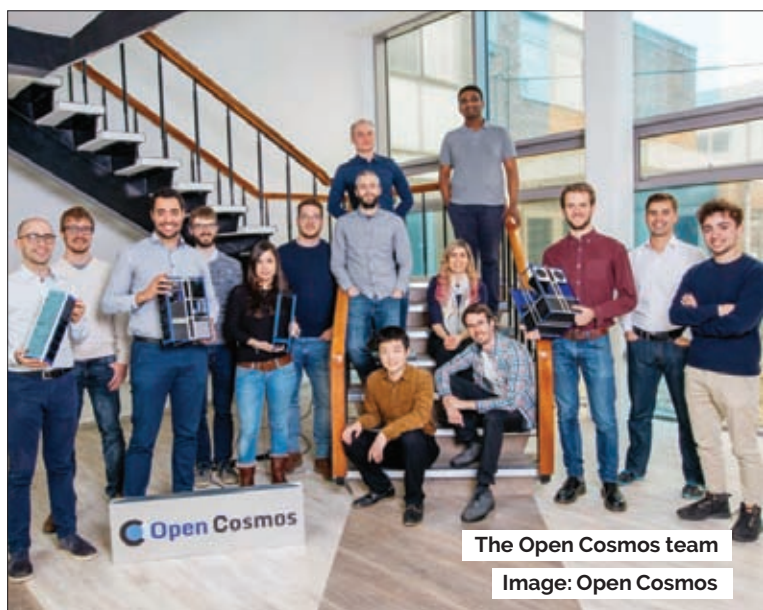
Open Cosmos intern Guillem Megias Homar working in the lab

Image: Open Cosmos



Open Cosmos intern working with a printed circuit board

Image: Open Cosmos



The Open Cosmos team

Image: Open Cosmos

# Modernizing the launch sector

The satellite launch industry has had decades to shroud itself in tradition; beyond the standard updating of vehicles and technology, there was very little change in the sector for many years. All that has changed now that we've entered the era of small satellites and constellations, and significant opportunities are available for those bold enough to grab them.

The satellite launch market is a costly place to do business. Designing, developing and manufacturing the launch vehicles is just the start of it; then there's the associated costs, the insurance, the launch pads, the regulations, the list goes on and on... However, as satellite trends move beyond traditional GEO satellites and high throughput satellites (HTS) towards small satellites, the launch sector must modernise to keep up with demand. Those companies that are slow to react will be left behind, as new start-ups, eager to get in on the action, make a killing.

## A US\$27.18 billion market (in 2025)

It's clear that the launch market is a great place to be doing business right now, as demand rises and technologies advance, making more launches possible than ever before, and with more choice for satellite operators.

ResearchAndMarkets' *'Space Launch Services Market by Service Type (Pre-Launch, Post-Launch), Payload (Satellite, Human Spacecraft, Cargo, Testing Probes, Stratellite), End User, Orbit, Launch Vehicle Size, Launch Platform, and Region - Global Forecast to 2025,'* expects the launch services market to grow at a CAGR of 15.01 percent in 2017-2025 to US\$27.18 billion.

North America is expected to lead the launch services market owing to increased launch service demands for satellites, human spacecraft, and space probes. In addition, the rise in the number of spaceflights to the International Space Station (ISS) and increased

investments in space exploration missions are additional factors projected to drive the growth of the market in North America. However, the Asia-Pacific market is projected to grow at the highest CAGR from 2017-2025 due to the increased demand for launch services from the space industry in this region.

More specifically on the small satellite front, Frost & Sullivan's *'Small-satellite Launch Services Market, Quarterly Update Q1 2018, Forecast to 2030,'* report expects an estimated 11,631 launch demands by 2030 for new constellations and replacement missions, which could take the market beyond US\$62 billion. The current rideshare capacity, wherein small satellites are launched as secondary payloads on existing launch programmes, is insufficient to meet upcoming launch demand.

"While North American and European companies will be the leading developers of flexible, dedicated launch vehicles, players in Asia-Pacific are looking to follow suit," said Vivek Suresh Prasad, SpaceIndustry Principal, Aerospace & Defense. "Many players are also analysing the feasibility of the small-satellite spaceport business model to provide dedicated launch services to small-satellite operators."

Frost & Sullivan expects significant market opportunities to be created by the high-volume demand created by the next wave of satellite constellations. Some 32 small satellite operators are expected to generate more than 90 percent of launch demand, with small satellites in the mass segments of 0-15kg and 150-500kg accounting for 65 percent of the launch demand.

New Shepard on the launch pad the morning of Mission 9, July 18, 2018

Image: Blue Origin





The projected launch capacity of existing and planned launch providers is expected to reach 11,640 small satellites, capable of launching 2,473 tonnes.

#### Arianespace prepares for a new era of satellite launches

One of the most well-established satellite launch companies on the market today, Arianespace has a great history in successfully and reliably launching satellites into a variety of orbits. The traditional launch provider has branched out in recent years, and while it has yet to make any announcements about reusable launch vehicles, Arianespace has proven itself more than capable of adapting to a new era for the satellite launch market, filled with small satellite launches for a wealth of new constellations and technology demonstrators.

In 2018, Arianespace successfully launched four additional O3b satellites for the constellation operated by SES Networks. The launch provider has now placed all of the 16 satellites in the current O3b constellation into orbit, demonstrating Arianespace's expertise in NGSO launches. The launch provider also orbited four more Galileo satellites for the European Space Agency (ESA); it has now launched 26 satellites for the constellation, with more to come in 2019.

