

# SatMagazine



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*Cover image is courtesy of Astranis*





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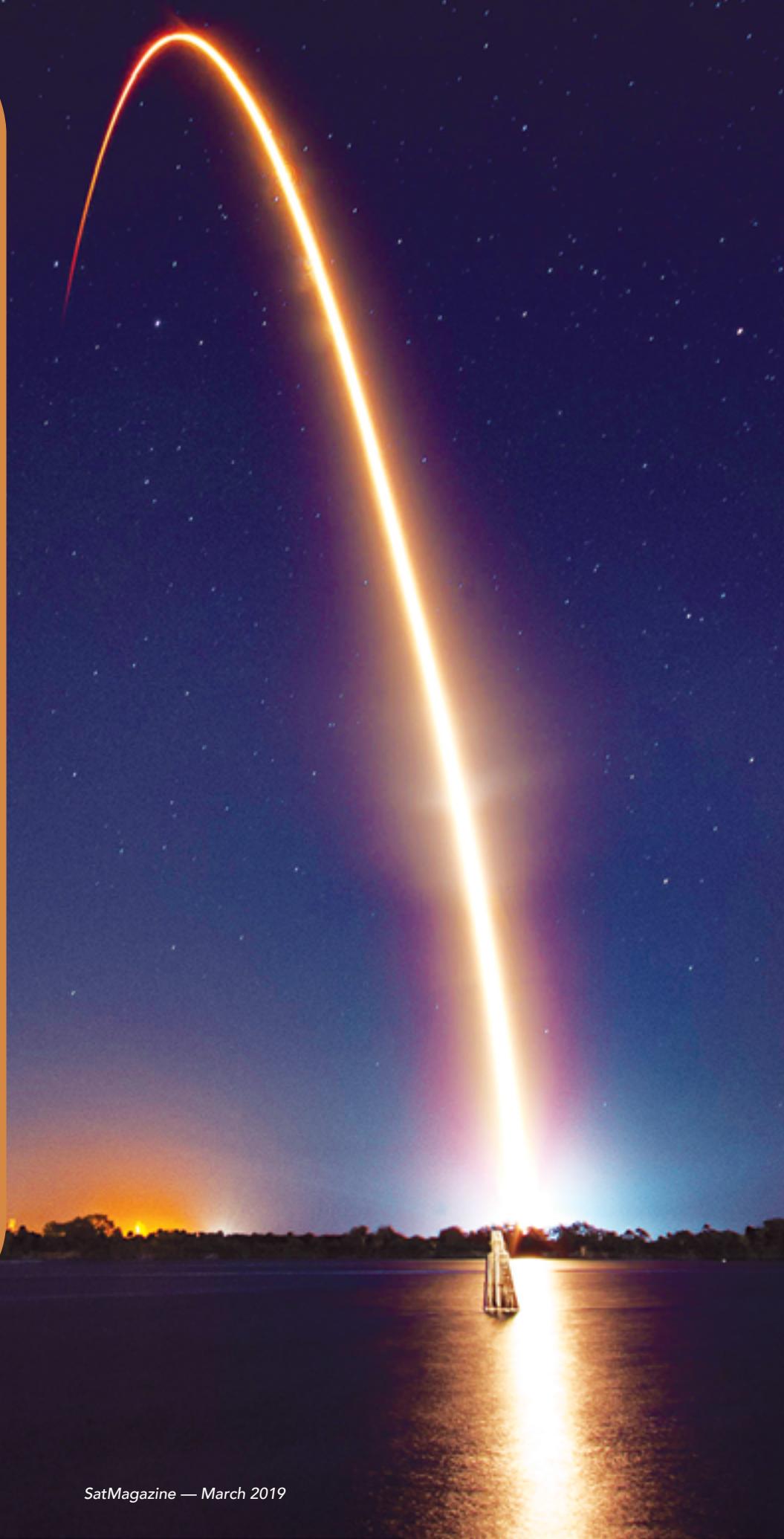
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#### *Page image:*

*The SpaceX Falcon 9 launch of the Nusantara Satu satellite, the SpaceIL Beresheet lunar lander and the U.S. Air Force Laboratory S5 experimental smallsat payloads from Cape Canaveral AFS on February 22, 2019. Photo is courtesy of SpaceX.*





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# InfoBeam

SpaceX sends Israeli lunar lander, the Nusantara Satu satellite and an AFRL smallsat to their destinations



The liftoff of the PSN6, Spacell and AFRL payloads aboard the company's Falcon 9 rocket.  
Image is courtesy of SpaceX.



Falcon 9 first stage landing on the "Of Course I Still Love You" drone ship, completing this booster's third launch and landing. Photo is courtesy of SpaceX.

**On Thursday, February 21, SpaceX launched the Nusantara Satu satellite from Space Launch Complex 40 (SLC-40) at Cape Canaveral Air Force Station, Florida, at 8:45 p.m. EST, or 1:45 UTC.**

The Falcon 9 launch vehicle also delivered the **Spacell Beresheet** craft — the first privately funded lunar lander — to space as well as the experimental **U.S. Air Force Research Laboratory** (AFRL) **S5** smallsat to orbit.

Deployments occurred at approximately 33 and 44 minutes after liftoff.

The Falcon 9 rocket's first stage for this mission had previously supported the Iridium-7 mission in





July of 2018 and the SAOCOM 1A mission in October of 2018.

Following stage separation, SpaceX landed Falcon 9's first stage on the "Of Course I Still Love You" droneship, which was stationed in the Atlantic Ocean.

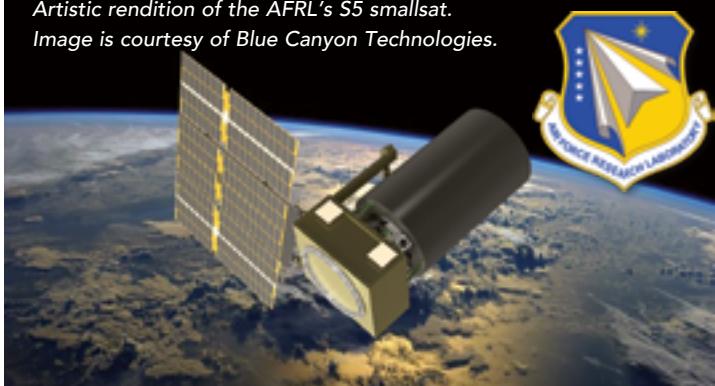
A replay of this important launch may be viewed at:  
[youtu.be/XS0E35aYJcU](https://youtu.be/XS0E35aYJcU)

The **Nusantara Satu** satellite was built by **SSL** using the company's nexgen electric propulsion system for **PT Pasifik Satelit Nusantara** — PSN — a provider of SATCOM telecom services in Asia.

The C- and Ku-band transponders aboard this satellite will be used for voice, data and video distribution throughout Indonesia.

The U.S. Air Force's Air Force Research Laboratory (AFRL) brought

*Artistic rendition of the AFRL's S5 smallsat.  
Image is courtesy of Blue Canyon Technologies.*



kilometers above Earth's surface, and started, under its own power, a two-month voyage to the Moon's surface.

The engineers at the Spacell and IAI control room conducted numerous on-orbit tests and identified high sensitivity to blinding by the sun's rays in the star trackers and that issue is being thoroughly checked.

The spacecraft conducted its first maneuver around Earth two days after the launch.



The Beresheet spacecraft in the clean room during its construction.  
Photo is courtesy of Alan Polo.

The spacecraft successfully disengaged from the SpaceX Falcon 9 at around 60,000

*Morris Kahn*, President of Spacell, said the successful launch positions Israel on the map. History has been made. The company looks forward to an amazing seven week journey that will mark yet another historic even and the company thanks the amazing teams of Spacell and IAI. Israel is now on the space map.

[www.spacex.com](http://www.spacex.com)

[www.spaceil.com](http://www.spaceil.com)

[www.wpafb.af.mil/afrl/](http://www.wpafb.af.mil/afrl/)

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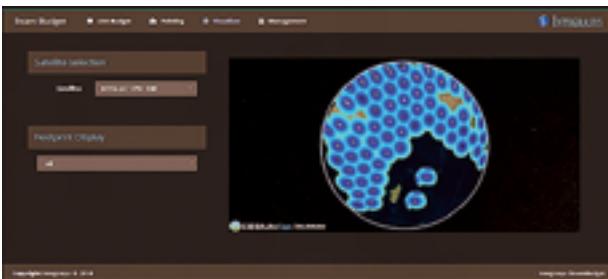
[bluecanyontech.com](http://bluecanyontech.com)



*Artistic rendition of the Nusantara Satu satellite, manufactured by SSL.*

# InfoBeam

## Beam Budget tools debuts from Integrasys



**Integrasys has launched the firm's new, easy-to-use, link budget tool — Beam Budget.**

Beam Budget drastically reduces the complexity surrounding link budget calculations and makes it simple for anyone to perform link budget calculations, which are a vital way of accounting for gains and losses on any given satellite link.

The results are displayed in an easy-to-understand format and can be exported as Excel and .pdf reports as required and customized with the user logo and information.

Beam Budget is a highly accurate link budget tool and is able to provide more than 75 results from 25 inputs, where most tools require at least 50 such inputs.

This offering covers every modulation and is available for any frequency band. A web-based tool that can be accessed anywhere, it can be easily scaled for unlimited users, networks, and satellites.

Beam Budget can be used by satellite operators when establishing new satellite networks or quoting for new business. At the same time, it can be used by satellite customers, giving them the peace of mind knowing that the service quoted will be the correct choice.

This tool minimizes time and effort while maximizing return on investment, thanks to new sales generated by a much simpler quoting system.

Alvaro Sanchez, CEO, Integrasys, said that processing and reviewing link budget calculations is extremely complex and requires expert knowledge. This tool is democratizing link budget, making it accessible for anyone within the organization, as well as making it

easy for stakeholders to understand the results. This ultimately helps the firm's customers to be efficient and to maximize return on investment and materializing new business with users not in the satellite arena.

**[www.integrasys-sa.com](http://www.integrasys-sa.com)**

# InfoBeam

Comtech expands X/Y antenna product family to the LEO/MEO and HAPS markets

**Comtech Command and Control Technologies has introduced a new line of transportable, full motion antennas for tracking Low Earth Orbit (LEO), Medium Earth Orbit (MEO) satellites and High Altitude Pseudo-Satellites (HAPS).**

The **Micro Deployable X/Y Tracking Antennas** use the same two-axis pedestal technology and control software used on Comtech's larger X/Y systems, thereby eliminating the keyhole at zenith, cable wrap, and backlash problems found on traditional El/Az tracking antennas.

These advantages of the X/Y design are now offered in small and lightweight packages.

This cost effective, full hemispheric coverage solution set can be transported on a commercial airliner and can be assembled for operation by one individual in less than 30 minutes — without the need for any special equipment.

The Micro Deployable X/Y Tracking Antennas come in three sizes:

- Series A that can hold 30 to 60cm reflectors
- Series B that can hold 80 to 1.2m reflectors
- Series C that can hold 1.4 to 1.6m reflectors.

Comtech offers the antenna systems in single and multi-band frequencies from L-band to Q-band.

The antenna includes a GPS system that provides precision time and terminal position, and pointing accuracy is better than 0.1 degree.

With a flexible system configuration, low power consumption and high reliability, the Micro Deployable X/Y Tracking Antennas include

Ethernet (TCP/IP) remote control for monitoring and control based on a Linux operating system.

Additional features include a TLE-based program track satellite scheduler and precision carbon composites reflectors.

This system does not require several range tracking stations in the significant maintenance. South Pacific.

The introduction of the Micro Deployable X/Y Terminals caps a successful year of market expansion for the industry's most extensive and mature line of X/Y antenna systems, as well as a full range of high wind rated radomes.

Over the past 16 years, SCT added an extensive line of LEO/MEO X/Y tracking antennas for the industry. Using the concept of product families and platform-based product development to increase variety, shorten lead-times, and reduce costs without compromising system performance, Comtech is able to offer a product range with generic 'family' features from 30 cm to 13 meter apertures, to include

**Comtech Command and Control Technologies** of a range of deployable, trailer mounted, or fixed systems. Annapolis, Maryland, is a wholly owned subsidiary of **Comtech Telecommunications Corporation** of Melville, New York.



[www.comtech-cct.com](http://www.comtech-cct.com)



# InfoBeam

Updated Airbus geospatial tool now available

**Airbus Defence and Space has released a new version of The OneAtlas Platform, the company's collaborative environment to easily access premium imagery, perform large-scale image processing, extract industry-specific insights and benefit from Airbus assets for solution development.**

The OneAtlas Platform provides access to data within the Living Library as well as value-added layers, Basemap and WorldDEM. The Living Library contains multi-resolution and premium optical satellite data, updated on a daily basis and immediately available via streaming, download and API.

Basemap is a curated global imagery layer, updated annually and created from 1.5 and 0.5 meter resolution imagery. WorldDEM dataset, for 3D analytics and rendering, is available in streaming format.

The OneAtlas Platform also combines premium imagery and industry-leading expertise to deliver Thematic Services.

There are new change detection capabilities that allow for monitoring and analysis using machine learning to automatically detect and identify infrastructure changes.

Ocean Finder, for maritime-focused applications, allows users to directly order satellite-based maritime detection and identification reports.

Additional Thematic Services include those to help serve environmental needs: Starling, that supports companies monitor their forest impact with unprecedented accuracy and Verde, a new API service that delivers detailed crop analytics with easy-to-use vegetation maps.

OneAtlas is available now at [oneatlas.airbus.com](http://oneatlas.airbus.com) and will be soon accessible by mobile app — a free, 30 day trial of OneAtlas is available.

*Francois Lombard*, Head of the Intelligence Business at Airbus Defence and Space, said the OneAtlas Platform is the cornerstone of disseminating the company's imagery and services and provides immediate access to data and analytics and gets it into the hands of many more users and partners to create new business opportunities.

The OneAtlas Platform is a cutting-edge tool for the geospatial community.

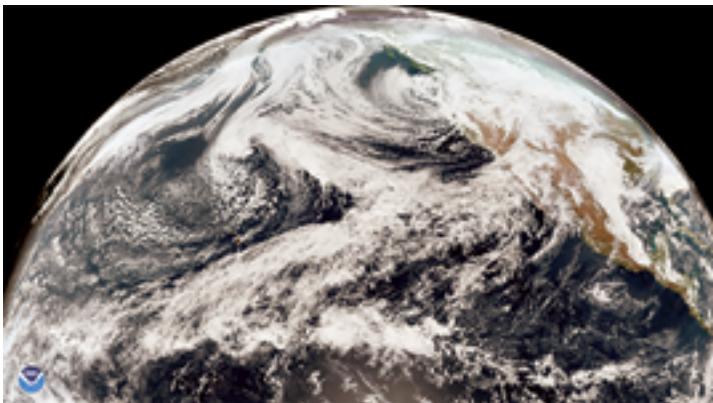


[www.airbus.com/space.html](http://www.airbus.com/space.html)



# InfoBeam

GOES-17 now operational to serve as NOAA's primary Pacific weather satellite



GOES-17 GeoColor view of the Northern Hemisphere, acquired on February 9, 2019. Image is courtesy of NOAA.

**GOES-17 is operational as NOAA's GOES West satellite — the satellite will serve as NOAA's primary geostationary satellite for detecting and monitoring Pacific storm systems, fog, wildfires, and other weather phenomena that affect the western United States, Alaska, and Hawaii.**

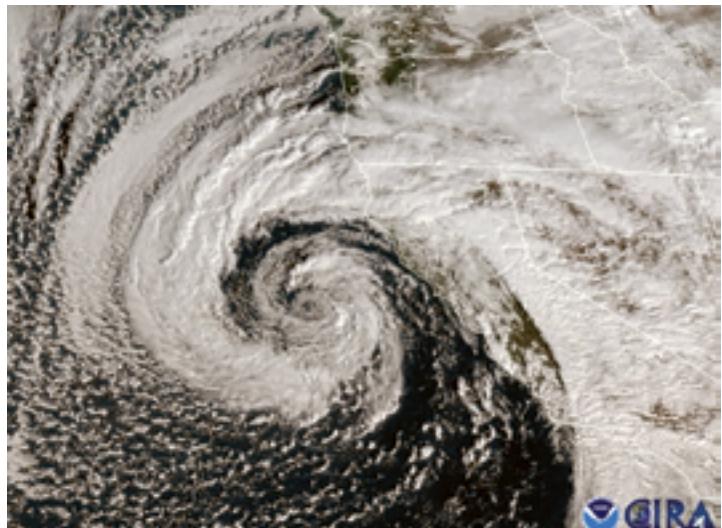
The latest milestone for GOES-17 comes exactly 11 months after the satellite first reached its geostationary orbit 22,000 above Earth.

Launched March 1, 2018, GOES-17 is NOAA's second advanced geostationary weather satellite

and the sister satellite to GOES-16 (also known as GOES East). Together, the two satellites provide high-resolution visible and infrared imagery as well as lightning observations of more than half the globe — from the west coast of Africa to New Zealand and from near the Arctic Circle to the Antarctic Circle.

GOES-17 has already been helping forecasters track the weather and other environmental hazards in places such as California, Alaska and Hawaii.

The satellite began transmitting its first images from its new orbital position in November of 2018.



GOES-17 watches a storm nearing California on February 2, 2019. Image is courtesy of NOAA.

Since then, forecasters have been using GOES-17 data to see weather forming over the northeastern Pacific Ocean, where many weather systems that affect the continental U.S. first form.

Until recently, high-quality data coverage of the Pacific Ocean was sparse. Now that GOES-17 data is available, forecasters have access to more detailed views of high-impact weather systems and other environmental hazards such as wildfire smoke and volcanic ash.

For example, GOES-17 helps forecasters predict the intensity and impact of Pacific storms that hit the West Coast. These include atmospheric river events that bring heavy rain and high-elevation snow to California and the Pacific Northwest, especially during the winter months.

