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SatMagazine

Hybrid Satellite and OTT Solutions

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Geospatial AI

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VC Funding

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Communication Failure = Lives Lost

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Tapping Satellite Technology

Tapping Satellite Technology

Your Space Startup

Your Space Startup

Enhancing LandViewer

Enhancing LandViewer

Seamless Radio

Seamless Radio

Polar Telecomms with Smallsats

Polar Telecomms with Smallsats

The New Race for Space

The New Race for Space

Space Debris

Space Debris

Very High Speed Networks

Very High Speed Networks

Arianespace's Ariane 5 lifts off with AT&T's T-16 and the EUTELSAT 7C satellites aboard.
Photo is courtesy of Arianespace



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SSTL-Built FORMOSAT-7 heads into orbit

The successful launch on June 24, 2019, EST of six satellites for the FORMOSAT-7 joint U.S.-Taiwanese weather forecasting constellation marks the start of another SSTL-enabled space mission.

The launch on the SpaceX Falcon Heavy rocket from the Kennedy Space Center was attended by SSTL staff including Managing Director, *Sarah Parker*. The company congratulated their customers, NSPO in Taiwan, and NOAA in the United States, on the successful launch of their constellation.



Artistic rendition of the Fomosat-7 smallsat. Image is courtesy of SSTL.

FORMOSAT-7, also known as COSMIC-2 in the U.S., is a joint constellation meteorological satellite mission between Taiwan and the United States for observing and monitoring the global meteorology, climate, and ionosphere. In addition to two science payloads for detecting ionospheric data, each of the six satellites in the constellation is carrying an advanced GNSS receiver to low-inclination-angle orbits and will collect atmospheric data at low and mid latitudes to provide sounding data to improve regional and global weather forecasting. The processed data will be provided by two data processing centers located in Taiwan and USA.

www.sstl.co.uk

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InfoBeam Ariane 5 successfully launches AT&T's T-16 and the Eutelsat 7C satellites



For the company's second launch of the year, Ariane 5 successfully placed two telecommunications satellites, T-16 and EUTELSAT 7C, into geostationary transfer orbit (GTO), from the European spaceport in Kourou (French Guiana).

The total performance required of the Ariane 5 launcher was 10,594 kg., of which the two satellites accounted for 9,736 kg. The payloads were injected into an orbit inclined 6 degrees in relation to the equator.

André-Hubert Roussel, the CEO of ArianeGroup, said that each new success of Ariane 5 is a new victory for the thousands of technicians and engineers whose know-how has guaranteed the success of the European heavy launcher on the global commercial market and their independent, sovereign access to space for almost 40 years. The company has just initiated series production of the first 14 Ariane 6 launchers and are actively working on the transition from Ariane 5 to Ariane 6, so each new success is a source of pride and encouragement for ever-higher space ambitions to benefit their customers around the world.

ArianeGroup is the industrial lead contractor for the development and deployment of Ariane 5 and Ariane 6 launchers. The company coordinates an industrial network of more than 600 companies (including 350 SMEs) in 13 European countries.

ArianeGroup oversees the entire industrial supply chain, from performance optimization and the corresponding studies associated with the Ariane 5 to production, from the supply of mission-specific data and software to the marketing of the launcher through Arianespace. This chain includes equipment and structures, engine manufacturing,

integration of the various stages and finally launcher integration in French Guiana.

Arianespace's June 20 mission marks the fifth flight in 2019 by its launch vehicle family — which consists of the heavy-lift Ariane 5, medium-size Soyuz and lightweight Vega. It will be the second this year using Ariane 5.

In performing this 104th Ariane 5 mission — the 71st with an Ariane 5 ECA version — Arianespace confirms its full capability in the geostationary launch services market segment.

The T-16 is the 11th satellite to be orbited by Arianespace for AT&T, following SKY Mexico-1 and DIRECTV 15, launched together on an Ariane 5 in May 2015; and SKY Brasil-1, launched in February of 2017.

T-16 was manufactured by Airbus Defence and Space and will provide high-power broadcast services in Ku- and Ka-bands. Being flexible, the spacecraft can be operated from five orbital slots (from 99 degrees West to 119 degrees West) and will cover the continental United States, Alaska, Hawaii and Puerto Rico.

EUTELSAT 7-C will be Eutelsat's 33rd satellite to be launched by Arianespace since the first mission at its service, which deployed EUTELSAT-1 F1 in 1983.

EUTELSAT 7C is a high-power broadcast satellite for markets in Africa, Europe, the Middle East and Turkey. It is equipped with 49 36-Mhz equivalent Ku-band transponders and will be located at Eutelsat's 7 degrees East position. EUTELSAT 7C was built by Maxar Technologies in Palo Alto, California.

www.arianespace.com



Artistic rendition of the Arianespace nexgen Ariane-64 launch vehicle. Image is courtesy of ESA.