Arianespace is building up to a Small Spacecraft Mission Service (SSMS) Proof Of Concept (POC) flight in 2019, due for launch from Europe's Spaceport at the Guiana Space Center. The Vega POC flight will also be the first mission of the SSMS, a modular carbon fibre dispenser, a program initiated by ESA in 2016, with the contribution of the European Commission. For all the European partners involved, its purpose is to address the burgeoning institutional and commercial small spacecraft market with a new rideshare concept. Participants of the SSMS POC flight include:

- **Spaceflight:** The rideshare and mission management provider will launch one microsatellite and several CubeSats on board the SSMC POC flight in early 2019. Spaceflight will also launch further small satellite payloads on subsequent Vega missions one year later.
- **D-Orbit:** D-Orbit's ION CubeSat Carrier, a free-flying CubeSat deployer and technology demonstrator that will host several CubeSats once deployed in orbit, will be launched on the SSMC POC flight. D-Orbit's InOrbit NOW is a revolutionary launch and deployment service designed to transport CubeSats to space and release them into independent orbital slots. The launch contract includes a significant number of CubeSats with an overall separated mass of about 100kg. Positioned in a sun-synchronous orbit at 500km., ION CubeSat Carrier will deploy the hosted CubeSats along the orbit over a period of approximately one month. After completing the CubeSat deployment phase, ION CubeSat Carrier will initiate the in-orbit validation phase of payloads directly integrated on the platform.
- **SITAEL:** The first small satellite delivering STRIVING services will be launched on the SSMC POC flight. STRIVING is a new one-stop-shop commercial service offering to both private and public entities affordable and effective access to space for testing, validating and/or operating their innovative technologies and solutions.

SITAEL, the Space Mission Provider (SMP), acts as a single interface to customers, leading an industrial team composed also of IMT, Planetek and Tyvak International. The service infrastructure is currently under development within a public-private partnership between ESA/ASI and SITAEL in the frame of the ARTES PIONEER Initiative. Built by SITAEL using its S-75 microsat platform, the first STRIVING satellite will weigh approximately 70kg at launch and is designed to have a nominal service life of at least two years once positioned in a sun-synchronous orbit at 500km.

- **Innovative Solutions in Space (ISIS):** ISIS' QuadPack deployer for multiple CubeSats will be launched on the SSMS POC flight, along with options for several microsatellites and more QuadPack deployers for the SSMS POC mission – as well as for subsequent Vega SSMS launches.
- **Spire:** A multi-launch contract will see several CubeSats launched on the SSMC POC flight, as well as options on subsequent Vega flights. Built in-house by Spire using its LEMUR2 CubeSat platform, the nanosatellites will weigh approximately 5kg at launch and are designed to have a nominal service life of two to three years once positioned in a Sun-synchronous orbit at 500km. Each satellite carries multiple sensors, making them capable of performing data collection for all of Spire's data products.

Arianespace is also well on its way with the development of its new Vega C and Ariane 6 launch vehicles. The first launches are expected in 2019 and 2020, respectively. Ariane 6, which comes in two versions, has already won two launch contracts from the European Space Agency (ESA) for four additional satellites for the Galileo navigation system, while Vega C has won three contracts; two to orbit satellites for the Airbus Earth observation constellation Pléiades Neo, and one to launch the COSMO-SkyMed satellite for the Italian space agency (ASI) and Italian Ministry of Defense.

#### Northrop Grumman: Full steam ahead with Omega launch vehicle

Not as ostentatious a player in the satellite launch sector as some of its competitors, Northrop Grumman's expertise stems from the production of the Pegasus, Minotaur and Antares launch vehicles by its Flight Systems Group, as well as the Cygnus spacecraft from its Innovation Systems group – newly-formed from the 2018 acquisition of Orbital ATK.

In addition to its existing capabilities, Northrop Grumman is also developing a new rocket, the Omega. Originally an Orbital ATK design, Omega is a new intermediate-and large-class launch vehicle, capable of launching the full range of national security missions required by the US Air Force, as well as scientific and commercial payloads. An Evolvable Expendable Launch Vehicle (EELV), the Omega will launch from both East and West coast launch facilities and will be the largest and most capable of Northrop Grumman's rocket range.

In April 2018, Northrop Grumman provided a detailed update on its Omega launch vehicle system. In the previous three years, Orbital ATK and the US Air Force have invested more than US\$250 million into its



Electron 'Its a Test' at Launch Complex 1

Image: Rocket Lab

development, and the vehicle is on track to begin ground tests in 2019, and to conduct its first launch in 2021.

The rocket configuration consists of Orbital ATK-built first and second solid rocket stages, strap-on solid boosters and a cryogenic liquid upper stage. Orbital ATK recently selected Aerojet Rocketdyne's RL10C to be Omega's upper stage propulsion engine. The RL10 has provided reliable upper stage propulsion for more than five decades and provides a low-risk, affordable engine with outstanding performance. The next phase of the Omega program began in the middle of 2018, when the US Air Force awarded Launch Services Agreements, including the remaining development and verification of the vehicle and its launch sites. After initial flights of its intermediate configuration in 2021, Omega will be certified for operational EELV missions starting in 2022 with initial heavy configuration flights beginning in 2024.

In other news, July 2018 saw the ninth successful cargo supply mission to the ISS under NASA's Commercial Resupply Services (CRS-1) contract. The Cygnus spacecraft removed more than 3,000kg of disposable cargo, a new record for Cygnus. The 'S.S. J.R. Thompson' Cygnus vehicle also successfully executed secondary missions that included the demonstration of Cygnus' ability to reboost the space station and the deployment of six CubeSats into orbit from a NanoRacks CubeSat deployer.