In Hawaii and the central Pacific Ocean, GOES-17's high-resolution visible and infrared imagery will improve hurricane forecasts and allow meteorologists to better predict areas of intense rainfall. In 2018, Hawaii set a new national rainfall record when 49.69 inches of rain fell in 24 hours. The state also faced several tropical weather threats in what became an active hurricane season in the Central and Eastern Pacific.

Forecasters in Hawaii and other remote territories like the Marshall Islands and American Samoa are also now able to track thunderstorms in real-time.

The Geostationary Lightning Mapper (GLM) on-board GOES-17 helps forecasters determine when thunderstorms and convective weather events are intensifying or becoming more dangerous. In 2018, the National Weather Service began using GLM data to issue severe thunderstorm warnings and keep the public out of harm's way.

Among the benefits of GOES-17's high-resolution and rapid-scan capability is the satellite's ability to detect wildfires and monitor smoke coverage in near real-time.

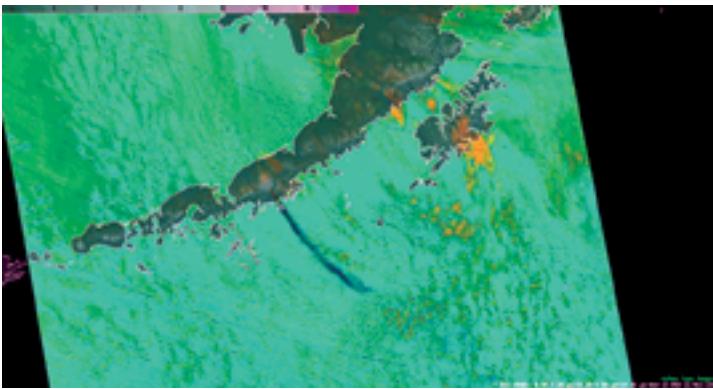
The dry climate of the western U.S. makes the region especially vulnerable to wildfires. In 2018, for example, California faced one of its deadliest and most destructive wildfire seasons on record. Providing high-definition images as often as every minute, GOES-17 helps forecasters distribute critical information to firefighters and emergency managers that saves lives.

Additionally, real-time imagery of smoke plumes from fires also improves air quality forecasts.



Map showing the geographical coverage of the GOES East and West satellites. Image is courtesy of NOAA.





A screenshot capture of a GOES-17 loop from November 21, 2018, of sulfur dioxide concentrations that allowed forecasters to track volcanic ash from the eruption of Alaska's Veniaminof Volcano. The ash clearly stands out even when other clouds are nearby.

Image is courtesy of NOAA.

GOES-17 has been especially valuable to Alaska, where NOAA's older geostationary satellites provided far less coverage.

The state's vast territory and sparse population mean that Earth-based observations from radar, aircraft and buoys, are limited. The satellite's combinable image channels (known as "multi-spectral imagery") help forecasters distinguish between clouds, snow-covered ground and sea ice around Alaska's coasts.

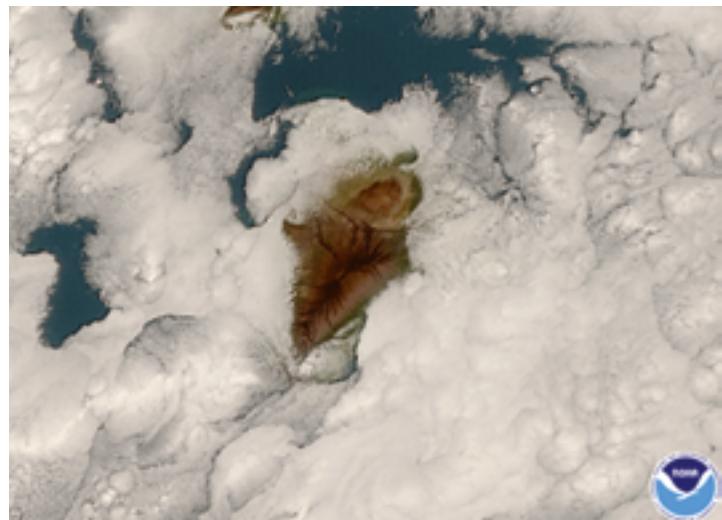
These advanced imaging capabilities mean safer, more accurate aviation and shipping forecasts, especially during Alaska's long, dark winter months,

when visible satellite imagery is less useful.

Fog and icy conditions often cause flight delays and impact airport operations.

At Ted Stevens International Airport in Anchorage, fog occurs almost daily during winter. The airport is the second-busiest cargo airport in the U.S. and fourth-busiest in the world, which makes understanding the timing of fog and low clouds especially important.

Just as GOES-16 data helped airlines mitigate flight delays at San Francisco International Airport in early 2017, GOES-17 data will help forecasters to predict when



GOES-17 watches clouds form around Hawaii's Big Island on January 15, 2019. Image is courtesy of NOAA.

fog will form and clear with much greater accuracy.

Among GOES-17's many benefits to Alaska is the satellite's ability to track volcanic ash clouds.

Data from GOES-17 makes it easier to determine the site of an eruption, as well as the height and direction in which an ash cloud is moving.

Forecasters share this information with other agencies, such as the Alaska Aviation Weather Unit and the U.S. Geological Survey's Alaska Volcano Observatory to issue volcanic ash advisories and other warnings to keep air travel safe.

Now that the satellite is operational, GOES-17 replaces GOES-15 as NOAA's GOES West satellite. The latter entered service in December of 2011.

However, due to technical issues with GOES-17's Advanced Baseline Imager — or ABI, the satellite's main instrument — GOES-15 and GOES-17 will operate in unison until early July 2019.

The overlap will allow scientists and engineers to make sure that GOES-17 is performing adequately before the older GOES-15 satellite gets placed in storage as a backup.

According to Dr. Stephen Volz, the Director, NOAA's Satellite and Information Service, the GOES-17 ABI is now projected to deliver more than 97 percent of the data it was designed to provide.

Michael Ottenweller, a National Weather Service forecaster at the Anchorage, Alaska field office, said that in his nearly six years forecasting here, he has never seen a product revolutionize the ability to forecast the way GOES-17 has — the advent of GOES over this domain makes forecasting tangibly easier and better. Now, not only is there reliable data, but that data can be looped. This changes everything. The GOES constellation will continue to meet the needs of forecasters across the country.



Artistic rendition of NOAA's GOES-17 satellite.

[www.noaa.gov](http://www.noaa.gov)

# InfoBeam

*Strategic relationship initiated between BridgeSat and Es'hailSat*

**Es'hailSat Qatar Satellite Company and BridgeSat have joined together with a strategic relationship that will provide businesses and governments across the Middle East with affordable access to laser-based satellite broadband services.**

This is the latest milestone toward BridgeSat's goal of providing organizations worldwide with a faster, less expensive and most secure alternative to traditional radio frequency (RF) solutions for LEO and GEO applications.

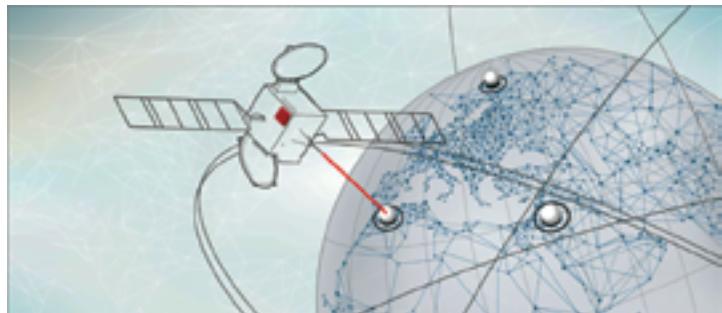
BridgeSat owns and operates a growing global network of optical ground stations (OGS) and complimentary satellite terminals that provide high-bandwidth, high-security solutions for unique applications while complementing RF in hybrid networks.

Es'hailSat owns and operates a growing number of Ka- and Ku-band satellites that serve broadcasters, businesses and governments in the MENA region and beyond.

Under this strategic relationship, BridgeSat will build their first OGS for the Middle East, which will be co-located at Es'hailSat's new satellite operations center in Doha, Qatar.

The new OGS will support LEO and other satellite systems owned by Es'hailSat and other companies that are equipped with BridgeSat and other compatible space terminals.

*Barry Matsumori*, BridgeSat CEO, said this new relationship with Es'hailSat gives the company a critical gateway to the MENA region and is a major milestone toward the firm's goal of providing organizations worldwide with



fast, secure, enterprise-grade broadband services.

*Ali Al Kuwari*, President and CEO of Es'hailSat, noted that the Es'hail-1 and Es'hail-2 satellites are fully operational and the company recently commenced satellite control and other satellite services from the firm's state-of-the art teleport in Doha.

He added that collaboration with BridgeSat is step forward for the company in expanding the type of services provided to customers in the region, beyond the traditional satellite services.

**[www.bridgesatinc.com](http://www.bridgesatinc.com)**

**[www.eshailsat.qa](http://www.eshailsat.qa)**

# InfoBeam

## Newtec collaborating with Wind River for development of 5G solutions

**Newtec is collaborating with Wind River to use the Wind River Titanium Cloud virtualization platform to develop a Newtec 5G solution based on the Newtec Dialog® multi-service platform.**

3GPP has defined a service-based architecture where flexibility and dynamic adjustments are the key drivers to meet performance and cost requirements. This architecture defines network functions which can be triggered by other services, leveraging virtualization and network slicing.

Wind River's complete Network Functions Virtualization (NFV) software platform infrastructure will help Newtec Dialog leapfrog these 5G requirements. The Titanium Cloud platform delivers the features needed to successfully build and deploy a virtualized network running multiple Virtual Machines.



Newtec has signed a joint statement with the European Space Agency (ESA) and a number of industrial companies to carry out trials to demonstrate the use of satellite communications capabilities integrated and interoperable in the 5G environment, achieve interoperability of networks and demonstrate the functionality, performance and benefits brought by the use of satellite.

A first phase is leveraging existing space and ground segment assets and trialling the latest developments, including with newer LEO and MEO constellations.

Bart Van Poucke, VP Product Management at Newtec, said NFV promises lower-cost, highly flexible and scalable infrastructure, as well as providing customers with the ability to get better service access anywhere in the world. The combination of Newtec Dialog with Wind River's Titanium Cloud platform will enable the firm's customers and service providers to scale services up or down quickly to address changing needs. It also simplifies the architecture and enhances scalability, which is paramount for 5G.

Paul Senyshyn, VP of Telecommunications at Wind River, added the company is delighted that Newtec has selected the Wind River Titanium Cloud platform for use in their new, 5G satellite infrastructure solution. Titanium Cloud delivers the high

service reliability, ultra-low latency and low-cost deployments that are critical for scalable satellite communications infrastructure.

Semir Hassanaly, Market Director Mobile Backhaul at Newtec, noted that a number of use-cases for 5G over satellite require close interworking with terrestrial mobile networks where NFV/SDN technologies are becoming key and satellite architecture must leverage network orchestration, virtualization and slicing functions to offer a truly seamless connectivity service. The integration of Wind River's Titanium Cloud platform is an additional step Newtec is making toward 5G. The same architecture principles will be also leveraged in Newtec's terminals in the near future, paving the way for a 5G solution addressing Mobile Backhaul, OTT Broadcast, Broadband and Mobility markets.

[www.newtec.eu](http://www.newtec.eu)

[www.windriver.com](http://www.windriver.com)

## Virgin Galactic's SpaceShipTwo Accesses Space

**Virgin Galactic conducted their fifth powered test flight and second space flight of its commercial SpaceShipTwo, VSS Unity.**

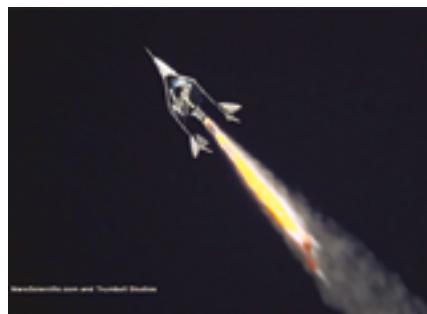
In this powered test flight, Virgin Galactic reached space for the second time in the skies above Mojave, California. Spaceship VSS Unity reached its highest speed and altitude to date and, for the first time, carried a third crew member on board along with research payloads from the **NASA Flight Opportunities** program.

This space flight means Chief Pilot Dave Mackay and co-pilot Michael "Sooch" Masucci become commercial astronauts and the 569th and 570th humans in space. Beth Moses, Virgin Galactic's Chief Astronaut Instructor, flew as the third crew

member in a first, live evaluation of cabin dynamics. She is the 571st person to fly to space and the first woman to fly on board a commercial spaceship.

VSS Unity flew higher and faster than ever before, as its world record-holding hybrid rocket motor propelled the spaceship at Mach 3.04 to an apogee of 295,007ft. The glide back home was followed by a smooth runway landing.

This flight notched several additional firsts for the industry: The flight was the first time that a non-pilot flew on board a commercial spaceship to space, and it was the first time that a crew member floated freely without restraints in weightlessness in space onboard a commercial spaceship; it was the first time



which exceeded all our expectations. I am incredibly proud of my crew and of the amazing teams at Virgin Galactic and The Spaceship Company for providing a vehicle and an operation which means we can fly confidently and safely."

that three people flew to space on a commercial spaceship, and Dave Mackay became the first Scottish-born astronaut (Brian Binnie, who was raised in Scotland, flew to space in 2004).

Dave said, "Beth, Sooch and I just enjoyed a pretty amazing flight which was beyond anything any of us has ever experienced. It was thrilling yet smooth and nicely controlled throughout with a view at the top, of the Earth from space,

Sir Richard Branson added, "Flying the same vehicle safely to space and back twice in a little over two months, while at the same time expanding the flight envelope, is testament to the unique capability we have built up within the Virgin Galactic and The Spaceship Company organizations. I am immensely proud of everyone involved."

[www.virgingalactic.com](http://www.virgingalactic.com)



# InfoBeam

Senior leaders from SpaceX and Virgin Orbit join the Relativity Space executive team

**Relativity has appointed three aerospace veterans to the company's executive team and has received an industry-leading, new, patent grant for their autonomous 3D printing technology.**

The company has now hired 12 former senior leaders from SpaceX, Blue Origin, Virgin Orbit, Aerojet Rocketdyne, Waymo, Zoox, and Tesla, and has also secured a key patent for 3D printing metal using machine learning.

*Tim Buzza, recognized as one of the world's foremost experts in rocket development, as well as among the first*



leaders and a 12 year at SpaceX, as well as the former Co-President and Vice President of Launch at Virgin Orbit, officially joins Relativity as Distinguished Engineer after serving as an Advisor to the company.

*Josh Brost, a nine year veteran at SpaceX responsible for securing \$3 billion in contracts with the U.S. Government and commercial entities, joins as VP, Government Business Development.*



*David Giger, a 13 year SpaceX veteran who directed engineering, program, and leadership responsibilities for more than 200 engineers in the design, testing and build of the multi-billion dollar Cargo Dragon and Crew Dragon spacecraft programs, joins as VP, Launch*



*Relativity's Stargate, the largest metal 3D printer in the world — Built for rockets.*

*Photo is courtesy of the company.*

Vehicle Development for Relativity's Terran 1 rocket.

Relativity was recently granted US Patent Number US20180341248A1, Real-time adaptive control of additive manufacturing processes using machine learning, for the company's groundbreaking 3D metal printing technology using advanced sensors and control software.

Disrupting 50 years of aerospace technology, Relativity is the first and only aerospace factory to use a proprietary and patented autonomous 3D printing technology, machine learning and software to optimize every aspect of the rocket manufacturing process.

Relativity's Stargate, the largest metal 3D printer in the world — Built for rockets. Photo is courtesy of the company.

Relativity can print their next-generation Terran 1 rocket in less than 60 days, while traditional rockets require 18 months or more to complete.

Terran 1 is the world's first completely 3D printed rocket, with 100x fewer parts than traditional rockets, vastly better manufacturing reliability, rapid build time, and faster time to launch.

Relativity is on track to conduct their first full orbital launch by the end of 2020 and continues to grow a global customer manifest of commercial and government payloads.

The company recently became the first venture-backed company to secure a launch site Right of Entry at Cape Canaveral from the U.S. Air Force, adding to the firm's portfolio of major government partnerships, including a 20 year, exclusive-use, CSLA agreement at the NASA Stennis Space Center E4 test complex as well as a NASA ACO test award.

The company is expanding its infrastructure this year with a fourfold expansion to more than 240,000 square feet of operations, production, testing, and launch facilities.

Relativity's team has grown almost 5x since March, from 14 to 64 full time employees in under a year.

*Tim Ellis, the CEO of Relativity, said the company's progress toward launching the first 3D printed rocket is fueled by a deeply experienced team that has built and scaled other space companies — Tim, Josh, and David are renowned leaders in their fields. These executive appointments, combined with the company's recent patent grant, are great indicators of Relativity's market momentum.*

*Jordan Noone, the CTO of Relativity, added that the grant of this patent is a recognition of how the company's autonomous 3D metal printing technology can quickly and iteratively optimize rocket production on Earth and other planets and is a pivotal step toward our technology differentiation and leadership in the market.*

[www.relativityspace.com](http://www.relativityspace.com)



# InfoBeam

SSTL's RemoveDEBRIS satellite capture mission is a success

## A successful capture was completed by the SSTL-developed RemoveDEBRIS satellite.

The harpoon was fired at a speed of 20 meters per second and penetrated a target made of satellite panel material.

The harpoon and 1.5 meter target boom were designed by a team at Airbus in Stevenage, UK.

The photo below shows the harpoon target bottom left, with the onboard camera to the right. The spherical structure in the center with the white cover is the net housing.

The success of the harpoon firing marks the third successful experiment for the RemoveDEBRIS project which has already demonstrated a net capture experiment and trialed its state-of-the-art LiDAR based vision

navigation system to identify a target cubesat.