The mission started on 21 May, when Cygnus launched aboard a Northrop Grumman Antares rocket from NASA's Wallops Flight Facility in Virginia. Upon arrival at the orbiting laboratory, Cygnus delivered approximately 3,350kg of cargo, supplies and scientific experiments to the astronauts. The spacecraft remained docked for 52 days at the orbiting laboratory and departed the ISS on 15 July. The mission officially

concluded on 30 July, when Cygnus performed a safe, destructive re-entry into the Earth's atmosphere over the Pacific Ocean East of New Zealand.

"From launch to our safe re-entry, the 'S.S. J.R. Thompson' performed every phase of this mission perfectly," said Frank Culbertson, President, Space Systems Group, Northrop Grumman. "We now turn our attention toward final preparations for the next Cygnus cargo mission later this year with a continued focus on supporting the needs of the crew members aboard the International Space Station, as well as enabling crucial research programs in space."

Later in August, Northrop Grumman demonstrated its capability to develop booster systems and key launch components for use in other launch provider systems. The company provided the fully-integrated third stage propulsion system of the ULA Delta IV Heavy rocket, giving a critical boost for NASA's Parker Solar Probe spacecraft on its journey to study the sun. The spacecraft was successfully launched aboard a ULA Delta IV Heavy rocket, for which Northrop Grumman also provided several large composite structures.

The goal of the Parker Solar Probe mission is to increase understanding of the sun, where changing conditions can propagate out into the solar system, affecting Earth. The spacecraft required a third stage to provide the necessary velocity to place it on a heliocentric, Earth escape trajectory toward the sun, making it one of the fastest human-made objects ever launched with a top speed of over 121mps. At that speed, it could travel from the Earth to the moon in under 30 minutes. The third stage system includes a Northrop Grumman STAR 48BV solid rocket motor configured to enable precise insertion of the spacecraft into its final trajectory. This mission marks the first time the Delta IV rocket has flown with a third stage.





Rocket Lab Electron 'It's Business Time' on the pad at LC-1

Image: Rocket Lab

"It has been an honour to work on a historic program that will provide major advancements in the understanding of the sun," said Phil Joyce, Vice President, Small Space Launch Systems, Northrop Grumman. "The team was able to draw on its expertise in developing mission-unique stages for our own launch vehicles and applied that knowledge to building the first ever third stage for the Delta IV Heavy."

Under a subcontract from ULA, Northrop Grumman designed and manufactured the third stage using the company's flight-heritage components with some modifications to withstand the higher radiation environments unique to the Parker Solar Probe's Earth escape trajectory. This included all stand-alone avionics, ordnance, structures and flight software. It also included guidance, navigation and control systems, and instrumentation, telemetry and the separation systems for third stage and spacecraft. Northrop Grumman also provided 14 key large composite structures for ULA's Delta IV Heavy rocket. These structures include the following on each of the three Common Booster Cores (CBC): A thermal shield that house and protect the RS68 engine during flight, the centerbody that connects the liquid oxygen (LO<sub>2</sub>) tank and the liquid hydrogen (LH<sub>2</sub>) tank, the nosecones on the strap-on CBCs, the interstage on the core CBC that connect to the Delta Cryogenic Second Stage (DCSS), and the X-panel structures that connect the DCSS LO<sub>2</sub> tank and the LH<sub>2</sub> tank. Additional contributions include the approximately 63ft long payload fairing, payload attach fitting, and payload attach fitting diaphragm, all of which encapsulate and protect the payload. These large-scale composite structures measure up to 15ft in diameter and range from three to 63ft in length.

In addition, Northrop Grumman manufactured the propellant tank for the Delta IV second stage roll control

system and a diaphragm tank for the Parker Solar Probe spacecraft and designed and manufactured the nozzles for the Delta IV's RS-68A engines. The company also designed and produced the nozzles' thermal protection material, which is capable of shielding the nozzle from external temperatures that can exceed 4,000 degrees Fahrenheit during launch. In addition, Northrop Grumman manufactured the eight booster separation motors for the Delta IV Heavy.

#### Rocket Lab announces significant contract wins

Founded in 2006, Rocket Lab has become a major player in the global launch sector in recent years, with a mission to open access to space to improve life on Earth. The company develops and launches advanced rocket technology to provide rapid and repeatable access to orbit for small satellites.

Rocket Lab's first launch vehicle, the Electron rocket, was explicitly designed to serve the small satellite market with dedicated high-frequency launch opportunities, delivering payloads of 150kg to a 500km Sun-synchronous orbit. The two-stage launch vehicle utilizes Rocket Lab's Rutherford liquid engines in both stages, using pumps which are uniquely-powered electric motors instead of a gas generator, expander or pre-burner. The engine is fabricated largely with 3D-printing methods. January 2018 saw the 500<sup>th</sup> test fire of the Rutherford engine, which saw a 100 second burn.

Although the company remains in its infancy compared with industry stalwarts like Arianespace, Rocket Lab has already signed an impressive number of launch deals.

In April, Rocket Lab and spacecraft platform developer York Space Systems entered into a Memorandum of Understanding (MoU) to develop a universal Interface Control Document (ICD) and



supporting Concepts of Operations (CONOPS) that will streamline the manifesting process for small satellite launch customers.

By removing the time spent in selecting a bus and launch provider, and developing the standard products required to get a spacecraft programme off the pad. Rocket Lab and York are establishing a framework to shorten the integration process required for York spacecraft on the Electron launcher. Currently the mission integration campaigns take months, adding to the lead time on top of that required for regulatory approvals. By creating standard launch integration products that have already established compatibility, many months of mission integration can be cut. Standard interfaces, requirements and capabilities will be pre-verified, and a set of operational services and enhancements will also be defined.

"Sending a satellite to orbit used to mean commissioning a large, one-off spacecraft that required a purpose-built payload adaptor and often a tailored launch vehicle. By developing an optional standardized launch vehicle and bus ICD, we can radically reduce the customer costs and speed up the manifesting process to get satellites on orbit faster," said Rocket Lab CEO Peter Beck.

In June, Rocket Lab announced a partnership with rideshare and mission management provider Spaceflight for three orbital launches across 2018 and 2019. The first mission, scheduled for the end of 2019, was for a BlackSky microsatellite and several rideshare customers. The missions join a busy manifest which will see Rocket Lab launch monthly by the end of 2018, and every two weeks in 2019. All three missions will be launched from Rocket Lab's Complex 1 on the Mahia Peninsula in New Zealand, deploying the satellites into low Earth orbit (LEO). Spaceflight will provide mission campaign services, while Rocket Lab will assist with vehicle integration on the Electron vehicle.

Later in August, Rocket Lab signed an agreement with Circle Aerospace for ten dedicated Electron launches, with the first scheduled for launch in the fourth quarter of 2019. Circle Aerospace is a new turnkey launch

brokerage and satellite development company from Dubai which aims to catalyse the growth of commercial space and small satellite industry across the UAE. Circle Aerospace's contract will see most of the missions launched from Rocket Lab's New Zealand site.

### Blue Origin nears suborbital space tourism flights

Blue Origin was founded by Amazon Founder and CEO Jeff Bezos back in 2000 with the aim of providing private human access to space with dramatically lower costs and increased reliability. The company has two launch vehicles; the New Shepard, a reusable suborbital vehicle with more than a handful of successful flights; and the New Glenn, an orbital two or three-stage vehicle with a reusable first stage, expected to enter the market in the 2020s.

In July 2018, the New Shepard achieved its ninth successful flight, which delivered its third round of commercial payload customers with the following missions:

- **Schmitt Space Communicator Xperimental (SC1-x):** On New Shepard Mission 8, Solstar demonstrated the first commercial WiFi in space. On this reflight, they will take advantage of the Crew Capsule's high altitude escape and continue testing WiFi access throughout the flight.
- **GAGa (Granular Anisotropic Gases):** The GAGa payload investigates the statistics of granular gases, dilute collections of solid grains that interact by random collisions. Data from GAGa on New Shepard Mission 9 will help validate existing theoretical models and contribute to understanding the dynamics of related systems like avalanches and cosmic dust clouds.
- **Suborbital Flight Experiment Monitor-2 (SFEM-2):** SFEM-2 was first flown on Mission 8 of New Shepard and will collect additional data on Mission 9. The experiment will record vehicle conditions including cabin pressure, temperature, CO<sub>2</sub>, acoustic conditions, and acceleration.
- **Condensed Droplet Experiment for NASA in Sub-Orbital Spaceflight (ConDENSS):** ConDENSS will examine the behaviour of small droplets of water in order to support the development of small and efficient heat transfer systems for spaceflight. These systems, called phase change heat transfer systems, provide more uniform surface temperatures and higher power capacities.
- **APL Electromagnetic Field Experiment:** This experiment marks the first flight of the JANUS 2.1 platform with sensors to monitor magnetic fields and ambient pressure inside the vehicle. Previous versions of JANUS were flown on New Shepard Missions 6 and 7.
- **Vibration Isolation Platform Data Logger:** VIP DL is a technology demo for an active stabilization platform that aims to allow the most sensitive payloads flying on *New Shepard* to be isolated from ambient vibrations, allowing for even higher precision microgravity studies.
- **mu Space-1:** The first of Blue Origin's New Glenn customers to purchase a slot on New Shepard, mu Space's payload includes an assortment of



scientific and medical items, several textile materials they plan to use on their future space suit and apparel, and other special articles for their community partners.

- **Blue Origin 'Fly My Stuff':** A special addition to the Mission 9 payload manifest is a suite of payloads from Blue Origin employees as a part of our internal 'Fly My Stuff' program.

Mission 9 also saw the latest launch of its Crew Capsule 2.0, Blue Origin's first plan for suborbital space tourism. The capsule seats six astronauts and is large enough for passengers to float freely. Sitting on top of the New Shepard rocket, Crew Capsule 2.0 was ejected safely and extensively stress-tested before it was successfully landed back on Earth with the help of a retro-thruster system. The capsule also features three independent parachutes for redundancy. According to recent reports, Blue Origin plans to start selling tickets on the Crew Capsule 2.0 in 2019, with prices estimated anywhere from US\$50,000 to US\$250,000.

### SpaceX sends Tesla into space in world-famous Falcon Heavy launch

Another famous business name, Elon Musk's SpaceX company was founded in 2002 in order to reduce space transportation costs and enable the colonization of Mars. The company has come a long way in such a short time, with the development of several launch vehicles and crew capsules. Falcon 9, the world's most famous reusable launch vehicle, has now successfully launched hundreds of satellites into orbit, and SpaceX is going full steam ahead with its next vehicle: The Falcon Heavy.

Back in February, SpaceX successfully launched the

Falcon Heavy launch vehicle into space for the first time, delivering its cargo, the Tesla Roadster, into orbit. The three-stage Falcon Heavy, the first heavy-lift capability launch vehicle seen in space in decades, is set to change the path of human space exploration. The vehicle exceeded expectations during the launch: The first two stages were successfully re-landed, while the third was lost during the attempted re-land at sea due to too high speeds. SpaceX has stated that it expects to cut launch costs from tens of billions to US\$90 million with the Falcon Heavy, compared with US\$1 billion for NASA's comparable SLS rocket (currently under development).