The RemoveDEBRIS satellite platform was designed and manufactured by SSTL to house two target cubesats and four debris removal technologies — a net, a harpoon, vision based navigation using cameras and LiDaR, and a de-orbit dragsail. The spacecraft is operated in orbit by SSTL's engineers from the company's Spacecraft Operations Centre in Guildford, UK.

The RemoveDEBRIS team is now preparing for the final experiment, which is scheduled to take place in March and will witness the RemoveDEBRIS spacecraft inflate a sail that will drag the satellite into Earth's atmosphere for destruction.

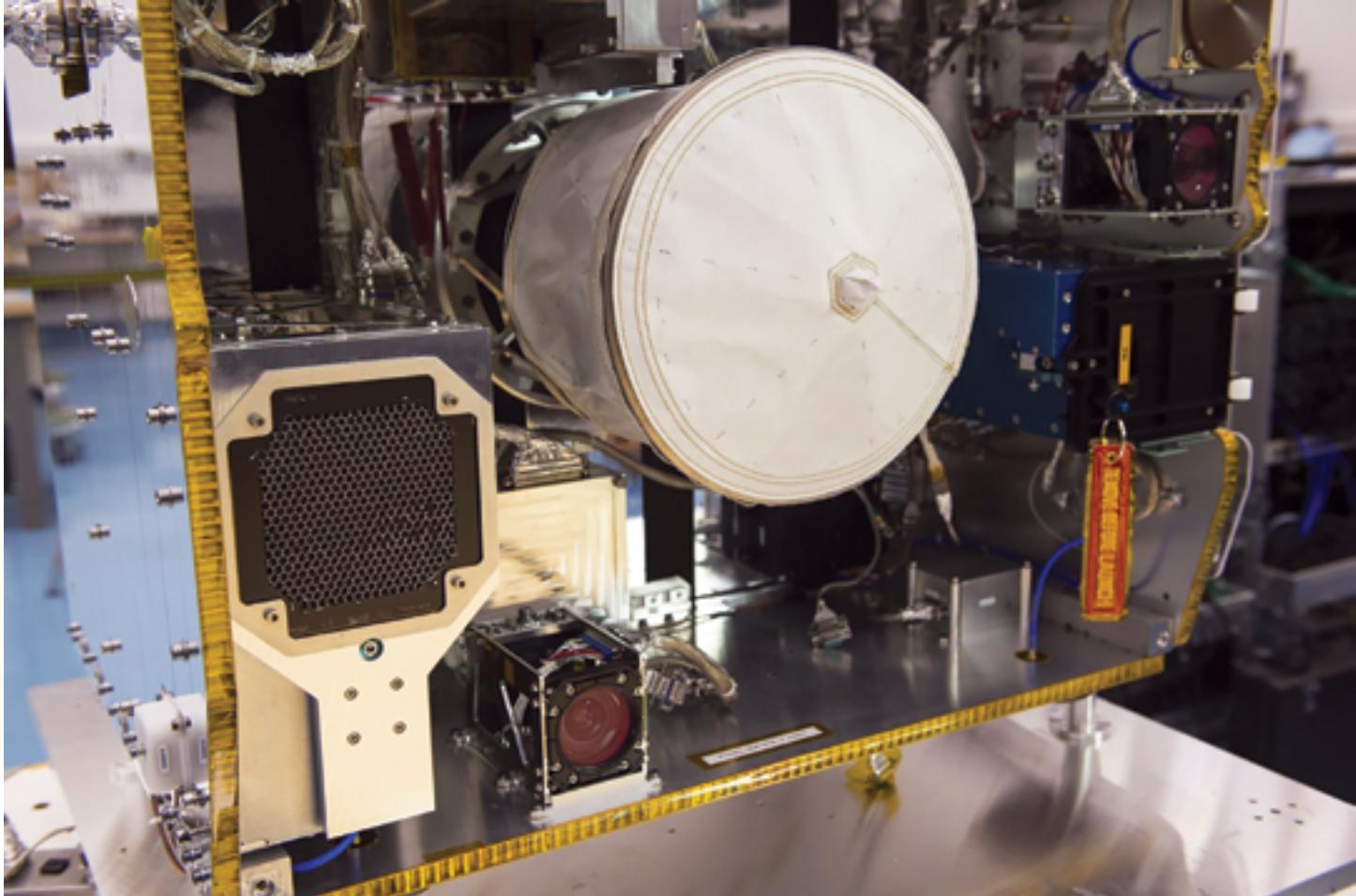
A video produced by SSL is available for viewing at [https://youtu.be/\\_uPw9KP4li0?t=7](https://youtu.be/_uPw9KP4li0?t=7)

The U.S. Space Surveillance Network tracks 40,000 objects and the estimate is that there are more than 7,600 tons 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. The RemoveDEBRIS consortium is:

- Mission and consortium coordination – Surrey Space Centre (UK)
- Satellite system engineering – ArianeGroup (France)
- Platform, avionics and spacecraft operations – SSTL (UK)
- Harpoon – Airbus (UK)
- Net – Airbus (Germany)
- Vision based navigation – CSEM (Switzerland)/ INRIA/ Airbus (France)
- CubeSat dispensers – Innovative Solutions in Space (Netherlands)

- Target CubeSats – Surrey Space Centre (UK)/ Stellenbosch University (South Africa)
- Dragsail – Surrey Space Centre (UK)

The RemoveDEBRIS project is co-funded by the European Commission and the research leading to the results has received funding from the European Union Seventh Framework Program (FP7/2007-2013) under grant agreement n°607099.



# InfoBeam

## Hellas Sat-4 climbs to orbit

**The Hellas Sat 4 satellite was successfully launched by an Ariane 5 launch vehicle from the Guiana Space Center in Kourou, French Guiana, in early February for Hellas Sat.**

**Hellas Sat 4** is a Ku-band satellite positioned at 39 degrees East to provide coverage over Europe, the Middle East and the Southern Africa.

The satellite is expected to commence service in the third quarter of 2019.

The new satellite will extend Hellas Sat's capacity and geographical reach to meet the growing demand for applications that include video, maritime connectivity, cellular backhaul, corporate networks and government services.

Hellas Sat 4 will also serve as a backup to Hellas Sat 3 satellite, which is located at the same orbital slot and was launched in 2017.

Christodoulos Protopapas, CEO of Hellas Sat, said that the Hellas Sat 4 is a powerful addition to the company's network and a major milestone to the firm's business plan. The satellite brings new capacity that will enable our existing and new customers to unlock new growth opportunities in applications including broadcasting, mobility and private data networks.



*The Hellas Sat-4 payload launch by Arianespace.*

Protopapas continued that, moreover, it will enable the company to deliver high quality services at competitive prices as well as unmatched performance, resiliency and redundancy to customers.

Hellas Sat is a subsidiary of **Arabsat**.

**[www.hellas-sat.net](http://www.hellas-sat.net)**

**[www.arabsat.com](http://www.arabsat.com)**

**[www.arianespace.com](http://www.arianespace.com)**

# InfoBeam

Spaceflight reviews their SSO-A mission success



The SpaceX Falcon 9 launch of the Spaceflight SSO-A mission.

**December 3, 2018 was an historic day for Spaceflight and SpaceX — the company**

**successfully launched 64 customer spacecraft to orbit and SpaceX flew a rocket for**



## **the third time and landed the booster successfully on a barge in the Pacific Ocean.**

The launch was picture perfect, with the Falcon 9 ascending to space against the back drop of a cloudless California sky.

Ten minutes after liftoff, the Falcon began its six deployments; four Spaceflight customer spacecraft and two Spaceflight satellite carriers.

These carriers began their deployment sequences an hour and a half later and continued over the course of about three hours.

Several of the company's customers contacted their spacecraft before the first telemetry signal was received, which confirmed their separation and as the day wore on, customers reported contact with their spacecraft.

The most common question that the company has received since launch has been "How did it go?"

The short answer is 100 percent mission success since the system did all it was designed to accomplish.

The next question received is "How are the customers doing?"

Overall, they seem to be doing extremely well.

One customer was not deployed, as expected, because their payload was sealed inside their dispenser when they could not demonstrate adequate licensing.

The company strongly suspects that a second spacecraft did not fully deploy from their customer-provided dispenser, which is still under investigation.

Currently, all but six spacecraft have been contacted by their owners and the hope is that the organizations continue to work to contact their spacecraft and will have success in the next few days as all objects are positively identified and labeled by the Combined Space Operations Center (CSpOC) established at Vandenberg Air Force Base.

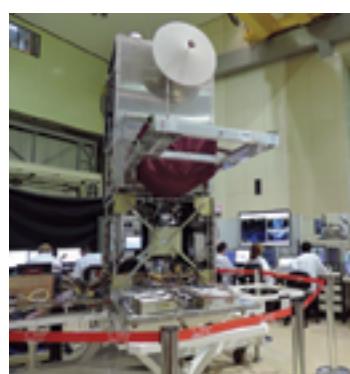
This mission is the culmination of three years of work by the talented engineers at Spaceflight to enable access to space for more than 35 organizations in 17 countries around the world.

Although the firm's work on this record-setting mission is complete, the customers' work has just begun as they continue their early orbit operations and initiate the transition to operational status.

Spaceflight has more customers to launch, with the first commercial lunar lander mission in a couple of months plus a new contract to launch Brazil's first indigenous spacecraft, Amazonia-1, pictured to the left.



[spaceflight.com/](http://spaceflight.com/)





# InfoBeam

New transmission gateway established between PSSI Global Services and Sydney Teleport Services

**PSSI Global Services and Sydney Teleport Services (STS) have collaborated to establish a gateway between PSSI International Teleport (PIT) in Pittsburgh, Pennsylvania, and the STS teleport in Sydney, Australia — this connection expands both companies' broadcast footprints to cover the U.S., Europe and Asia-Pacific regions.**

This new bidirectional connection means PSSI Global Services customers now have unique access to Asia-Pacific satellite fleets as well as STS's expansive fiber network, which reaches from the U.S. to Australia and the U.K.

Meanwhile, STS customers gain access to PIT's 50-plus antennas that

support transmissions throughout the Americas and the production services at the PSSI Pittsburgh Videotech Center.

The gateway between the two teleports leverages PIT's dual 10 Gbps AT&T Global Video Services connectivity.

This high-capacity fiber network connects PIT to STS's point of presence (POP) in Los Angeles, California — and Nimbra units at both ends allow for fully programmable ASI and data connections.

PSSI Global Services and STS deployed the gateway in time to provide successful transmission services for the UFC 234 pay-per-view on February 10. The broadcast

originated in Melbourne, Australia, and several pathways were carried between PIT and STS for distribution to international viewers.

Jason Land, VP of PSSI Global Services' Strategic Television division, said that partnering with top-tier service providers like STS allows PSSI Global Services to deliver even more seamless, efficient, cost-effective solutions for our ever-growing global client base.

This new connectivity gives the company the ability to offer clients instant, scalable solutions for international distribution.

Scott Jenkins, MD at STS, noted that with this new circuit, the company is able to offer clients a breadth of exciting broadcasting options that weren't possible before — STS is proud to be partnering with a trusted industry leader such as PSSI Global Services.



[www.pssiglobal.com](http://www.pssiglobal.com)

[www.sydneyteleport.com.au](http://www.sydneyteleport.com.au)





# InfoBeam

Blue Origin's New Shepard rocket successfully launches... and returns

**Blue Origin's New Shepard reusable launch system was launched and landed at Blue Origin's West Texas Launch Site, on January 23, 2019, at 15:05 UTC (09:05 CST).**

This was the fourth mission, launch and landing, for this New Shepard launch vehicle. For Blue Origin's mission NS-10, the New Shepard Crew Capsule 2.0 transported nine NASA-sponsored research and technology payloads.

A video of the New Shepard launch is available at [www.youtube.com/watch?v=YUzYCDbDlnc](https://www.youtube.com/watch?v=YUzYCDbDlnc).

Blue Origin supports NASA's Flight Opportunities program and the agency's role in perfecting technology for a future human presence in space.

The NS-10 payloads:

- Carthage College Space Sciences Program: The Modal Propellant Gauging experiment led by Dr. Kevin Crosby is a joint effort with the NASA Kennedy Space Center Cryogenics Laboratory. It demonstrates a way to measure fuel levels in microgravity by using sound waves.
- Controlled Dynamics Inc.: The Vibration Isolation Platform (VIP) aims to separate payloads from the normally occurring vibrations experienced during spaceflight. The payload led by Dr. Scott Green allows researchers to have a clear understanding of microgravity's effects on their research results.
- Johns Hopkins University Applied Physics Lab: On its second flight with Blue, the EM Field experiment will observe and collect data on the naturally occurring electromagnetic fields both inside and outside New Shepard during the launch. Principal Investigator Dr. Todd Smith will use success of this experiment to determine how global measurements of the Earth's electromagnetic field can be conducted in the future.
- NASA Goddard Space Flight Center: Cooling tightly-packed electronics onboard a spacecraft can be challenging, and many solutions have not been able to undergo robust testing. Principal Investigator Franklin Robinson will test one of these solutions in his Flow Boiling in Microgap Coolers experiment.
- Purdue University: Dr. Steven Collicott's payload looks at Zero-Gravity Green Propellant Management Technology, which aims to help advance the use of a safer and more environmentally friendly rocket propellant by better understanding the fuel's behavior in microgravity.
- University of Central Florida: Two teams led by Dr. Josh Colwell and Dr. Addie Dove both have planetary science payloads on NS-10. The Collisions Into Dust Experiment (COLLIDE) aims to understand how dust particles react after surface contact during exploration missions to places such as the Moon, Mars and asteroids. The Collection of Regolith Experiment (CORE) addresses the unique challenge of collecting and analyzing material samples in microgravity.
- University of Florida: Dr. Rob Ferl and Dr. Anna-Lisa Paul are adapting technology designed for the ISS to suborbital uses with their experiment, Validating Telemetric Imaging Hardware for Crew-Assisted and Crew-Autonomous Biological Imaging in Suborbital Applications. By recalibrating the way data is collected, the experiment will enable more biological research on suborbital missions.



The return of the New Shepard rocket.  
Photo is courtesy of Blue Origin.

[www.blueorigin.com](http://www.blueorigin.com)

# InfoBeam

*EgyptSat-A launched from the Baikonur Cosmodrome*

**The EgyptSat-A spacecraft has been launched from Kazakhstan's 'Baikonur Cosmodrome' space port, according to Egypt's National television.**

Egypt's third Earth Observation (EO) satellite was launched via a Soyuz-2-1b/Fregat rocket following the EgyptSat-1 spacecraft that was launched in 2007 and EgyptSat-2 launched in 2014.

According to statement issued by the Cabinet's Information Center, the satellite will be replacing the EgyptSat-2 EO satellite, which failed on-orbit in 2015.

The satellite, which cost approximately \$100 million, weighs more than a ton, fully fueled.

EgyptSat-A incorporated several improvements over the EgyptSat-2 design, including improved solar batteries and a high-speed radio link with ground stations.

EgyptSat-A, which arrived to its designated orbital slot 11 minutes after launching, is expected to serve the environmental and agricultural sectors in Egypt.

Compared to EgyptSat-2, EgyptSat-A incorporates modernized electrical and flight control systems, an improved imaging payload, a higher-throughput communications system and more efficient solar arrays.



EgyptSat-A also benefits from being launched by a more powerful carrier rocket, that allowed the satellite to be placed into SSO that's more suited to Earth imaging than the lower-inclination orbit into which EgyptSat-2 operated.

The EgyptSat-A Earth's remote sensing satellite was developed by the Russian Energia Space Rocket Corporation along with Egypt's National Authority for Remote Sensing and Space Sciences (NARSS).

[www.energia.ru](http://www.energia.ru)

[www.narss.sci.eg](http://www.narss.sci.eg)

# The Forrester Report

8K is launched... but where is the 8K content? Will satellite benefit?

By Chris Forrester, Senior Columnist



**CES in Las Vegas in January was, as usual, chock-full of the latest gadgets and gizmos. Most of the items on show will never see the light of day, but the world's electronics giants were all showing 8K TVs.**

These TVs will be in the retail stores this spring and analysts from **Strategy Analytics** are forecasting that by 2023, some 600 million of us will own a 4K UHD display — by 2023, some 6 percent of the world's UHD-TVs will be able to handle 8K.

These 8K displays offer 16 times as many pixels as an 'ordinary' high-definition TV (7680 x 4320 = 33.2 megapixels). This new technology is cool and highly desirable — provided that 8K prices are manageable.

Those of us (like me) who purchased large panel HD Plasma sets when they were first launched (idiots!) paid small fortunes for the right to possess such units. Then, it was an identical maneuver with 3D TVs (idiot again), when high prices were charged by the manufacturers.

Undoubtedly, some will buy into 8K today (not quite idiots — yet) and will get their hands on super-sleek models that are capable of beautifully upscaling existing 4K material.

The adoption of 8K — other than in Japan and perhaps South Korea — is not currently expected

to be more widespread. Even most Chinese buyers seem content to stick with 4K, although **Statista** states that China will be the largest market for 8K displays.

Most analysts expect some traction with 8K, if only in sports production where the extra pixels make it easier for program directors to zoom into an area of play, much as they did initially with 4K on and around the sports ground. This could represent valuable extra bandwidth demand for the world's major satellite operators.