The Falcon Heavy successfully launched its ostentatious cargo, a Tesla Roadster, towards Mars; however, due to slight overthrust, the Roadster is unlikely to orbit Mars as planned. Its current trajectory is uncertain, although it could well end up in an asteroid belt.

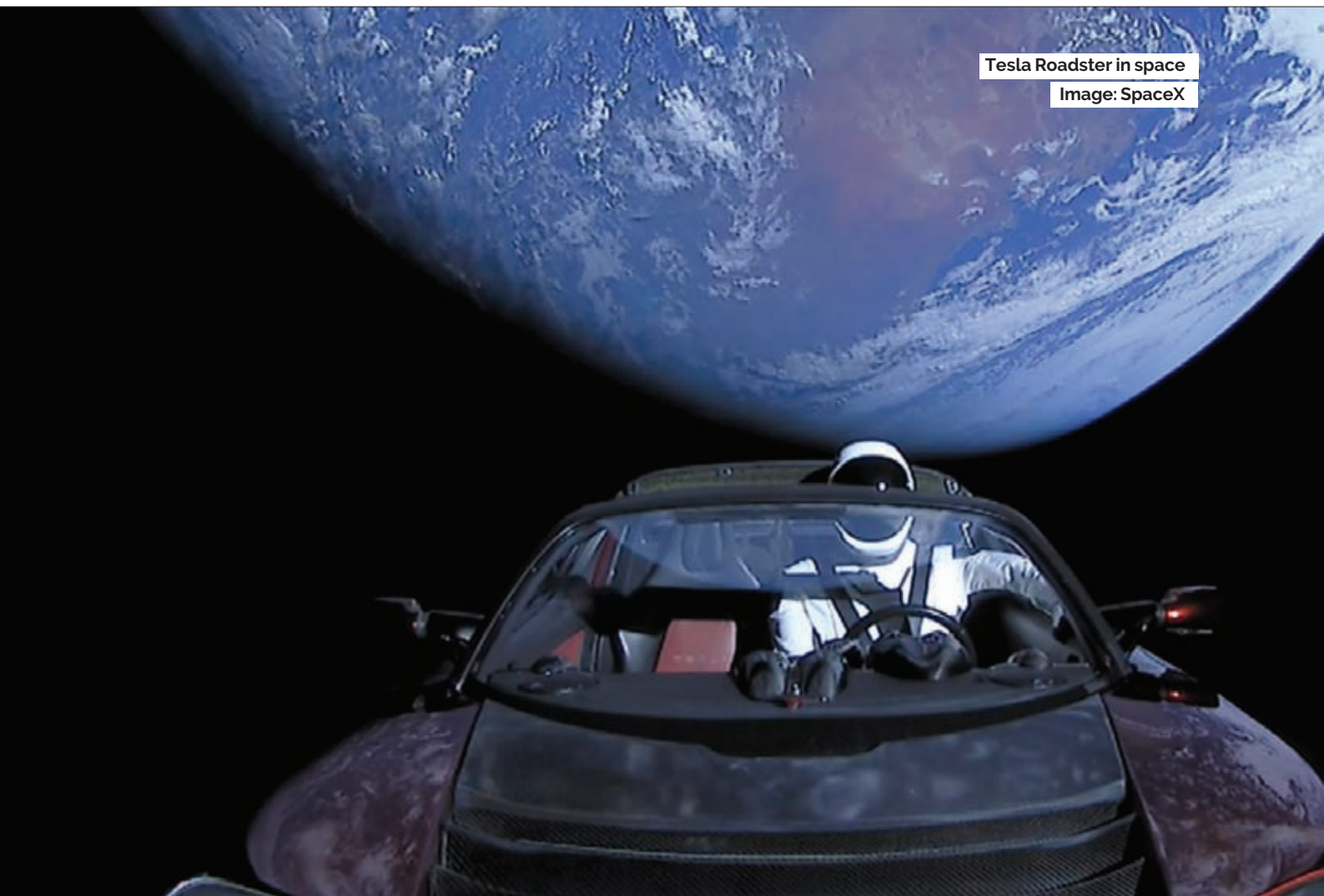
Although no dates have yet been made available, several commercial Falcon Heavy spaceflights are on the books at SpaceX, for Arabsat (Arabsat 6A), Inmarsat, US Air Force (STP-2) and Viasat.

2018, a hugely successful year for SpaceX, which achieved a large number of commercial and governmental satellite launches – the Merah Putih mission for PT Telkom Indonesia, tens of Iridium NEXT satellites, Telstar 19 VANTAGE, SES-12, two GRACE-FO satellites, Bangabandhu Satellite-1, NASA's TESS, HISPASAT 30W-6, PAZ and GOVSAT-1, in addition to Dragon resupply missions for the ISS – pales into comparison with what the company has planned next.

With the Falcon Heavy nearing commercialization, Elon Musk's team is rapidly developing its next step forwards: The BFR, which SpaceX President Gwynne

Tesla Roadster in space

Image: SpaceX



Shotwell has insisted stands for 'Big Falcon Rocket,' in contrast with less polite, but more popular, thoughts on the abbreviation.

The BFR is Musk's next step in realizing the goal to colonize Mars; the reusable launch vehicle will be capable of lifting as much as 150,000kg into orbit, and will ultimately replace the Falcon 9 and Falcon Heavy vehicles, as well as the Dragon spacecraft. Testing is expected to start in 2019, with cargo flights to Mars pegged for an optimistic 2022 launch date.

### Virgin Galactic nears suborbital space tourism readiness

2004-founded Virgin Galactic is Richard Branson's spaceflight company within the Virgin Group. The company plans to provide suborbital spaceflights to space tourists, as well as for launching science missions. Unique in its approach, Virgin Galactic's launch vehicle, SpaceShipTwo, is air-launched from a carrier airplane called WhiteKnightTwo. Virgin Galactic works in harmony with its sister company, The Spaceship Company, an aerospace-system manufacturing organization.

In April 2018, VSS Unity, the first SpaceShipTwo built by The Spaceship Company, successfully completed its first supersonic, rocket-powered flight. This flight milestone was the result of many years of extensive design, manufacturing, ground testing and flight testing activities. The flight starts the final phase of VSS Unity's flight test program before the vehicle is delivered to Virgin Galactic for commercial service.

VSS Unity was launched from the WhiteKnightTwo carrier when the vehicles had reached 46,500ft over the Sierra Nevada Mountains. After a few seconds to ensure adequate separation, VSS Unity's rocket motor was brought to life and the pilots aimed the spaceship upwards into an 80 degree climb, accelerating to Mach 1.87 during the 30 seconds of rocket burn. The hybrid nitrous oxide/rubber compound rocket motor, which was designed, built and tested by The Spaceship Company, powered VSS Unity through the transonic range and into supersonic flight for the first time. On rocket shutdown, VSS Unity continued an upwards coast to an apogee of 84,271ft before readying for the

downhill return. At this stage, the pilots raised the vehicle's tail booms to a 60 degree angle to the fuselage, or into the 'feathered' configuration. At around 50,000ft, the tail-booms were lowered again and, while jettisoning the remaining oxidizer, VSS Unity turned to glide home for a smooth runway landing.

The flight has generated valuable data on flight, motor and vehicle performance. It also marks a key moment for the test flight program, now entering the exciting phase of powered flight and the expansion to full duration rocket burns. Further VSS Unity test flights were completed throughout 2018, and in July, the spacecraft broke Mach 2 when released from carrier aircraft VMS Eve at 46,500ft. The planned 42 seconds rocket burn took pilots and spaceship through the Stratosphere and, at an apogee of 170,800ft, into the Mesosphere for the first time. This region, often referred to by scientists as the 'Ignorosphere,' is an under-studied atmospheric layer because it is above the range of balloon flight, and in the future is an area we can help the research community explore further.

Looking ahead, once in commercial service, Virgin Galactic's spaceships are designed to be turned around and flown at a higher frequency than has traditionally been the case for human spaceflight.

Later in July, Virgin Galactic, The Spaceship Company, Altec and SITAEL signed a framework agreement to bring Virgin Galactic spaceflights to Italy. The agreement comes after two years of business discussions, government regulatory analysis, studies on potential operations and market assessment.

The agreement envisions a dedicated space vehicle system being positioned at the future Grottaglie Spaceport, which will integrate significant technological and industrial contribution from SITAEL and the rest of Italian Aerospace industry, pending regulatory approvals.

The space vehicle would be utilized by customers like the Italian Space Agency as a science platform for high-frequency space research, as well as private individuals to experience space. This dual nature is expected to drive innovation, spur industrial development, STEM education, as well as promote further investments and economic growth in Puglia and Italy as a whole. ■

What do you want from your PR?



**PROACTIVE  
INTERNATIONAL PR**

To find out more contact:

Brian Dolby

tel: +44 1636 812152

email: [hello@proactive-pr.com](mailto:hello@proactive-pr.com)



**GVF** *Satellite.  
Solutions.  
The World.*

- **GVF serves as the unified voice of the international satellite industry** ●

[www.gvf.org](http://www.gvf.org)

# Enhancing Earth observation technologies



Paul Jerram

Image: Teledyne e2v

Teledyne e2v delivers RF power solutions, imaging solutions and semiconductor solutions for a wide variety of sectors, including the satellite communications industry and government and military defence programmes. The company was recently involved in supplying critical components for the European Space Agency's (ESA) new Earth observation satellite, Aeolus. Paul Jerram, Chief Engineer at Teledyne e2v, describes this groundbreaking new technology and the implications for Earth observation capabilities.

**Question: Can you provide a brief overview of Teledyne e2v's solutions and expertise?**

**Paul Jerram:** Teledyne e2v is part of the Teledyne Imaging group. Teledyne is an important supplier to the world's space agencies and satellite producers. With respect to imaging sensors for Earth observation, the Chelmsford facility is the main Centre of Excellence in Europe and is the biggest presence outside of North America.

With Teledyne DALSA (Canada), Teledyne Imaging Sensors (California) and Teledyne e2v's other Centres of Excellence in France and Spain, we as a group provide a complete range of detector solutions and expertise for any satellite application covering the full wavelength of the electromagnetic spectrum i.e. from infrared to X-ray.

Our value proposition covers space-qualified Charge Coupled Device (CCD) and Complementary Metal-Oxide-Semiconductor (CMOS) technologies of small and large format high resolution devices with very high quantum efficiency, and producing these as tailored solutions, whether just the detector package or the full imaging sensor system sub-assembly.

With a trend for products to become more standardised for NewSpace applications, yet meet the radiation tolerance, qualification and traceability requirements for space missions, Teledyne is leading the way in new CMOS technologies such as Time Delay and Integration (TDI) and easy-to-use large format general purpose imager devices.