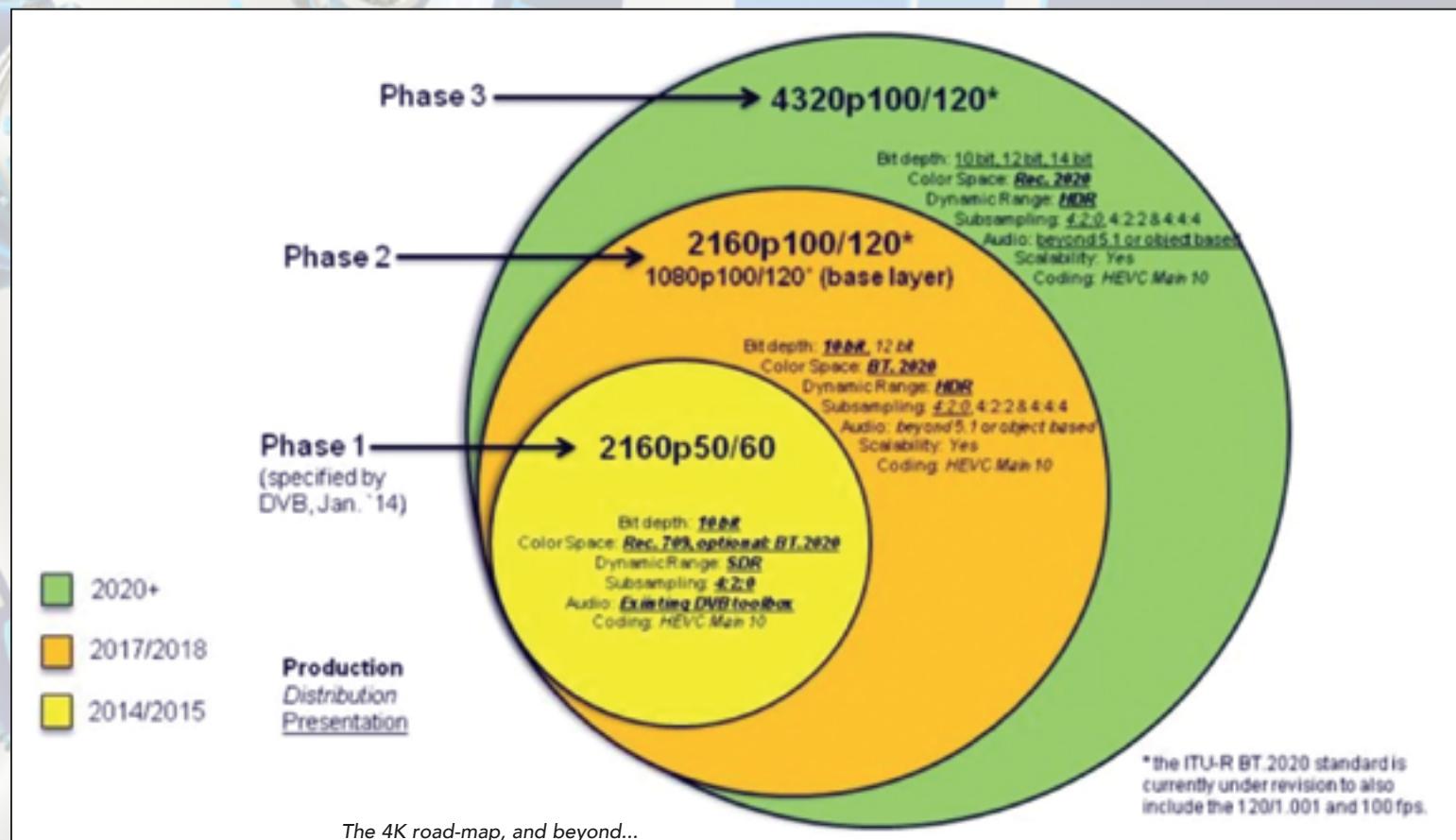
Indeed, drill down into Strategy Analytics numbers and their 6 percent forecast represents about 400,000 8K units to be sold in 2019 and approximately 11 million units sold annually by 2023.

As far as North America is concerned the study reports that 3.9 percent of UHD homes will own an 8K set by 2023 and slightly more in Asia, where 4.1 percent is the expected rate, although only 1.7 percent in Western Europe.

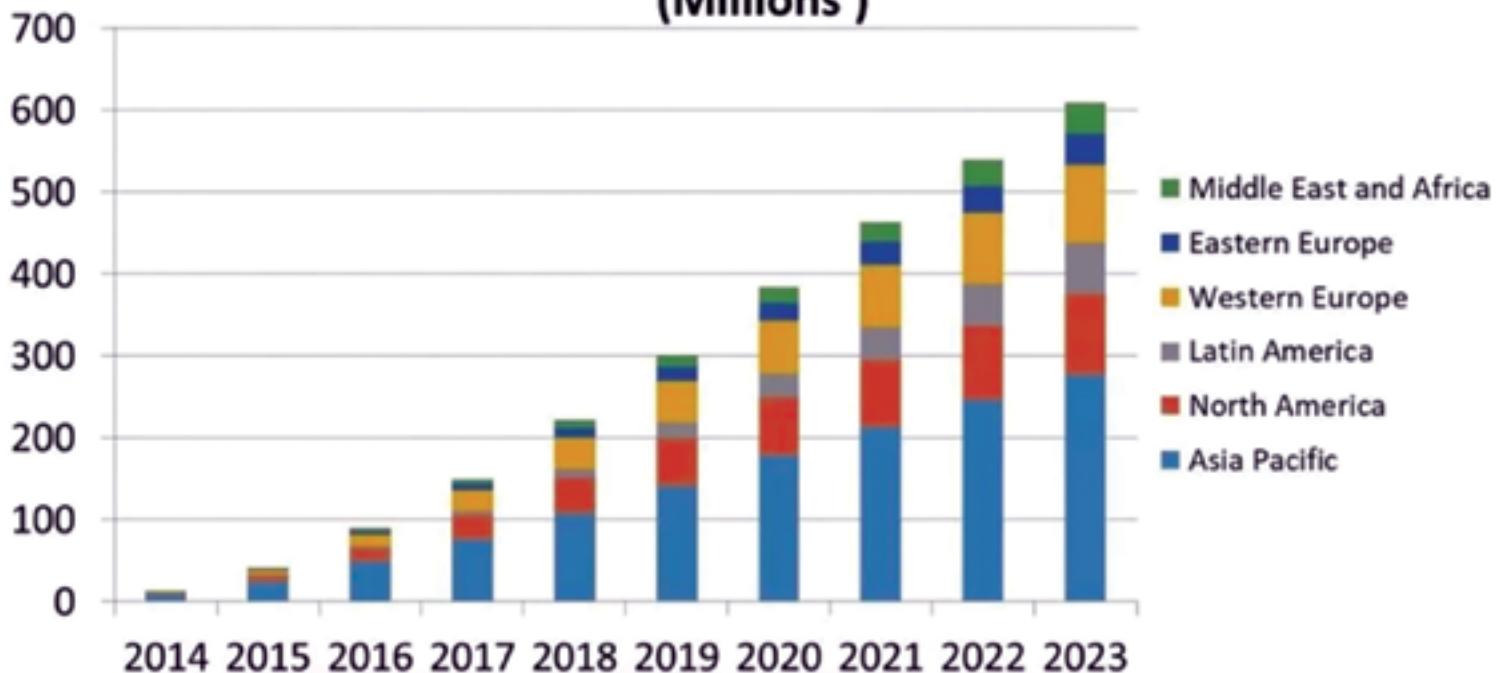
"The success of Ultra HDTV has been driven by technology adoption rather than content and services," says **David Mercer**, Principal Analyst at Strategy Analytics and the report's author.

"4K video and TV services are now becoming more widely available, meeting the expectations of 4K Ultra HDTV owners for the best quality TV experience. But our expectations for 8K services should be cautious: while Japan has now launched 8K TV in preparation for the 2020 Tokyo Olympics, the rest of the world will be slower to follow suit, given that the number of homes with 8K-ready TVs will remain low until the mid-2020s."

"Owners of 8K TVs will primarily be watching 4K and HD content, while the TV's image processors will do a good job of scaling most content to give impressive images," explained **David Watkins**, Director at Strategy Analytics. "Amidst the



## Global Ultra HDTV (4K+8K) Households By Region (Millions)



**Source:** Strategy Analytics' Connected Home Devices service, Dec 2018

excitement surrounding 8K TVs, it is important to remember that image resolution, whether native or otherwise, is only one element in perceived video quality, and TV vendors and content players alike should not lose focus on other important drivers of consumer satisfaction, such as High Dynamic Range (HDR) and High Frame Rate (HFR)."

The data also confirms a dramatic trend in consumer buying habits — ever-larger screens are, indeed, being purchased. For example, although overall UHD TV shipments in Q3/2018 were flat compared to the previous year, the average TV unit-shipment screen size increased more than in any previous quarter in more than a year, according to critical information analysis firm IHS Markit.

While strong seasonality from promotions for the World Cup raised TV unit sales more than 7 percent in the first half of 2018, Western Europe, Latin America, and the MENA region all experienced double-digit TV shipment year-over-year (y-o-y) declines in the third quarter.

Global shipments of 60 inch and larger TV screen sizes increased more than 40 percent, y-o-y in Q3/2018, with even stronger growth in North America and emerging markets as prices fell to new lows for the 65 and 75 inch screen sizes. This growth rate is more than 10 percent higher than in recent quarters, said IHS.

"Each year during the holiday shopping season, **Xiaomi** and other brands have aggressively pushed prices lower as competition intensifies sizes to keep revenues growing and encourage adoption of value-added features like 4K and smart TV," said Paul Gagnon, research and analysis executive director, IHS Markit. "This year, there's higher interest in 65-inch 4K TVs for many of the key promotional deals, leading to less focus on smaller screen sizes under 50 inches."

Growth in larger size TVs leads to a rising share of 4K resolutions as larger sizes have already largely completed the transition from 1080p to 4K. In fact, the share of 4K TV shipments in the third quarter reached a record high of nearly 44 percent. Due to sustained premiums and larger average size, 4K TVs comprised more than 71 percent of all TV revenues during the quarter. 8K TV shipments remain small, said IHS, adding that the company expects additional brands to start shipping 8K TVs by early 2019.

Prices of 65 inch 4K LCD TVs fell to an average of \$1,110 in North America during the third quarter, from \$1,256 in the previous quarter. In China, the average price of 65 inch TVs was even lower — just \$928, after already falling below \$1,000 in the second quarter.

### The Usual Suspects

All the major Japanese and South Korean electronics companies used CES to showcase their latest models, and some are arguing that yesterday's 60 and 65 inch versions are now considered "small" in size and definitely old fashioned. Indeed, some major names are now using 98 inch screens as their flagship models that are more than equal to the screen size of most home projector units.

**Samsung**'s 98 inch class **Q900** was one model, and **LG** and **Panasonic** joined **Sharp** with new models.

**Sony**'s 98 inch **Bravia Master** units will also be bankrupting those of us who are not basketball or football stars, or Russian oligarchs or Arab sheiks. Sony's Bravia (Z9G range) is among the first 8K displays on offer to consumers and features the company's next-generation image processor **X1 Ultimate** equipped with 8K ultra-resolution algorithm custom database, enabling the 8K **X-Reality PRO** to up-convert any content to 8K resolution.



Sony's Z9G 98 inch LED TV at CES.

These Sony displays come with an automatic **Netflix Mode**, not simply for logging into Netflix output but which configure the receiver to the ideal parameters as specified by the creative team on the movie or program being screened.

Sony said, "These TVs are part of the IMAX Enhanced certification program that is the result of collaboration between Sony's engineers together with IMAX, DTS and content creators to faithfully deliver creators' vision and intent."

At CES, prices were not unveiled for these 8K models; however, be prepared to make an application for a second mortgage to fund one of these monster sets.

The Strategy Analytics numbers for set sales seem perfectly reasonable despite there being a shortage of 8K content available for viewing today. Indeed, you might justifiably grumble that there isn't a great deal of 4K content on TV screens.

**Netflix** and **Amazon Studios** do a good job of commissioning 4K UHD programming (*Grace & Frankie*, *The Kominsky Method*, *The Marvelous Mrs Maisel*, etc), and viewing this high-quality output in 4K is spectacular. Sport is produced in 4K by most major broadcasters, while Hollywood's movie output is easily transferred onto digital 4K for TV viewing.

However, 8K material does exist. As mentioned, Japan is already transmitting 12 hours a day of 8K material and is gearing up to the Tokyo Olympic Games in 2020 which will be fully captured in 8K.

Japanese public broadcaster **NHK** started Visitors to MIPtv will see some of NHK's latest 8K 8K broadcasts on December 1, 2018. 'super hi-vision' material, as well as music content Communications Minister **Masatoshi Ishida** said from France's **Paramax Films**, spectacular he hopes Japan will play a leading global role in footage from Italy's **Magnitudo Film**, and the 4K and 8K broadcasting.

USA's **K2 Communications**.

NHK President **Ryoichi Ueda** said the Japanese broadcaster **WOWOW** (which will broadcaster will aim to spread the service by show a locally produced version of '*Cold Case*' delivering exciting experiences for viewers. NHK in 8K) and famed director and cinematographer **Peter Chang (Golden Gate 3D)** will showcase his latest ultra-high resolution output. French factual producer **Saint Thomas Productions** were aloft

The 8K 'Super Hi-Vision' channel kicked off with a newly scanned (in 8K) of *Stanley Kubrick's 2001: A Space Odyssey* and followed it up with 12 hours of 8K entertainment.

One of the highlights was a special Outside Broadcast (OB) from Rome. NHK has had a three truck 8K OB unit gathering material from most of Europe's key tourist spots.

As 8K televisions and receivers are highly priced (Samsung's smaller QLED- Q900R 85" 8K sets are on the market at about \$8,000), NHK intends to showcase 8K equipment and broadcasts in venues around Japan, including public shopping centers and NHK retail outlets.

Paris-based **Eutelsat** helped NHK launch their 8K efforts with live 8K signals from Rome's Vatican City to Japan for NHK. The December 2 Vatican images were transmitted to Tokyo via **Eutelsat 12 West B** satellite with a mobile uplink provided by **M-three SATCOM**. "This momentous event by NHK has broken new ground for 8K contribution via satellite," said a joint statement.

To achieve the technologically challenging feat, NHK relied on DVB-S2X modulation, in 16APSK, and HEVC encoding. The images were shot at 60 fps in BT2020 color space, with 10 bits of color depth (1 billion colors) and high dynamic range HLG (Hybrid Log Gamma), combined with 22.2 channel audio.

In April, the giant **MIPtv** programming market in Cannes, on the sunny Cote d'Azur, will be showing 8K material.

The question as to how satellite might benefit from 8K is easily answered — "not just yet" is a reasonable response.

The Tokyo Olympics in 2020 will witness 8K carried around the world, if only for demonstration purposes. The one positive element in the equation is that 8K demands a ton of bandwidth.

Even with advanced compression in use, the signals are extremely fat and best suited for satellite content delivery. Time will tell how the global TV industry advances, beyond HDTV and into 4K and — hopefully — into 8K.

Senior Columnist Chris Forrester is a well-known broadcasting journalist and industry consultant. He reports on all aspects of broadcasting with special emphasis on content, the business of television and emerging applications. He founded Rapid TV News and has edited Interspace and its successor Inside Satellite TV since 1996. He also files for Advanced-Television.com. In November of 1998, he was appointed an Associate (professor) of the prestigious Adham Center for Television Journalism, part of the American University in Cairo (AUC), in recognition of his extensive coverage of the Arab media market.





# Passionate About Alaska

Serving the underserved... bridging the digital divide with a new kind of satellite

By John Gedmark, Co-Founder and Chief Executive Officer, Astranis



**Alaska is a rugged state. Glaciers, vast mountain ranges, and islands that can only be reached by helicopter or canoe—Alaska has some of the most remote, hardest to reach places on the planet.**

Although the state has cities such as Anchorage, Juneau, and Fairbanks, it's dominated by small towns far from communications hubs — and that means Alaska has a huge connectivity challenge.

According to *Broadband Now*, 39 percent of Alaskans are underserved when it comes to internet access — the highest rate of any state — and there are thousands of people living with no access to the internet at all. Those Alaskans who do have internet often pay multiples of what Americans in the lower 48 states pay.

The digital divide there is so severe and so challenging, it will take a new kind of satellite to solve it. That's why Astranis is launching a new broadband satellite dedicated just for Alaska.

This lack of high-speed internet is hardly a problem unique to Alaska. Large companies such as SpaceX, OneWeb, Google and others have set out to try to bridge the digital divide, but usually in the context of the developing world.

Last March this author wrote about the unfortunate reality that 4 billion people have no internet access at all. However, this is not just a problem for countries far from American shores.

According to the FCC's *2018 Broadband Deployment Report*, 25 million people have no access to 25 Mbps/3Mbps fixed broadband service. The vast majority, 77 percent live in rural parts of the country. In my home state of Kentucky, that includes more than a million people that are living without broadband.

The problem may well be worse than that. — in a recent blog post, Microsoft noted that the Astranis, not just because it's the firm's first Pew Research Center believes just 65 percent of Americans have broadband internet in their homes. This is a big deal for partnership, but because of lessons all expect to learn in Alaska that can then be used to engage in future partnerships in the U.S. or abroad.

That means as many as 115 million people in the U.S. may live without broadband internet.

If the problem is that severe in the U.S., the richest country in the world, is this not a wake-up call that this is a global problem that must be addressed.

Broadband internet beamed from the skies is often seen as the best solution to getting people in undeveloped areas online, mainly because doing it that way means not having to set up internet backbones in hard-to-reach or hard-to-serve areas. Instead, the signal comes from the sky and only local infrastructure needs be built.

However, the approaches being proposed to provide these signals are less than ideal: giant, hugely expensive constellations of satellites, balloons or 737-sized gliders. None of them are anywhere near being deployed at scale, or in a way that's cost-effective.

In Alaska, **Astranis** found a partner in **Pacific Dataport** that is ideally situated to bring broadband access to the state. Pacific Dataport is a new venture of **Microcom**, the largest satellite services provider in Alaska. Microcom has long been thinking about how to bring broadband to the many areas there without access, and the myriad challenges presented by its sometimes harsh terrain.

Pacific Dataport founder Chuck Schumann is someone whose passion for bridging Alaska's digital divide is strikingly similar to this author's for bridging this lack of connectivity anywhere in the world where people are isolated from high-speed internet.