**Question: Earth observation is one of the oldest satellite applications; how have capabilities advanced over the years?**

**Paul Jerram:** We have progressed from camera film technology through the age of CCDs, and we are now seeing CMOS image sensors being developed and going

into space! The big change currently is the update time of satellites. The Pléiades constellation, for example, has an update or revisit rate of one day, whereas with the advent of larger constellations, updates are becoming in the order of a number of hours i.e. two or three. This capability clearly comes with many benefits.

There was a reasonably long period of very little change, but there is a rapid evolution now, driven by NewSpace, reducing costs and getting small satellites up into space in larger quantities.

**Question: Late in August, the ESA's Aeolus satellite was launched, equipped with Teledyne e2v's Charge Coupled Device (CCD) for the Atmospheric Laser Doppler Instrument (ALADIN). What can you tell us about the device and its design?**

**Paul Jerram:** ALADIN works by emitting an ultraviolet laser beam through the Earth's atmosphere and measuring the reflected return signal from particles, or aerosols in the atmosphere.

Teledyne e2v, in collaboration with Airbus Defence and Space and the European Space Agency (ESA), has developed an innovative type of detector that simultaneously measures the distance of the returned ultraviolet laser pulse to resolve the altitude of aerosols in the atmosphere, and the Doppler shift that equates to the wind speed at each altitude. The returned signal is typically extremely weak; however, the detector has the capability to add together a number of returned pulses to improve the accuracy of the measurements. Aeolus is the first satellite of its kind to utilize this type of technology in space.

Teledyne e2v's detector consists of a 16x16 pixel CCD with a novel storage region that accumulates the signal from several successive laser pulses. The detector is housed in a hermetically sealed package with an integrated Thermoelectric Cooler (TEC) that uses the



Peltier effect to transfer heat away from the sensor. The CCD detector is optimized through a back-thinning process (a key capability of Teledyne e2v) to provide a very high detection efficiency at the laser wavelength of 355nm.

**Question: How does the ALADIN improve upon traditional methods for gathering wind data profiles for Earth?**

**Paul Jerram:** Traditional methods to gather this type of data involve deploying weather balloons, cloud tracking, and monitoring temperature and surface winds. Instead, the Aeolus satellite will employ a very powerful laser in an instrument known as ALADIN.

The data collected by this Earth observation system will calculate wind speed and atmospheric pressure changes. Meteorologists will be able to use this information to make significantly more informed global weather forecasts.

**Question: What other Earth observation projects is Teledyne e2v currently working on?**

**Paul Jerram:** Recently launched is Copernicus: Sentinel 3, and there are the Sentinel 4 and 5 pollution-monitoring missions yet to be launched – this is planned for 2021. Then there is also ESA's FLEX mission (vegetation fluorescence) and 3MI (weather and climate monitoring satellites)...

Teledyne e2v was awarded a multi-million-Euro contract by OHB System AG to supply customised CCD image sensors for the Fluorescence Explorer (FLEX) satellite mission, under a programme of and funded by the ESA. The FLEX mission, which is the eighth in ESA's Earth Explorer programme, is scheduled to launch in 2022. For the first time, it will enable plant photosynthetic activity to be measured from space by detecting the faint fluorescent glow emitted when atmospheric carbon dioxide and sunlight is converted into energy-rich carbohydrates.

The ESA Earth Explorer missions focus on the atmosphere, biosphere, hydrosphere, cryosphere and the Earth's interior, with emphasis on the interactions between these components and on the impact that human activities have on the Earth's processes. The FLEX mission will advance understanding of the functioning of the photosynthetic machinery and the actual health and performance of terrestrial vegetation. The mission will deliver a monthly global map with an on-ground spatial resolution of 300x300m. The FLEX payload consists of the high-resolution Fluorescence Imaging Spectrometer (FLORIS), a 'push-broom' type instrument with a swath width of 150km and covering the 500-780nm spectral range.

The Teledyne e2v CCDs are of custom frame transfer design, meeting the specific requirements of the ESA-funded FLORIS instrument. They feature large rectangular pixels, high quantum efficiency performance, low noise and the ability to run at fast transfer speeds. The custom package for the CCDs is designed to be compact as well as closely matching their thermal properties to meet the thermomechanical requirements. It also features two flexible cables for electrical connection and precision alignment of the sensors

in the FLORIS focal plane array.

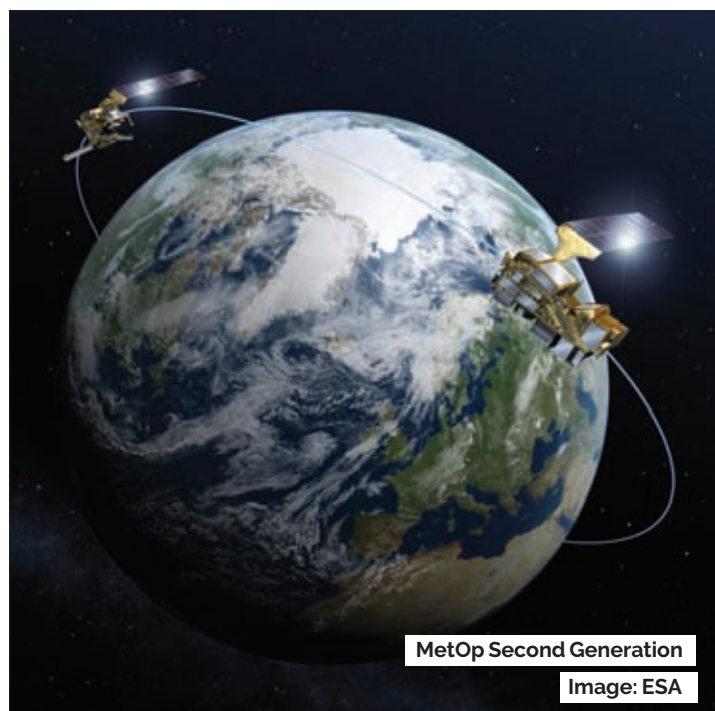
Information from FLEX will help scientists improve their understanding of the way carbon moves between plants and the atmosphere, and how photosynthesis affects carbon and water cycles. It will also lead to better insight into plant health and stress. This is of particular relevance since the growing global population is placing increasing demands on the production of food and animal feed.