Having spent countless hours over the last two years talking to Chuck and learning from his many decades of work, this author can safely say that there is no one with more expertise than he when it comes to working in remote places in all types of extreme terrain.

Chuck and his team deploy and maintain satellite ground stations to the farthest reaches of Alaska on a daily basis. Working with Pacific Dataport, Astranis can learn what will help people in other parts of the world as the firm rolls out future satellites with other partners.

Last year, Astranis Space Technologies came out of stealth with a plan for designing, building, launching, and operating proprietary telecommunications smallsats in geostationary orbit. The company is confident that accomplishing this goal will accelerate the availability of less expensive, faster and more reliable broadband internet.

A single Astranis satellite will be capable of serving entire mid-sized countries. Through the deployment of multiple satellites in sequence, new bandwidth can be delivered anywhere across the globe.

The company's commitment to a path of geostationary smallsats isn't meant to say that companies who deploy constellations of large, multi-hundred-million dollar satellites aren't going to contribute to bridging the digital divide — they will — however, it's likely going to take them years to do so. Astranis will be solving the problem soon — next year, in fact, in Alaska.

Under the terms of a new agreement, Astranis will launch a satellite in the second half of 2020 that will provide 7.5 Gbps of capacity to Alaska, roughly tripling the entire satellite capacity available to the state today and also reducing costs by as much as 3x. Eventually, the company hopes that the partnership will provide between 40 and 50 Gbps of dedicated bandwidth.

Across the world, increased access to high-speed internet has been vital in reducing inequality, improving education, lowering poverty levels, the betterment of health, and more.

Astranis will soon be able to draw a straight line from what the company and Pacific Dataport will be accomplishing together in small communities in rural Alaska to additional societal advances anywhere these satellites serve in the future.

[www.astranis.com](http://www.astranis.com)

[pacificdataport.com](http://pacificdataport.com)





# Satellite... Today and Tomorrow

## An important element of the Internet of Things connectivity mix

By Emmanuel Cotrel, Chief Executive Officer, FMC GlobalSat

**Satellite communications are a fundamental and crucial element for the delivery of classic Internet of Things (IoT) applications, such as asset tracking and monitoring, or for conveying machine status and telemetry data.**

In remote areas of the Earth, where terrestrial networks are inaccessible or unreliable, satellite is the preferred connectivity option. However, the expansion of IoT applications, and the subsequent increasing demand for bandwidth and real-time access in what was once a low-usage, latency-tolerant set of applications, is placing pressures on satellite network channels that were not originally designed to accommodate these demands.

Deciding upon the correct connectivity solution for a particular deployment is usually driven by an overarching requirement: *what is the best solution for maximum uptime, is secure and satisfies budgetary requirements?*

Selecting the best combination of services for any given customer should be driven by business needs — make the technology fit the business and don't try to change the business just to conform with a set, broadband technology.

The appropriate solution doesn't need to be one specific infrastructure over another — it usually isn't the case.

Most often, the answer will be a combination of options which strike an acceptable balance between needs and costs.

The concept of *Fixed-Mobile Convergence* (FMC) illustrates the reliability and performance advantages of balancing traffic across disparate network technologies in a converged implementation that best serves connectivity needs.

A converged approach that leverages both terrestrial and satellite networks is one way to deliver FMC while addressing operational cost and performance.

For example, an oceangoing vessel can best be served by a platform that balances traffic across wireless and satellite networks.

While in port, wireless service at 4G speeds (more than 30 Mbps) will be most efficient and cost effective. However, at sea, the situation changes drastically.

The satellite connection — now including *High Throughput Satellite* (HTS) — will carry the load.

An added benefit is the inherent reliability of two discrete networks that can put uptime rates at nearly 100 percent. Another example would be remote solar power installations that use low-bandwidth satellite connectivity.

Outstripping network capacity is an eventuality at these facilities from increased demand associated with equipment and software updates that deliver operational improvements along with new applications. These increases can be 10 to 100 times greater than current demand.

At one plant, approximately 250MB of data was transmitted per month, just for routine monitoring of sensors and management of control systems, which is considered a manageable load through low-speed satellite. However, with heightened concern about securing critical infrastructure, just with the addition of video monitoring to maintain security of the facility, bandwidth and access speed demands could increase fourfold or beyond. A business simply cannot satisfy these requirements using low-bandwidth network access.

An important element of this approach must include automation that prioritizes traffic, in remote regions or are in motion, balanced manages access and monitors network capacities to deliver seamless connectivity to users — without price/performance option for the time being. manual intervention or reconfiguration.

In these and many other use cases that operate wireless and satellite access provides an excellent price/performance option for the time being.





However, the escalating demands on the network will require still more satellite bandwidth and high throughput speed.

LEO constellations that provide global access performance, not on any pre-conceived notion at a relatively high cost-per-kilobyte with that one technology is inherently superior to another.

### **LEO Constellations to the Rescue**

A new wave of large, *Low Earth Orbit* (LEO) constellations promises to change the network capacity and speed landscape over the next several years.

For instance, the dramatic reduction of round-trip latency from 500 milliseconds with geostationary satellites, to the 50 to 75 millisecond delay for a LEO satellite, can empower more time-sensitive applications.

These new space constellations are primarily designed to deliver broadband access that will dramatically expand bandwidth availability in every location. With anticipated performance compatible to fiber, this should place satellite in a more prominent role for delivering IoT services as well as converged with broadband applications on the same network.

This expanded capacity will, no doubt, alleviate some of the pressures on the current networks, but it will not be a replacement for converged solutions that are best suited to address business-driven needs.

There is understandable excitement surrounding new LEO-based broadband. It is an altogether new technology compared to current GEO and

The real potential of new LEO access is in the projected large number of new satellites coming online, paired with their reduced launch costs. This will provide a significant increase in bandwidth, with higher speeds, and reduced latency – setting the scene for a highly competitive market.

The entire IoT industry will benefit from the technology changes being enabled through new LEO constellations. This next wave of satellite connectivity will deliver high-performance global network access.

These are the essential requirements of modern business applications ranging from voice and video communications to real-time asset tracking, monitoring, and security.

### **Keeping the Focus**

IoT service and solution providers have opportunities to leverage these expanded network options to best satisfy current and evolving customer requirements. The key will be to assemble the best combination of technologies for specific use cases.

Successful providers should offer a continuum of service options to keep customers satisfied while minimizing costs and maximizing service. Decisions on network options will be driven by ease of use, cost, reliability, and throughput

*Mr. Cotrel is a co-founder of FMC GlobalSat, and is responsible for overseeing the company's strategy, innovation, and go-to-market activities. Prior to launching FMC GlobalSat, he founded BlueNRGY LLC, a leading independent software company that provides data acquisition, control systems and big data analytics for solar power plants.*

*From 2009 to 2013, he was a co-founder and principal of the investment fund, L14 FCP SIF, which targeted investments in wind and solar power generation systems across Europe. Mr. Cotrel was also co-founder of SeaMobile, Inc. (USA) in 2004, which has evolved into an industry leader in global maritime telecommunications.*

*He is an active member of the U.S.-based Cotrel Spinal Research Foundation and the French-based Yves Cotrel Foundation affiliated with the Institut de France. Mr. Cotrel graduated from IMIP MBA Institute (INSEEC business school) in Paris, France.*

# Synthetic Diamonds to Empower SATCOM

Innovative conductive technology to minimize thermal waste

Jeanette Quinlan, Director of Space Systems, Akash Systems



**Akash Systems, Inc., founded by Felix Ejekam and Ty Mitchell in 2016 and whose seed fund was led by Khosla Ventures in Q4 2017, strives to resolve issues critical to the expansive growth of the satellite industry.**

With goals to extend the reach of fast, affordable information across the globe, the company is focused on enabling the next generation of smallsats using proprietary RF power amplifiers and radios. *Gallium Nitride (GaN)-on-Diamond*, a new material created by **Ejekam**, is at the heart of the company's RF products.

Akash's GaN-on-Diamond materials use the extreme thermal conductivity of synthetic diamond to minimize thermal waste in a satellite. This feature delivers record-breaking information data rates at little power consumption levels.

Launch costs, typically dominated by weight, are dramatically reduced due to the reduced size and weight of thermal management hardware.

## Innovative Technology

Akash's patented GaN-on-Diamond technology promises to transform the SATCOM industry.

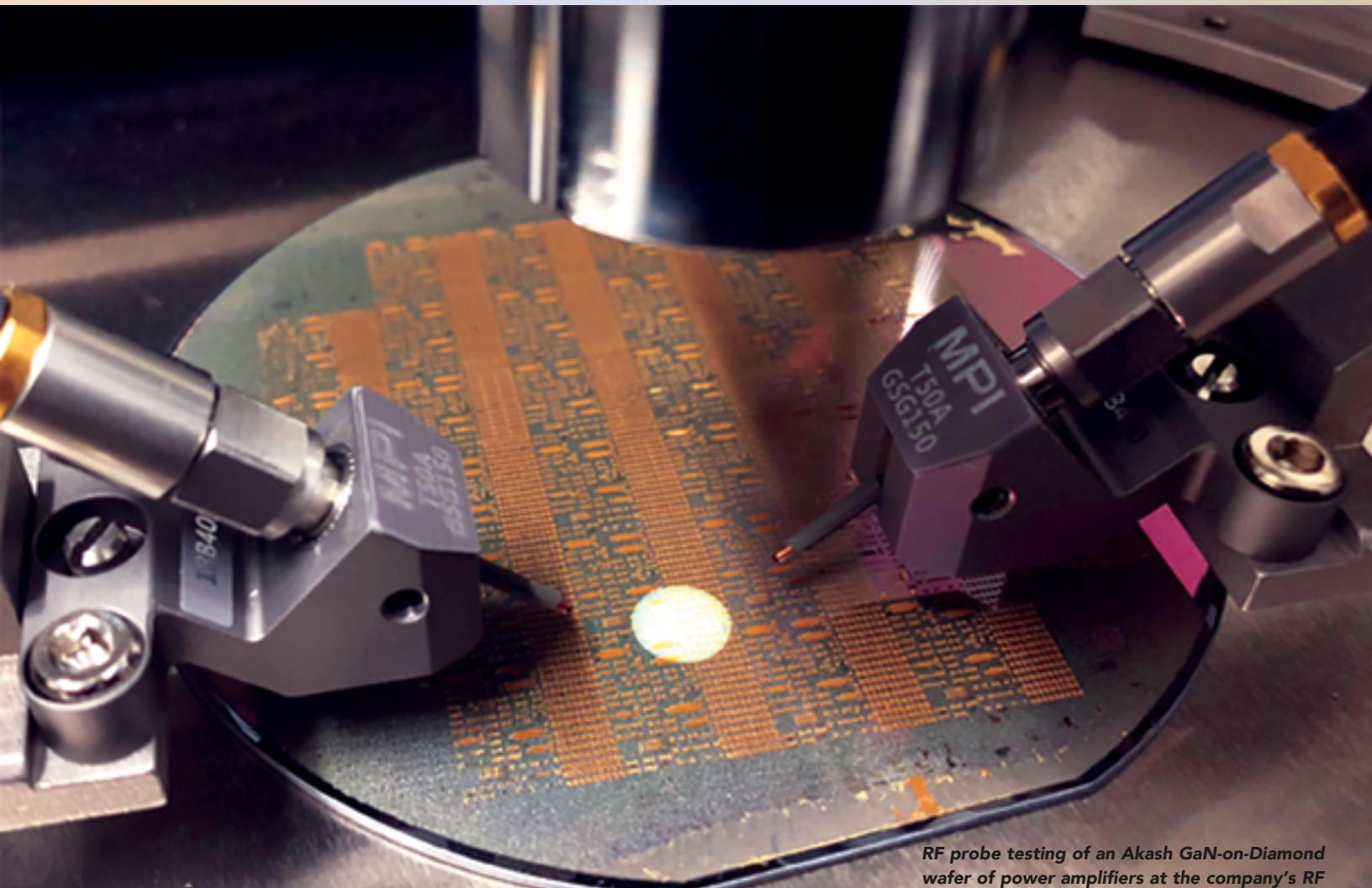
Radio frequency power amplifiers are used by every satellite on-orbit. Akash's solid-state power amplifiers bring diamond — the most thermally conductive material on Earth — within nanometers of the GaN heat source, resulting in power-added efficiency (PAE) that is 5 to 20 points higher than incumbent technology.

With less wasted heat, Akash customers will often decide to raise the temperature of the baseplate by as much as 80 degrees Celsius, shrinking the size of the thermal management mass of the

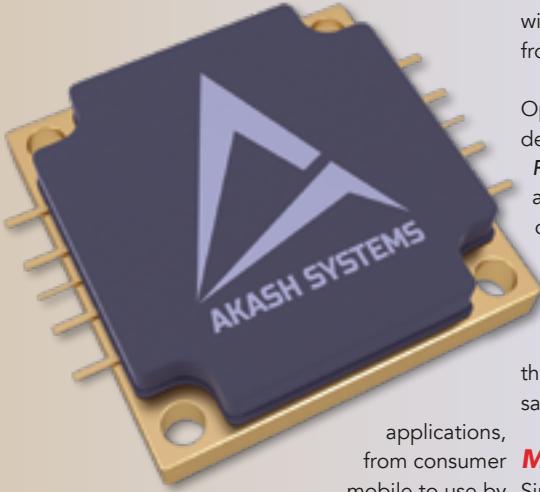
satellite. Simultaneously, due to increased PAE of the amplifiers, customers can reduce the size of the batteries and solar arrays needed to support a mission.

Many satellite systems can use the higher efficiency of GaN-on-Diamond amplifiers to achieve sharply higher data rates for a fixed satellite design. This allows satellite operators to serve more customers and increase the revenue derived from a single launch.

Akash envisions their RF amplifiers delivering new services to the market, such as 1 Terabit per second downlink data rates, extremely high-resolution (10 cm.) Earth imaging, terapixel (1012 bytes) video capabilities, powerful radars and opportunities in "burst" communications that will enable new



RF probe testing of an Akash GaN-on-Diamond wafer of power amplifiers at the company's RF facility near Dallas, Texas.



applications, from consumer mobile to use by the military.

Smallsats continue to be a dominant source of growth in the space industry, easily illustrated by the number of new startups and large companies that are launching satellites through rideshare programs.

Akash has designed its smallsat radios to easily integrate with existing ground station and satellite infrastructure — customers are typically Earth Observation (EO) satellites whose sizes can range from 3U CubeSats to microsatellites.

The small radios Akash is developing promise impressive performance that has not yet been seen on the market: the X-band will deliver up to 400 Megabits per second data rate at 8.0-8.4 frequency, and the Ka-band will boast more than 1 Gigabits per second data rate at 25.5-27 frequency. The CubeSat radios will be completed in 2019 with pre-sales starting immediately.

### **Business Strategy**

Akash is taking a phased approach to its business. Currently in Phase One, Akash is delivering GaN-on-Diamond HEMTs, Hybrids and MMIC Power Amplifiers to customers who make systems requiring high frequency and power efficiency. This year, the company plans to enter Phase Two, delivering radios with groundbreaking capabilities.

### **Recognition in the Industry**

As a three-year-old startup, Akash sets the bar for what's to come in the SATCOM industry.

In September of 2018, Akash earned the **Best Newcomer Award** at **FinSpace**, a Shark Tank-style business competition for startups during **Euroconsult's World Satellite Business Week (WSBW)** in Paris.

Akash presented alongside other startups such as Phase Four, NSLComm, Hiber and Exotrail. FinSpace provided an invaluable opportunity for Akash to share its work, learn from other leading companies and forge meaningful connections held

with trailblazers equally excited about the next frontier in satellites and space communications.

power and RF applications, lighting class LEDs and LED lighting.

Opportunities continue in 2019 for Akash to demonstrate leadership in the industry. **Daniel Francis**, Ph.D., VP of Materials, delivered a keynote speech at the Diamond D-Day conference in Bristol, England, to highlight Akash's recent work on the GaN-on-Diamond wafer materials.

In May of this year, Akash will compete alongside 15 industry entrepreneurs in the third annual *Startup Space Competition* at the satellite show in Washington, D.C.

### **Meet the Team**

Since the company's founding in 2016, Akash Systems has carefully built its team with the brightest industry minds.

Co-founders **Felix Ejeckam** and **Ty Mitchell**, both with backgrounds in science and engineering, paired their expertise to create a dynamic partnership. The company is now staffed with 20 full-time employees.

With a Ph.D. in Electrical and Computer Engineering from Cornell University, Ejeckam grounded his career in transformative technology. He is a seasoned entrepreneur, electrical engineer and venture capitalist and invented the GaN-on-Diamond technology in 2003 at Group4 Labs, Inc., by lifting GaN epitaxy from its original growth substrate, silicon, and transferring it to a synthetic chemical vapor deposition (CVD) diamond substrate. In 2013, Group4 Labs was acquired by Element Six, a DeBeers company.

Dr. Ejeckam has published more than 100 journal and conference papers and has obtained many patents. Prior to Group4, Felix was the co-founder and CEO of venture-backed Nova Crystals, Inc., a developer and maker of next-generation semiconductor lasers and detectors for the Telecom/Datacom markets.

Co-founder Mitchell started his career as an engineer at General Electric (GE) and International Business Machines Corporation (IBM) before earning his Ph.D. in Materials Science and Engineering from the University of California, Berkeley.

Dr. Mitchell gravitated toward business development and leadership roles within the GaN and SiC materials, optoelectronics and LED lighting fields. Prior to Akash, Mitchell held an executive

Akash's Dallas office is led by CTO **Kris Kong**, Ph.D. Along with VP of Device Technologies **Paul Saunier**, Ph.D., Dr. Kong was a Senior Fellow at Qorvo/TriQuint before joining Akash. **Daniel Francis**, Ph.D., VP of Materials, leads the Oakland, California, office.

Most recently, Akash Systems welcomed **Brian Holz** onto the team to serve as Chief Architect. Holz has more than 31 years in progressive space system engineering, program management and executive leadership.

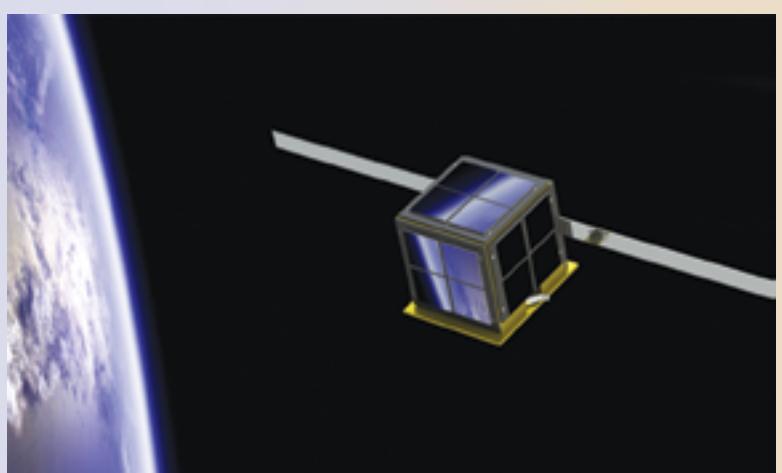
Akash's products share a common goal: to create smaller, lighter and less expensive satellites that reduce manufacturing and launch costs, while expanding communications access.

**[akashsystems.com](http://akashsystems.com)**

Jeanette Quinlan is Director of Space Systems at Akash Systems. Prior to Akash, Jeanette managed the U.S. Operations of Starburst Aerospace Accelerator, connecting traditional aerospace primes with startups in aerospace. Before joining Starburst in 2016, she spent more than 10 years as an engineer in the satellite industry. Her experience includes analysis, design, testing and on-orbit monitoring of RF and electro-optical satellites in LEO and GEO orbits.

Jeanette spent nearly two years at OneWeb on the satellite engineering team as the startup grew through its early stages of the Joint Venture with Airbus. Jeanette led as a Thermal Engineer at Space Systems Loral (SSL, now Maxar), working on the world's top geosynchronous communications satellites.

Her career began at ITT (now Harris) in Rochester, NY, working with optical systems for government contracts. Jeanette has a B.S. in Mechanical Engineering from the University of Rochester in Rochester, NY.



# Advanced Satellite Technologies for IoT

## The potential for satellite connectivity in IoT

By Payal Kaul, Research Analyst, Grand View Research



**Satellite communication plays a vital role in optimizing the business processes that make the Internet of Things (IoT) a reality, by delivering required reach and consistency, regardless of location.**

Smart and inter-connected, autonomous and self-managed, IoT continues to grow in intelligence and complexity. IoT is a network of numerous physical objects that uses sensors and APIs to establish connection and exchange data over the internet. These objects may include software, machines, and home appliances among others.

The IoT solutions offer greater accuracy and efficiency as compared to conventional communication alternatives. They require minimal human intervention and cost by direct integration of the physical environment into computer-based systems. The IoT umbrella encompasses its sub-verticals: consumer, commercial and Industrial IoT (IIoT).

IIoT is helping businesses across the world to improve worker safety, reduce operating costs via satellites and enhance productivity. Companies are increasingly establishing new products and service for the satellite market. The rising needs of hybrids globally to enhance their portfolios. They are increasingly shifting from selling products to monitor, track, and keep control over assets geographically dispersed mobile, as well as fixed, to delivering measurable outcomes, thereby generating fresh revenue streams.

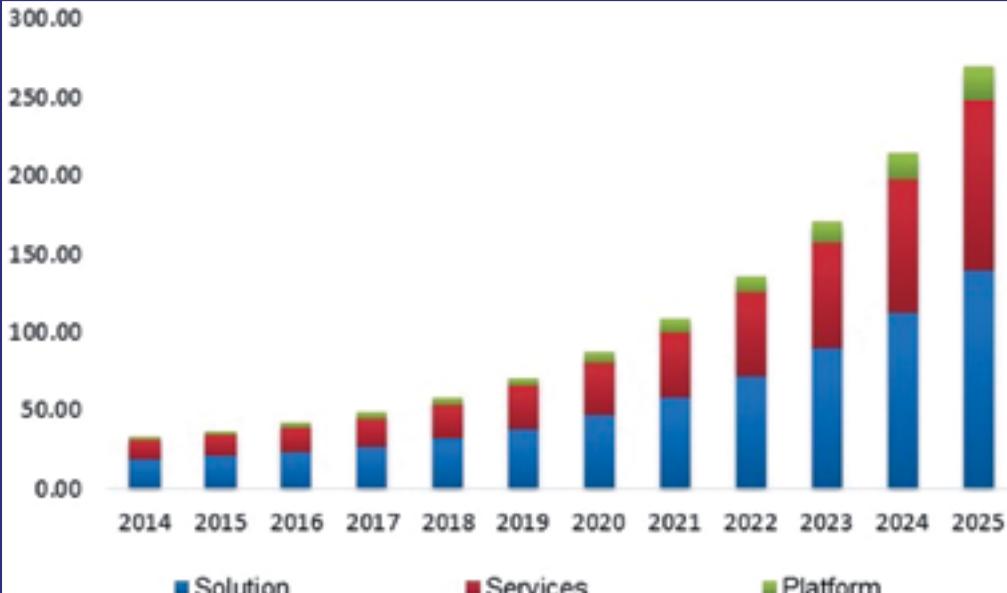
The role of IoT is increasingly becoming more prominent in enabling easy access to devices and machines. Government-sponsored initiatives and innovative efforts made by key companies, such as **Huawei Technologies Co. Ltd., General Electric**, and **Cisco Systems Inc.**, are expected to elevate the adoption of IIoT across the globe over the next few years. **Grand View Research** predicts the IIoT market will reach \$933.6 billion by 2025.

Several satellite operators, including **Inmarsat** and **ORBCOMM**, are already providing integrated and complete Machine-to-Machine (M2M) solution packages based on satellite.

### Driving SATCOM IoT

Disruptive developments in telecommunication technology and the high adoption of connected and mobile devices positively influence the demand for IoT solutions.





Source: Grand View Research

North America Industrial IoT Market Revenue by Component, 2014-2025 (USD Billion).

Easy access to high-speed internet facilities, in high-throughput, Ka- and Ku-band satellite decreasing average selling prices of sensors and modules as well as increasing penetration of cloud computing and Platform as a Service (PaaS) are also driving the demand. Cutting-edge analytics and data processing plays an important role in deriving results from high volumes of data gathered using M2M communication.

In spite of the roll-out of terrestrial networks to various parts of the world, numerous regions still lack connectivity and rely on satellites. As such, satellite communication plays a vital role in enabling business processes and applications that are making IoT a reality.

IoT has played an influential role in emerging economies by connecting businesses, services and devices. Although consumer-centric devices use terrestrial-based cellular networks, numerous business-centric applications require greater reliability when it comes to communications. Satellite technology efficiently delivers such required reach and consistency. Increasing adoption of IoT in businesses will subsequently result in the prominence of satellite communications.

Satellite operators are focusing on introducing hardware and services that can unleash the potential of IoT to the fullest extent possible. They are creating satellite-based solutions, which can be integrated with hybrid networks that combine satellite, fiber and wireless networks.

Presently, narrowband providers (L-band that operate in the frequency of 1 to 2 GHz in the radio spectrum) are being preferred for IoT connectivity purposes. However, advancements

### Benefits of SATCOM IoT Support

In the context of satellite communication, the global IoT market is set to witness rapid growth over the coming years.

Satellite technology acts as a key enabler for the transformation of IoT connectivity across numerous industries and geographical borders with applications ranging from mining to oil & gas (O&G) and transportation.

Connecting individual IoT-featured devices via satellites is presently facing various challenges. However, satellite technology plays a key role in making IoT a reality and has numerous benefits.

#### 1. Conducting Remote Monitoring:

Satellites provide crucial communication means to the business operations, which extend to geographically remote environments, for real-time asset management and conducting remote facility monitoring at offshore platforms and unmanned sites. The aim is to bring connectivity to these remote locations via a satellite link to a gateway device (concentrator) that will serve numerous IoT devices in the local area through Low-Power Wide-Area (LPWA) terrestrial solution.

#### 2. Increasing Usage of Sensor Networks:

The proliferation of wireless devices and sensors networks are expected to expand far beyond rural and

urbanized areas, owing to tremendous opportunity for satellite service providers. Energy and mining companies are increasingly exploring extensive usage of satellite-based sensor networks for supporting their offshore projects.

#### 3. Transformation of Transportation Infrastructure:

Globalization is resulting in a tremendous increase in the volumes of cargo transported. Majority of the logistics companies are at the forefront of technology adoption. IoT integration in container tracking can generate huge revenues for the marine industry. Further, broadband connectivity in cargo vehicles, trains, and maritime vessels is an emerging trend in the global transportation arena, and SATCOM plays a vital role in enabling innovative mobility solutions.

#### 4. Speed and Reliability:

The future of IoT revolves around the data exchange among the interconnected objects for facilitating fast decision making along with enhanced business processes. As such, the IoT adoption is driving the demand for high broadband speed for supporting real-time bandwidth-intensive applications.

Presently, in the era of increased communications traffic, maintaining high service reliability is of the utmost importance for effective IoT deployment. The carrier integrated providers are required to work with satellite provider offering a reliable network that distinctly caters to applications, including remote asset monitoring that ensures uninterrupted connectivity.

#### 5. Cost Reduction:

Volatility in pricing is pushing various industries to rethink and take a renewed look at initiatives for improving operational efficiency and cost reduction. Such initiatives entail greater usage of smart sensors as well as the devices that make use of advanced business analytics. Besides, terrestrial networks are expensive to deploy in remote regions, whereas mobile satellite services are being increasingly preferred owing to their affordable communications technology.

#### 6. Widespread Coverage:

While Bluetooth, terrestrial GSM networks, and Wi-Fi deployments support various IoT applications, they cannot provide seamless and ubiquitous coverage. Connectivity of intelligent devices via satellites will result in the emergence of a new range of innovative IoT



Source: Grand View Research

#### U.S. IIoT Market Revenue By Solution Type, 2014 - 2025 (USD Billion).

applications. The potential IoT scale is expected to encompass billions of devices across the globe and demands widespread network coverage between carrier integrated services and satellite operators, even in remote areas.

#### Key Verticals for Satellite IoT Implementation

Satellite communications in IoT create significant value across multiple industry verticals in order to make the organization's business processes smarter, efficient, and safer. Here are a few sectors that are witnessing prominent usage of satellite IoT.

##### Agriculture:

In agriculture, IoT is essentially used for increasing yields and productivity via optimization of crop production along with advancing its storage and distribution. IoT holds a strong position to address the limitations associated with capital costs that have curbed the agricultural productivity growth. The developed countries, such as the U.S. and Germany, are currently driving the growth of in-service satellite IoT terminals. However, emerging economies in Middle East and Africa and Asia Pacific are anticipated to witness substantial growth over the next few years.

Sectors such as precision farming in rural agricultural areas require thousands of individual sensors to be IoT connected. Several companies, such as Milk Smarts, are leveraging satellite backhaul of Low-Power Wide-Area (LPWA) to new solutions for carrying out precision farming in the Australian agribusiness. Service providers including Inmarsat and Vodafone provide backhaul for IoT devices in smart farms in remote locations across the globe.

As these networks offer a vast coverage, it presents as an alternative for tracking cattle. Identification of sick animals and monitoring of theft is possible with these connected devices.

##### Civil Engineering:

High-level monitoring of civil engineering projects, especially in remote and hazardous locations, paves an opportunistic way for satellite IoT. The growth of construction IoT vertical is primarily driven by rising population in emerging economies. Structural Health Monitoring System integrates IoT and satellite technologies and offers a means of maintenance for various types of assets. This system provides a picture of the complete structure, along with tracing the threats that are caused by land motion, mining, environmental degradation, and industrial activities.

The growth of satellite IoT in civil engineering can be attributed to the increasingly aging infrastructure in North America, which requires constant monitoring of structures. The market possesses immense potential in Middle East and Africa since the revenues are driven by the absence of reliable terrestrial networks.

##### Healthcare:

Implementation of telemedicine is gaining prominence in the developed countries, especially in Europe. However, in the emerging economies across the globe, satellite IoT in healthcare is expected to register high gains by the expansion of healthcare services in remote locations, particularly in testing and diagnosis in remote clinics. In these emerging economies, IoT benefits are dependent on investments in communication

infrastructure to enable connectivity and reduction in the cost of sensors. Satellite IoT can leverage the network coverage to draw the remote networks together into an integrated data center. IoT data can also be aggregated through a Very Small Aperture Terminal (VSAT) network, which plays a vital role in acting as a backup when terrestrial networks fail.

##### Multi-modal Logistics:

Free trade and globalization are resulting in huge cargo volumes transported. Maritime transport is a vital aspect of globalization and involves cross-border transport networks that enable international trade and support supply chains. Logistic companies are increasingly adopting technologies to optimize their processes. Cargo shipments are subjected to several threats, which makes their tracking problematic. In such cases, satellite integration proves as an optimum solution for connecting IoT devices. The technology is increasingly being used for monitoring of refrigerated shipping containers on high seas. Deploying satellite connectivity for complementing terrestrial networks for IoT applications are transforming IoT into "Internet of Everything Everywhere." Technology choices are sometimes dependent on the availability of the spectrum. Co-existence of multiple networks within a territory might be useful for IoT. However, different countries have created different guidelines for governing data management.

The aspects outlined above capture the relevance that satellite communications bring to the IoT landscape. However, they are only the tip of the proverbial iceberg.

Although, presently, satellite implementation in IoT has been in the picture on a low scale, Grand View Research anticipates Satellite IoT market to exhibit exponential growth over the coming years. Carrier integrators and satellite operators need to work together for enabling seamless connectivity that will propel our generation into the future.

[www.grandviewresearch.com/](http://www.grandviewresearch.com/)

Payal Kaul is a Research Analyst with Grand View Research and is responsible for providing quantitative and qualitative analysis across the next generation technologies and aerospace and defense domains. Her primary focus is on producing in-depth reports that suggest strategic and operational amendments to the clients.



# Aero Roaming

**A game changer for consumers, operators and carriers**

By David Shiff, Vice President, Aeronautical Sales, Hughes

**It's difficult to recall a time before the advent of broadband technology and the widespread use of connected devices that hurtled us into our current state of hyper-connectivity.**

Whether in one location or on the move, we are on the cusp of a new era — one of constant connectivity.

A 2018 Pew Research study found that more than one quarter of Americans already report being online "constantly." This continuous connectivity doesn't just benefit consumers; it's a cornerstone of Machine-to-Machine (M2M) communication and the burgeoning Internet of Things (IoT).

When it comes to mobility, the aero industry presents a rapidly expanding frontier in this constantly connected future — with new aero roaming capabilities helping realize the promise of connectivity in flight anywhere, worldwide.

Since its introduction just over a decade ago, inflight connectivity (IFC) has "taken off" and continues expanding.

According to Euroconsult's June 2018 report, *Prospect for In-flight Entertainment & Connectivity*, more than 23,000 commercial aircraft will offer connectivity to passengers by 2027 (up more than 200 percent since 2017).

of the globe — and to the skies above those regions.

The introduction of aero roaming propels IFC into exciting, new territory.

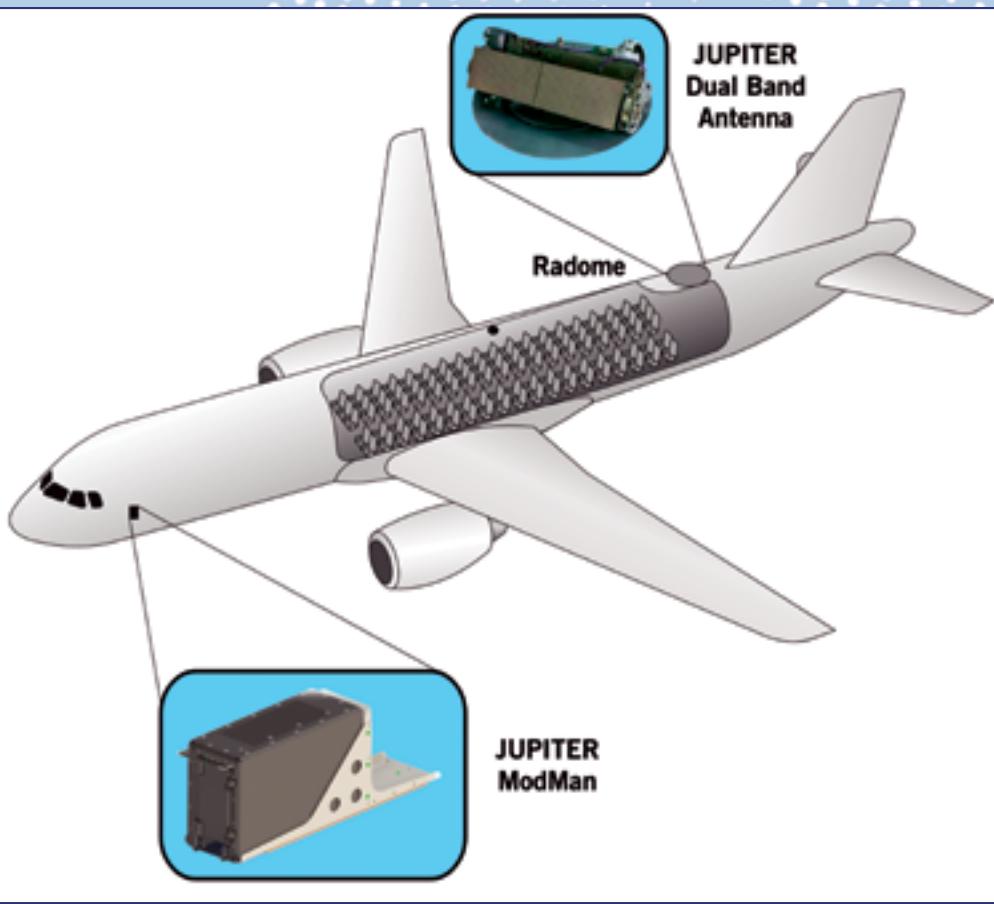
The concept of roaming is not new to the telecom industry. If you use a cell phone, you know that you have the ability to connect nearly anywhere through your carrier's "roaming coverage."