Meanwhile, with respect to the 3MI mission, Teledyne e2v was awarded a contract by Leonardo-Finmeccanica for the supply of customised CCD image sensors for their Multi-viewing, Multi-channel, Multi-polarisation Imager (3MI), an instrument for a series of weather and climate monitoring satellites. The 3MI instruments will be integrated by Airbus Defence and Space as the prime contractor on the three Meteorological Operational Second Generation (MetOp-SG) 'A series' of satellites, being developed by the ESA for EUMETSAT.

The customised CCD design is based on the CCD47-20 image sensor which has been used in many star tracker missions and scientific instruments for atmospheric monitoring. The frame transfer image sensor will be used in the visible and near infrared channels of the instrument, which will measure aerosol properties with unprecedented accuracy and resolution, compared to other current optical missions. 3MI has 13 spectral channels that are optimised for different wavelengths and will scan Earth image strips up to 2,200km in width, with a ground resolution of 4km. The pixel size of the sensor has been optimised for high dynamic range in order to increase the accuracy of the radiometry performed.

Teledyne e2v will deliver image sensors for three instruments on the MetOp-SG 'A series' of satellites, which will be launched in series starting from 2021 for a total mission lifetime of 21 years.

In addition, we are working on a number of programmes for other large space agencies such as the CNSA, NASA, JAXA, and of course with independent customers such as SSTL. ■







Check out the website now at [www.newspaceinternational.com](http://www.newspaceinternational.com)



Send us a tweet at @NewSpaceIntl



Join our LinkedIn community at <https://bit.ly/2GFXYIR>



For general enquiries contact [Amy.Saunders@dsairpublications.com](mailto:Amy.Saunders@dsairpublications.com)



Contact Chris for sales queries at [Chris.Ayres@dsairpublications.com](mailto:Chris.Ayres@dsairpublications.com)

Your one-stop hub for the NewSpace sector - Website - Magazines - Social media - Newsletters - eBlasts - Events - Brochures

NewSpace International is brought to you by the world-class information group - Satellite Evolution. Published six times per year, NewSpace International is available online and via email, direct to your desktop or mobile device.

NewSpace describes the move towards today's emerging private spaceflight industry. Gone are the days when the satellite and space sectors were dominated by government organisations - today, it's all about the commercial players who are looking to harness space in a completely new way. Developing faster, better, and improved access to space and spaceflight technologies, we're entering an exciting new era for the global space community.

## GET YOUR MESSAGE HEARD NOW WITH NEWSPACE INTERNATIONAL

Marketing packages start from US\$250 for a web presence up to our Platinum Package covering six magazine issues, newsletters and web presence for a year, at the special launch price of just US\$10,100. Contact Chris Ayres or Amy Saunders to find out more.



## ADVERTISERS' INDEX

The November issue of NewSpace International has featured the following advertisements:



Advertiser	Page
Advantech Wireless	2
CABSAT	13
Comtech Xicom	9
GVF	31
Proactive	30
PTC	OBC
SpaceBridge	IBC
SpacePath	5

## COMING SOON...

Enjoyed this issue of NewSpace International magazine? Hold onto your hats, because there's much more to come!

Coming up in NewSpace International January:

- News
- Interview: Orbex
- Interview: LGS Innovations
- Interview: Goonhilly Earth station
- Feature: Space tourism
- Feature: Asteroid mining



The Axiom Space Station



# Advantech

## Satellite Networks

# New name, New adventure

Advantech Wireless Inc., doing business as Advantech Satellite Networks™  
is now  
SpaceBridge Inc. doing business as **SpaceBridge™**

We thank all our partners, clients and suppliers for helping us significantly grow our business and we remain committed to the same degree of excellence, spirit of innovation and customer delight. Above all, we commit to reward our customers with unsurpassed technologies and solutions developed by our talented and loyal team that has earned your trust over the past 30 years

A new journey has begun



# Recognizing the most outstanding innovations that transform the ICT industry

JOIN PACIFIC TELECOMMUNICATIONS COUNCIL  
IN HONOLULU FOR THE



**PTC**  
Innovation Awards

**TUESDAY, 22 JANUARY 2019**

**18:30**

Hilton Hawaiian Village® Waikiki Beach Resort  
Tapa Tower, Tapa Ballrooms

PTC's signature fundraising event, offering you the opportunity to give back and support the advancement of ICT in the Pacific Region. Net proceeds will fund PTC's yearlong initiatives.



PTC ACADEMY



PTC BROADBAND REPORTS



PTC PROJECTS



PTC YOUNG SCHOLAR PROGRAM



PTC RESEARCH PRIZE AWARDS

Contributions are tax deductible.

LEARN MORE AT [PTC.ORG/INNOVATIONAWARDS](http://PTC.ORG/INNOVATIONAWARDS)



**PACIFIC  
TELECOMMUNICATIONS  
COUNCIL**

[PTC.ORG/PTC19](http://PTC.ORG/PTC19)

+1.808.941.3789

[ptc19@ptc.org](mailto:ptc19@ptc.org)

Pacific Telecommunications Council

PTCouncil

PTC