One report forecasts IFC will generate \$37 billion in cumulative revenue by 2027 and attributes this boom to new High Throughput Satellite (HTS) services and greater penetration in all local providers, allowing you to connect regions of the world. That penetration is poised to expand with the addition of non-GEO (NGSO) constellations in the coming years from players such as OneWeb, SES, Telesat and others.

Keeping in touch when you travel outside your provider's coverage area is possible because they have roaming agreements in place with other local providers, allowing you to connect regions of the world. In the realm of aero connectivity, however, true roaming capability has been elusive. A plane relying on satellite connectivity previously has been limited to the service area of a single Airline Service Provider (ASP).

As NGSO constellations come online, providers will have the ability to take advantage of both GEO and NGSO systems to deliver connectivity to previously underserved and unconnected regions





**The Hughes JUPITER Aero system —** The JUPITER Aero Terminal is comprised of two major components: a high performance, high-throughput satellite modem system (ModMan) and a compact, lightweight dual Ka- and Ku-band antenna system. The system can dynamically switch from one type of satellite to the other (and from beam-to-beam within the footprint of a single spot beam satellite) with no interruption of service or manual intervention of any sort, thus ensuring passengers of a superior user experience and no loss of connectivity from gate-to-gate. The terminal is based on ARINC 791 for both the in aircraft equipment (IAE) LRUs and out of aircraft equipment (OAE) — antenna, mounting adapter plate, and radome.

Now, with the newest **JUPITER™** System With this roaming capability enabled, an ASP in technology from **Hughes**, ASPs can enable one part of the world operating a JUPITER-based roaming inflight connectivity with other JUPITER-equipped ASP partners anywhere in the world.

An integrated system of airborne equipment, ground equipment and software that, together, delivers high throughput, high reliability, broadband performance for commercial aircraft, the **Hughes JUPITER Aero System** is fully compatible with HTS and conventional satellites and is capable of speeds >600 Mbps to an aircraft.

As the aircraft flies, the onboard JUPITER terminal automatically switches between beams and satellites; multiple JUPITER systems deployed around the world have the capability of seamless roaming across ASP networks, subject to agreements among operators.

With this roaming capability enabled, an ASP in one part of the world operating a JUPITER-based system can maintain seamless connectivity to its passengers as the aircraft flies into the system of another JUPITER-equipped ASP roaming partner.

Roaming partnerships allow service operators to support incoming aircraft from other providers into their system and vice versa. This leap forward in IFC is the next logical step in powering the connected experience and enabling truly constant connectivity for the millions of passengers in the air, every minute of every day, globally.

The most obvious benefit of aero roaming is uninterrupted connectivity for long haul international flights, which to date has not always been possible.

Providing that benefit to passengers creates a competitive advantage for ASPs and carriers, as multiple studies have found that today's airline passengers regard in-flight connectivity as a must-have, rather than a luxury.

Availability and quality of IFC influences the loyalty of passengers to an airline and the price they are willing to pay.

Airlines also benefit from broadband-enabled ancillary revenues stemming from access charges, onboard e-commerce shopping, advertising and/or premium content.

Perhaps even more impactful over the long-term, aero roaming unlocks the potential of applications that rely on continuous exchange of real-time data.

Put simply, this is a game changer for the future of IoT in aviation. An uninterrupted flow of real-time data and continuous machine-to-machine communication can improve safety and efficiency of flights, providing pilots guidance for optimizing fuel and time savings, not to mention equipment diagnostics.

With this level of real-time information, airlines can identify routine maintenance needs well in advance and automatically connect with parts suppliers and engineers located in the next layover location, enabling much speedier and less costly maintenance of the aircraft, as well as less down time.

Constant connectivity via aero roaming also brings us one step closer to the reliable use of sensors on aircraft and, ultimately, the possibility of single-pilot operations or autonomous aircraft.

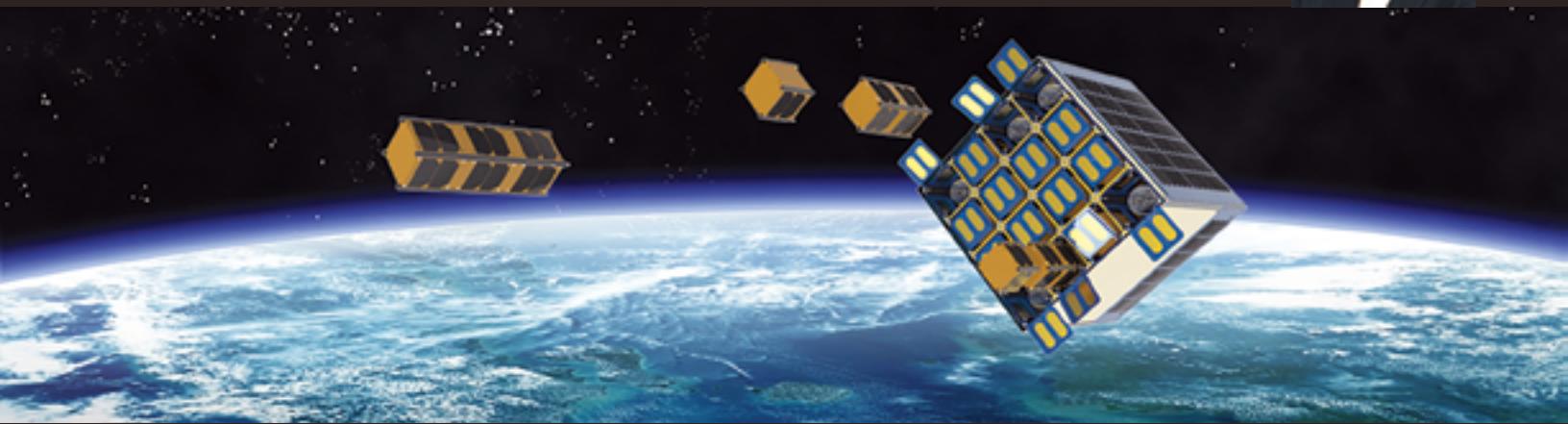
Roaming represents the latest advancement in aero broadband connectivity that expands coverage, satisfies demand and enables a new constantly connected reality.

[www.hughes.com/collateral-library/hughes-jupiter-aeronautical-solution](http://www.hughes.com/collateral-library/hughes-jupiter-aeronautical-solution)

# Satellite Deployment

The future of the CubeSat launch technology

By Stefano Antonetti, Head of Sales—Institutional Business, D-Orbit



**The term "CubeSat" was coined at the end of the 20th century to denote a satellite platform that would enable college and graduate students to design, build, test, and operate a cube-shaped satellite made with inexpensive, off-the-shelf components, including some components that were not even space qualified.**

This design philosophy enabled the fast evolution of this smaller class of spacecraft. Different objectives were targeted by these smallsats in terms of their use and their operational lifetime in relation to the well-known, traditional spacecraft,

from Sputnik-like space beepers to sophisticated, multi-instrument, scientific, institutional platforms.

Today's state-of-the-art CubeSats include 3U, 6U, and 12U high-performance smallsats and there

are plans underway for 16U and even larger units. While these spacecraft continue to be developed according to the CubeSat standards and philosophy, calling them "CubeSats" sounds reductive, like calling a house a "Brick."

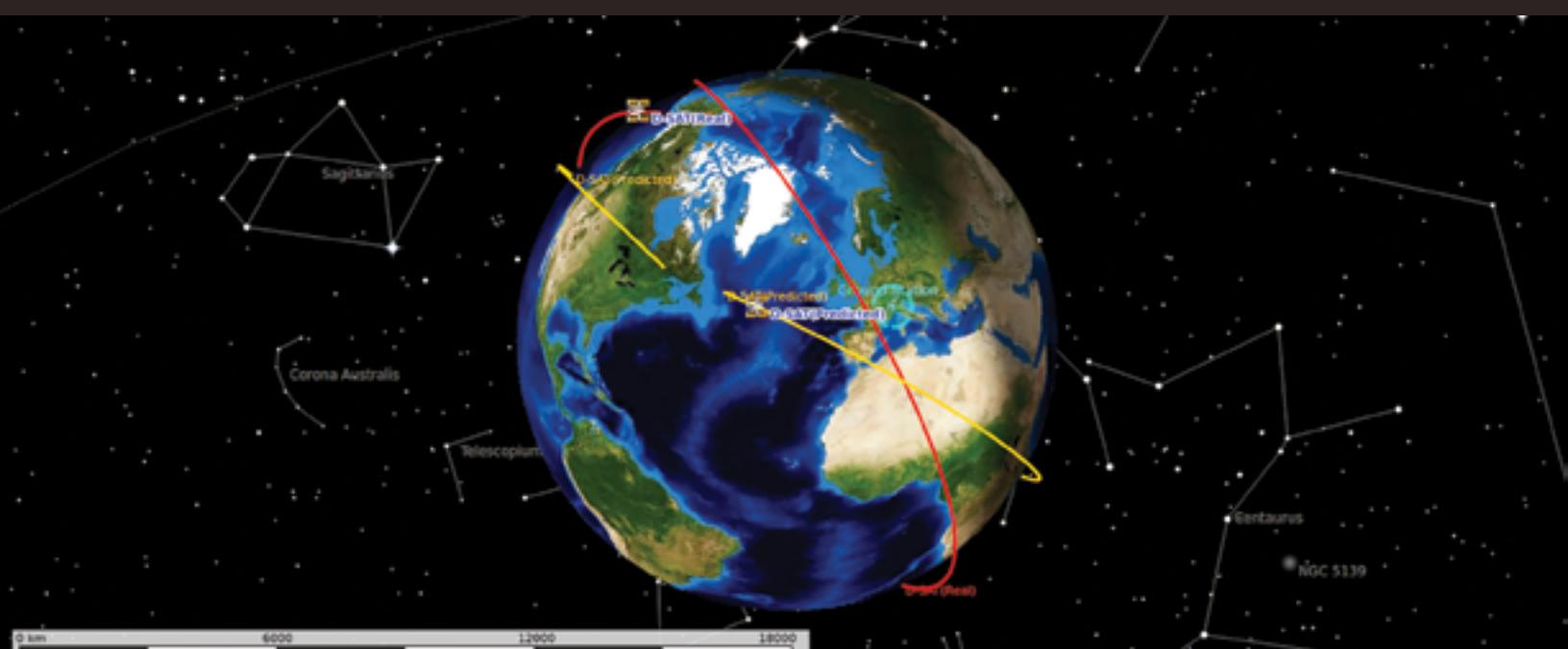
When we consider the upcoming mega-constellations, with hundreds or thousands of smallsats operating as a single entity, we are actually witnessing the birth of new concepts of space missions. The deployment and operation of these mega-constellations poses unprecedented challenges in terms of spatial logistics.

then reached their operational orbit within a day or two of the launch using internal propulsion.

However, when it comes to CubeSat technology, the performance of internal propulsion remains severely limited — the current deployment strategy for a constellation's orbital plane consists of placing 50 or more spacecraft on a large rocket as secondary payload, releasing them in close proximity to one another in a sub-optimal transfer orbit, and then exploit gravitational anomalies and residual atmospheric drag to gradually phase them over a period of up to one year.

A major challenge is deployment — Iridium's constellation, the largest such deployment deployed in five or more distinct orbital planes, prior to the smallsat revolution, used dedicated launches to deliver as many as seven spacecraft that are not reachable with rideshare launches. Moreover, most constellations need to be launched to deliver as many as seven spacecraft that are not reachable with rideshare launches.

at a time to a single orbital plane. The spacecraft



This extremely inefficient process increases the time-to-market, raises operational costs, erodes revenues, and wastes a significant amount of the already limited lifespan of smaller spacecraft. Some of the deployment strategies could decrease the time-to-revenue by as much as 80 percent and reduce the launch costs for an entire constellation by up to 40 percent.

During the past three years, **D-Orbit** has been developing a novel approach to CubeSat deployment with its **InOrbit NOW (ION)** launch service. This service leverages the **ION CubeSat Carrier**, a type of orbital taxi designed, built, and operated by the company. ION CubeSat Carrier is a 200 kg. satellite that hosts a combination of as many as 48 CubeSat units that consist of various form-factors.

As an example, a single launch of an **Arianespace Vega** can deliver up to five ION CubeSat Carriers into polar orbit. Thanks to ION's internal propulsion, each CubeSat carrier can reach a different plane by altering its *local time of the ascending node* (LTAN). Each ION CubeSat Carrier can set up a constellation plane in less than a month, enabling an operator to establish an entire constellation in a few weeks with a single launch.

Once released in orbit, ION uses its own propulsion and attitude control to reach the optimal deployment conditions for each one of the hosted smallsats. This approach provides operators with a level of service that was previously only available for far larger spacecraft. While D-Orbit is preparing for the first mission, which is planned for the second half of 2019, the company's engineers are already working on the second generation of the vehicle that will include enhanced propulsion capability, and power and data connections between ION and the CubeSat until the moment of release.

While the economic advantage of a safe and fast deployment is clear, there are other, less obvious advantages that can positively impact mission design. The availability of an orbital transportation cargo that reduces the propulsion needs of every single satellite of a constellation enables multiple cost-saving strategies, while extending the number of operational orbital planes as well as reducing the time-to-revenue.

This contract is in line with D-Orbit's vision for a new space transportation infrastructure, a vision that goes beyond CubeSat deployment.

The ION platform will evolve to a point where it will be able, within a single mission, to deploy new satellites into orbit, capture older spacecraft and destroy them via re-entry into the Earth's atmosphere. This ability will enable constellation operators to ensure orbital clearance, thereby significantly reducing the cost of operations over longer periods of time.

[www.deorbitaldevices.com](http://www.deorbitaldevices.com)

*Stefano holds a Master's degree in Space Engineering in a collaboration between the University of Rome "La Sapienza" and the Delft University of Technology. He has worked as Space System engineer in Paris for 7 years, focusing on feasibility studies for space exploration and the environmental impact of space activities. When he came back to Italy in 2014, he immediately joined D-Orbit as Program Manager for most of the activities done in collaboration with the European Space Agency. Now, Stefano is in charge of managing the Institutional Business, drawing the future of space transportation.*



# Maritime Networks...

## Ready for streaming

By Tore Morten Olsen, President, Maritime, Marlink

**Video streaming — even at 4K Ultra High Definition — is today a pretty straightforward, low-cost and usually seamless affair at home or in the office.**

Getting video to and from a ship in the middle of the ocean is more of a challenge. However, as more satellite capacity becomes available across the globe, speeds increase and prices decrease and demand for live streaming and content distribution at sea is growing. It's now perfectly feasible to reliably deliver Standard Definition (SD) and Full High Definition (HD) video almost anywhere on the oceans.

More video over a ship or fleet's communication network does introduce a certain element of risk if the rollout is not managed properly. Losing access to digital safety and efficiency focused applications on board because the latest season of the Crown has just released is not an ideal situation for anyone. Flexible and dynamic service management can mitigate the problem, ensuring that the bandwidth used on any video connection is optimized and does not affect the availability of other critical applications on the same network.

## Health & Safety

**Marlink's XChange** centralized communications management system is the center point for a new wave of maritime video applications helping to support business, crews and in a wider context, improving society's understanding of the oceans.

The most significant advances enabled by live video at sea is the improved health of crew and passengers at sea. Live, face-to-face contact with medical professionals on shore over a real-time video link can aid in the treatment and recovery of sick or injured patients on board. Delivering a complete solution for easy, reliable and global operation is essential though, in order to persuade shipowners and managers that telemedicine is financially and practically viable.

Using XChange, Marlink offers an innovative telemedicine service designed to improve the health and safety of crew and

passengers at sea, while meeting new ILO/MLC and IMO/STCW labor regulations for health and medical treatment on board. It provides a cost-effective way for shipping companies to manage both regular and emergency medical consultations on board, thereby supporting the medical health of seafarers and passengers, and reducing the risk of spiraling costs incurred due to medical emergencies on board.

**XChange Telemed** is the only turnkey, fully integrated telemedicine system available, with everything delivered and managed by Marlink. The solution integrates a reinforced, vibration-proof hard-case with CE certified medical equipment for on board diagnostics by designated medical crew, an intuitive touch-screen user interface and High Definition (HD) video camera, all of which seamlessly link with XChange and Marlink VSAT services to provide a direct live video and secure data connection to doctors on shore.

With XChange Telemed, medical diagnostic data taken from the medical instruments on board can be viewed remotely alongside the patient's own medical file in the online and secure web portal, ensuring the remote doctor has access to all pertinent information about the specific illness or injury, in addition to the patient's medical history during video consultations.

This data adds significant value for the live consultation, where the professional ashore can support both the patient and medical

officer to treat the issue correctly. The system also allows for the transmission on video and stills prior to or instead of a live consultation.

## Platform for Remote Consultations

The system has been adopted by a number of major vessel operators.

Most recently, **Genavir**, the vessel operating arm of the *French Research Institute for Exploitation of the Sea* (a.k.a. Ifremer: [www.ifremer.fr/en/The-Institute](http://www.ifremer.fr/en/The-Institute)) started using XChange Telemed, to minimize the impact of illness and injury on five ocean-going research vessels; Alis, Antea, L'Atalante, Pourquoi Pas? & Thalassa. All are part of the *French Oceanographic Fleet* and are connected using a customized VSAT service from Marlink. Now with XChange Telemed fully integrated, crew and scientists aboard benefit from a highly reliable direct link to medical experts on shore, should they fall ill or suffer an injury.

Remote medical assistance is especially important for research vessels. In Genavir's case, the ships are often chartered and deployed for two to three months at sea on a scientific mission without a port call. Previously, any serious medical conditions or injuries on board could entail a return to port, resulting in a premature end to the scientific mission. By providing a high quality live video and data link to medical experts on shore, XChange Telemed can help to mitigate the need for returning to port for medical reasons, and contribute to the comfort, wellbeing and recovery of the patient while the vessel remains





**Marlink's XChange Telemed Service.**

Considering the public funding nature of many scientific missions, remaining at sea for the full duration is the only way to complete the planned research, as financial challenges would normally rule out restarting the project. Genavir selected XChange Telemed to avoid these circumstances and enable its vessel charterers to maximize their investment and time at sea.

Through integration with Marlink's VSAT service, XChange Telemed sessions are bandwidth prioritized to ensure high availability of service for connecting with medical staff ashore. This integration of application and network allows for greater control and optimization of the link on ship and ashore, ensuring fast data connectivity and best quality video, audio and HD images.

Providing the flexibility to integrate XChange Telemed into their existing welfare programs, for the first time in a maritime telemedicine service, customers can choose between utilizing remote medical assistance from compatible public *Telemedical Maritime Assistance Service (TMAS)* centers, or an appointed doctor or a private medical organization. This adds flexibility and is especially important for charterers who may already have existing medical support agreements in place.

"By combining live data from the on board medical kit and patient file with a live video link, XChange Telemed enables professional support from shore for trained medical personnel on board," said Pierre Aldebert, QHSE Manager, Genavir. "It will help to diagnose conditions and develop treatments for crew members and scientists, which may enable our ships to remain at sea and complete their mission in the event of illness or injury."

### **Enabling Scientific Collaboration**

Genavir's research vessels have been enjoying the high bandwidth provided by Marlink's VSAT services for six years. Using a customized configuration, it provides the speed and capacity needed for collaboration with colleagues on shore and the transfer of research data, in addition to flexibility that can accommodate special projects, such as the *2014 Night of the Abyss* event.



**Doctor access via interactive web portal**

For this educational event, Marlink was tasked with temporarily boosting bandwidth for a short period, enabling Ifremer scientists to conduct a live video broadcast and conference from the 'Pourquoi pas?' research ship located in the mid-Atlantic.



**The Tamesis vessel crossing the equator with Linie Aquavit aboard.**

Germany, Holland, the UK, the USA, Mexico, New Zealand, Singapore, China and Japan en route.

This type of videoconferencing is also referred to as *telepresence*. It uses satellite connectivity solutions as a means of transmitting real-time HD video feeds from subsea vessels' data sensors,

Tamesis already benefits from a Marlink VSAT solution, but in order to achieve the high upload speeds required to produce consistent live footage over such an extended distance and duration, Marlink has allocated a temporary bandwidth upgrade to the vessel, adjusting its existing hardware setup, ensuring no additional hardware was required.

The spur for the project came from **Arcus**, the world's largest producer of *Linie Aquavit*, a celebrated Norwegian beverage dating back to the early 19th century. The drink derives its name from a tradition whereby oak barrels of Aquavit are routinely transported on boats from Norway to Australia and back again, thereby crossing the equator ('linje' in Norwegian) twice before being bottled.

Scientific procedures of this nature would previously have been conducted from the vessel itself, but as telepresence allows such assignments to be remotely controlled and operated by any number of teams from shore, the reduction of the ecological footprint is also considerable.

Aquavit's makers have always maintained that the incessant motion, high humidity and wildly varying temperatures encountered by ships on this 2,880-hour passage are all major contributory factors to the drink's accelerated maturation and eventual taste.

In one week alone, the research team was able to share daily research data from five separate dives with multiple shore teams. The campaign showed just how telepresence functionality will allow ever-greater numbers of scientists and students to manage and direct ROV dives in real-time collaboration from their respective laboratories, mitigating the problem of limited passenger space on board research ships and reducing the need for physical travel.

Arcus approached Marlink to assist in proving the importance of the actual voyage for the taste of the aquavit — hence the absorbing live stream, which can be accessed at [linie.com/live/](http://linie.com/live/).

### **Enjoying 'Slow TV'**

While the following customer project may not be the most serious development in history, it does demonstrate the resilience that SATCOM can provide for video transmission globally.

A camera provides a clear, sharp view of Tamesis' cargo deck, with the relevant containers aboard: and while leveraging the calming nature of the recent Norwegian phenomenon of 'slow TV', the real-time coverage has already captured some stirring sights since the vessel left Bremerhaven late 2018 — not least a heavy snow storm in the Atlantic.

Currently, Marlink VSAT is proving integral to the success of a unique 'slow TV' experiment spanning four months and two equatorial crossings. For the purposes of the exercise, Marlink's brief was simple: to enable unbroken live streaming of the **Wallenius Wilhelmsen** vessel **Tamesis** on a four month sea voyage from Bremerhaven in Germany to Australia and back again, taking in stopovers in

While this endeavor is about 'slow TV,' contrastingly high upload speeds are required and the quality of the live stream is a testimony to the effectiveness and flexibility of Marlink's global VSAT delivery.

[www.marlink.com](http://www.marlink.com)

# Data Service Growth Drives...

## A year of change and SATCOM innovation

By Dr. Thomas Fröhlich, Chief Executive Officer, WORK Microwave



**During 2018, the satellite industry continued its evolution as today's operators are delivering higher quality broadcast and high-speed broadband offerings over constrained networks. To drive continued success, they need flexible, scalable and future-proof SATCOM solutions in order to achieve those goals.**

The past year was exciting for **WORK Microwave**. The company experienced strong growth in SATCOM sales, building on the success of several major customer wins over the last three years.

In 2018, WORK Microwave was awarded the largest single order in the company's history by a key system integrator. The firm's ground station equipment will be used within teleportes to support a high-speed satellite network that features a wide range of next-generation technology advancements, including higher frequency bands such as Q/V band, more powerful solid-state amplifiers and more efficient antenna designs, allowing 500 Gbps throughput.

Looking beyond the 2018 successes, here are four key takeaways about the company believes the SATCOM industry is headed in the future and how WORK Microwave is helping operators address the challenges they face today.

### Pivotal Roles

As mentioned earlier, change is rampant in the satellite industry and that will continue during 2019. The company is witnessing significant growth in data services and that is causing frequencies to go higher and bandwidth to increase. This creates new business opportunities as well as challenges for satellite operators.

Whether operators respond with GEO, MEO, or LEO, they have multiple options to fulfill the demand for more data. HTS (*High Throughput Satellite*), UHTS (*Ultra High Throughput Satellite*), UHDS (*Ultra High Density Satellite*), and mega LEO constellations may provide the most efficiencies and cost savings.

WORK Microwave is helping operators address this trend through the firm's multi-band converters. The company shipped more than 1,000 frequency converters in 2018. That massive number demonstrates that the industry is tackling growth in data services and is continuously exploring higher frequencies.

Satellite performance is improving and that, in turn, requires superior quality ground equipment to

enhance factors, such as phase noise, group delay, integration testing. With and stability. WORK Microwave's SATCOM analog and digital solutions meet these challenges head on, helping teleport operators, satellite operators and service providers realize their business objectives, including the critical need for flexibility, scalability, and a future-proof infrastructure.

One of the ways operators are being enabled is to adapt to future requirements for data services through the company's end-to-end solution for wideband applications. WORK Microwave's **AX-80** Series well as support for regulated services. This is of FPGA-based satellite modem, modulator, and demodulator platform supports the DVB-S2X standard for ultra-wideband transponders up to full 256APSK and 500 Msps. Through an all-IP structure, the platform supports native network operation as well as data streaming over IP, providing satellite operators with the flexibility that is critical in today's fast-changing connected world. WORK Microwave offers the first commercially available, end-to-end wideband solution.

### Q and V-Bands Heating Up

Operators are looking more and more at Q- and - band, going beyond the capabilities of Ka-band platforms. Recently, WORK Microwave introduced the industry's first V-band block upconverter as an available product to help operators keep pace with this important requirement.

The company believes Q and V bands will shape the blueprint of future broadband communications systems, as these bands will significantly enhance the performance of the next generation of high throughput satellite programs. Moreover, they will make more bandwidth available for users in Ka-band and will also reduce the number of hubs required. This, in turn, will help drive down cost per bit. WORK

Microwave's Q- and V-band technology has been successfully deployed by operators around the world for more than four years. In the future, the demand for higher quality broadcast and data services will continue to grow. Satellite operators can respond by partnering with bold and innovative technology providers that support higher throughput, higher frequency bands, and offer engineering service expertise.

### Customized Engineering Services = Innovation

Given the changes and growth in the SATCOM industry, the expectation is that there will be significant technology innovation in 2019, especially in the areas of digital, IP and FPGA solutions.

Innovation occurs when there is collaboration. WORK Microwave launched an engineering services program to help other businesses with everything from design and development to consultancy, prototyping, and small series production. What makes the firm's engineering services unique is that complete end-to-end product development and production processes

are offered, with electronic engineering, mechanical engineering, manufacturing and testing expertise all under one roof, enabling the company to resolve any design challenge.

[work-microwave.com/](http://work-microwave.com/)

Thomas Fröhlich has more than 20 years of professional experience in space and security systems. Prior to leading WORK Microwave, he held engineering, project management, and executive positions for the Airbus Group in Germany and France. He has a degree in mechanical engineering and a Ph.D. in engineering from the Technical University of Munich.



# Seraphim Capital's Space Predictions for 2019

The key trends for space tech start-ups...

**2018 was a year of significant milestones in the venture-backed Space Tech market, with acceleration and innovation in smallsats and launch vehicles.**

Strong growth prospects, fueled by a dramatic reduction in the cost of access to space and the exploitation of cloud computing, remain positive.

The near-term outlook for emerging category leaders is favorable, although valuations across the sector will likely soften during 2019, given the broader economic backdrop.

2018 saw a record number of launches and the first successful commercial launch of a venture-backed "small rocket" (**Rocket Lab**). It was also a year of large VC funding rounds for a diverse set of companies. Noted was the continued push of tech giants into space offering a positive indication of the market potential and maturing of the ecosystem.

This was typified by **Amazon's AWS Ground Stations** announcement that aims to enable data to be downloaded directly from space into Amazon's cloud computing platform.

What occurred in 2018 provides a strong foundation for an exciting 2019 — the company expects 2019 to be a record year for venture capital in space, based on the amount invested

as well as the number of VCs invested and companies funded.

As a leading specialist Space Tech investor, **Seraphim Capital** have a unique perspective from seeing all the latest innovations in the space and drone ecosystems around the world. The thoughts from across the company's team regarding the key trends impacting Space Tech start-ups in the coming year have been assembled and here are the predictions for 2019:

## Expansion of mega VC rounds for emerging leaders in New Space.

2018 was a breakthrough year with a record number of Space Tech companies raising "mega rounds" of more than \$75 million. Seraphim Capital expects to see this trend continue for emerging category leaders during 2019.

While mega rounds were once the preserve of **SpaceX** and **OneWeb**, 2018 saw a diverse range of start-ups, from small launch rockets, smallsat constellations, space-based cloud providers to commercial drone and data companies successfully closing large funding rounds. These companies included **SpaceFlight Industries** (\$150 million), **Rocket Lab** (\$140 million), **Cloud Constellation** (\$100 million), **iSpace China** (\$90 million), **HyperSat** (\$85 million) and **PrecisionHawk** (\$75 million).

These investments are a strong validation on both the market potential and commercial progress made by leading players in the ecosystem.

## Let the 2019 Consolidation Games begin!

2018 was an active M&A year in space with defense primes and category leaders looking to consolidate their positions through acquisitions.

Defense primes, including **Boeing** and **Lockheed Martin**, expanded into smallsats and the consolidation of satellite communications service providers continued with **Speedcast**'s acquisition spree.

In Earth Observation (EO), data providers continued to move up the value chain, with **Planet Labs'** acquisition of **Boundless Spatial** and **UrtheCast**'s acquisition of **Geosys**.

During 2019, expect the consolidation process to pick up steam. Not envisaged is any big IPOs in New Space, as tech companies are typically staying private for a longer period of time. However, do expect category leaders, such as Planet Labs and PrecisionHawk, to leverage their market position and funding to expand into analytics and acquire specific vertical expertise.

Given big exits are likely to remain elusive, expect smaller, early-stage companies

to access funding more challenging, should macro-economic drivers lead to a general retrenchment from risk within the investment community.

Mega-constellations and record smallsats will launch. After years of development, OneWeb and SpaceX will begin to deploy their *Low Earth Orbit* (LEO) mega-constellations in 2019, albeit their full constellation targets will take several more years. Both are planning global coverage to provide internet broadband to the billions of unconnected. Crucially, both still need to define their "go-to-market" strategy and solve the ground segment element of their proposition ahead of commercial roll-out.

Beyond these mega-constellations, record numbers of other smallsat start-ups will successfully reach orbit, including multiple dedicated IoT constellations and potentially the first 'swarms' of the next generation of miniaturized satellites — *picosats*.

The advent of these constellations of hundreds — if not thousands — of satellites will pose increased risks for space debris. Demand for *Space Situational Awareness* (SSA), and tracking and removal of debris will accelerate, in the company's view.

#### **Accelerating enterprise adoption of geospatial A.I. analytics and data convergence.**

As more satellite data comes online from new EO constellations with a plethora of sensors (SAR, hyperspectral, RF, IR, and so on), coupled with advances in A.I. / machine learning, expect to see an acceleration in the commercial adoption of geospatial analytics. In particular, anticipate that the benefits of SAR's day/night/all-weather imaging capabilities will become increasingly prevalent.

2019 to be a defining year for A.I. in Space Tech, as Fortune 500 companies start to shift from pilots evaluating how to leverage geospatial data within their businesses and toward large-scale "*real world*" deployments. Such early adoption is likely to be focused initially on using A.I.-led automation to drive cost savings and efficiencies.

Longer term, the convergence of satellite, drone and IoT imagery and location data powered by A.I. will provide powerful tools and insights to drive business' broader digital transformation. Additionally, the polarization of A.I. start-ups will occur, with some stars emerging at the expense of those with technology stacks more reliant on commoditized algorithms.

#### **Space cybersecurity becomes a top priority for governments and companies.**

Addressing cybersecurity and the growing vulnerability of mission critical space

assets, including satellites, communications equipment, ground stations and data storage from new attack vectors have become increasingly urgent for both government and commercial players.

Interest will grow in new solutions designed to mitigate these threats, such as *quantum encryption* and *embedded security*.

#### **Rise of counter-drone solutions opens up new business cases.**

2018 brought into sharp contrast the potential threat drones pose to public safety, with recent chaos at Gatwick airport and an alleged attempted assassination of a Latin American President examples of such threats.

Expect growing interest in security and counter-drone solutions. More importantly, regulators and the drone industry are collaborating to ensure safety by piloting *Remote ID*, *Unmanned Traffic Management* (UTM) solutions, night missions and *Beyond Visual Line of Sight* (BVLOS) technologies. This will open up new business cases with more autonomous and complex flight missions.

This to drive should further enterprise market penetration of drone solutions, especially in security, inspection and survey for key vertical markets such as Energy, Construction, Transportation and Insurance.

#### **FANGS take a bigger bite of space-tech ecosystem.**

2018 saw a continued push into space by the world's biggest tech companies.

The race intensified between **Google** and **Facebook** with stratosphere balloons and solar-powered drones to connect the billions of people around the world still without the internet.

**Amazon**, also, took aim at disrupting space with the launch of **AWS Ground Station**, which enables operators to download data from space directly into the Amazon's AWS cloud.

This new business model of pay-as-you-go integrated data services will drive more rapid turnaround and significantly lower cost/barriers to entry for new players.

Expect continued interest in space from tech giants in the coming year with new partnerships, projects and potential acquisitions, all driven by their vision of a connected world of *Internet of Things* (IoT) and A.I. enabling autonomous systems.

#### **Smallsat launchers — some will skyrocket — others will flame-out.**

Rocket Lab became the first venture backed small launcher to complete a successful commercial mission in 2018.

More smallsat launchers (**Virgin**)

**Orbit, Vector, Firefly** and **Astra**) are targeting orbital launches in 2019.

Seraphim Capital estimates there are close to 100 start-ups looking to address the small launch market of sending potentially thousands of smallsats into space during the coming years. A shake-out is inevitable, as these launchers prove their reliability and launch cadence while vying for market share.

#### **China continues to flex its Space Tech muscles.**

For the first time in history, China became the world's top launch provider, with 39 launches in 2018 versus 34 from the U.S.

China's **Beidou** GPS navigation constellation aims to rival the American (**GPS**) and European (**Galileo**) satellite navigation systems and the nation recently achieved the world's first successful landing on the far side of the moon.

In the Space Tech start-up ecosystem, the likes of **iSpace, One Space** and **Landspace** already rival western smallsat launchers both in terms of funding and technical capabilities.

In 2019, the expectation is that Chinese start-ups will extend their influence beyond the launch market into all facets of the Space Tech ecosystem, from smallsat manufacturing to constellations.

Near term, the belief is that Chinese space companies will primarily focus on the large and untapped domestic market. Longer term, they could represent serious new competition on a more global basis — simply look at how Chinese drone maker **DJI** has come to dominate the drone hardware market.

#### **Commercial human spaceflight comes to life.**

Fifty years after the Apollo moon landing, 2019 will be the year of commercial human spaceflight.

SpaceX and Boeing are scheduled to fly their demonstration missions to the International Space Station (ISS) as part of **NASA's Commercial Crew Development Program**.

Space tourism will finally become reality with both **Virgin Galactic** and **Blue Origin** preparing their maiden flights on their suborbital vehicles in 2019. Seraphim Capital expects this market to develop fairly slowly over forthcoming years, as pricing will remain cost prohibitive to all save the ultra-high-net worth individuals.