Viasat Inc. and Arianespace have modified the original ViaSat-3 satellite launch contract, signed in 2016 — under the new agreement, the two companies agreed to move the ViaSat-3 satellite from an Ariane 5 ECA launch vehicle to the next-generation Ariane 64 (A64) launcher.

With this contract, Viasat will become the first commercial customer to commit to launch on the A64.

The A64 launcher is expected to maintain launch quality and reliability, but with added mission effectiveness, efficiency and flexibility.

The A64 launch vehicle will feature a modular configuration based on core stages powered by lower and

upper liquid propellant modules, which is supplemented by four solid rocket motors.

The A64's configuration will also provide added performance to deliver a ViaSat-3 satellite into a high-energy geostationary transfer orbit where it can begin on-orbit operations faster.

Moving to the A64 launcher completes Viasat's integrated launch strategy, which is designed to bring

an on-time launch to all of the ViaSat-3 spacecraft through launch vehicle diversity and an integrated approach to launch planning.

Viasat will announce specific mission assignments for each of the contracted launch vehicles at a later date.

The ViaSat-3 class of Ka-band satellites is expected to provide unprecedented capabilities in terms of service speed and flexibility for a satellite platform.

The first two satellites will focus on the Americas and on Europe, Middle East and Africa (EMEA), respectively, with the third satellite planned for the APAC region, completing Viasat's global service coverage.

Each ViaSat-3 class satellite is expected to deliver more than 1-Terabit per second of network capacity, and to leverage high levels of flexibility to dynamically direct capacity to where customers are located.

Dave Ryan, president, Space and Commercial Networks at Viasat commented that the company has a long-standing partnership with Arianespace and trusts that their A64 launcher will allow Viasat to meet key business objectives, which include bringing high-speed, high-quality broadband connectivity to end-users, worldwide.

Arianespace Chief Executive Officer, Stéphane Israël, said the company is honored that Viasat initially chose Arianespace for one of their ViaSat-3 launches and has now evolved the program, enabling them to be the first commercial launch customer to commit to fly on the company's powerful Ariane 64 launcher.

www.viasat.com/

www.arianespace.com/



Arianespace will launch the ViaSat-3 satellite from the Guiana Space Center, Europe's Spaceport in Kourou, French Guiana. Artistic rendition of the ViaSat-3 satellite.

The SaT5G project has announced the operation of a number of successful demonstrations of 5G over satellite at the 2019 European Conference on Networks and Communications (EuCNC 2019) in Valencia, Spain.

The project vision is to develop a cost-effective plug-and-play SATCOM solution for 5G to enable mobile operators and network vendors to accelerate 5G deployment across all geographies and multiple use cases while at the same time creating new and growing market opportunities for SATCOM industry stakeholders.

The demonstration showcases a network that integrates 5G over parallel satellite and terrestrial delivery paths to provide enhanced Quality of Experience (QoE) for users consuming 4K video content. The innovative demonstration highlights how a Multi-access Edge Computing (MEC) proxy can incorporate bit-rate adaptation, link selection and enhance layered video streams for future satellite and terrestrial integrated networks.

The demonstration is undertaken in partnership with Avanti's high-throughput HYLAS 4 GEO satellite capacity, University of Surrey's 5G Innovation Centre testbed network and VT iDirect's 5G-enabled satellite hub platform and satellite terminals

The demonstration showcases over-the-air satellite multicast technology for the delivery of live channels using an MEC platform for Content

Delivery Network (CDN) integration with efficient edge content delivery.

The demonstration highlights the benefits, in terms of bandwidth efficiency and delivery cost, of using a satellite-enabled link for provisioning live content in a 5G system.

The demonstration is undertaken in partnership with Avanti's high-throughput HYLAS 4 GEO satellite capacity, Broadpeak's CDN, University of Surrey's 5G Innovation Centre testbed network and VT iDirect's 5G-enabled satellite hub platform and satellite terminals.

The demonstration showcases 5G technology aboard aircraft, leveraging virtualized services for content distribution.

An integrated approach for the delivery of 5G connectivity services based on a Medium Earth Orbit (MEO) SATCOM solution will be introduced. The innovation targets the next-generation inflight entertainment services to passengers and connectivity solutions for airplanes with a combined satellite and terrestrial 5G network.

The demonstration is undertaken in partnership with the Safran (Zodiac Inflight Innovations) virtualized A320 airplane cabin mock-up and connectivity infrastructure, Broadpeak's content delivery platform, Gilat Satellite Networks' Taurus VSAT unit and virtualized satellite hub, i2CAT's terrestrial satellite resource coordinator

(TALENT), Quortus' mobile network core, and SES' low-latency high-throughput O3b MEO satellite constellation.

Using a satellite emulator testbed, TNO demonstrates local access using an established satellite and terrestrial backhaul link with User Plane Function (UPF) located at a MEC node for content delivery. The UPF in the MEC node is used to handle requests for the local content with the ability to optimally select between satellite or terrestrial links depending on available capacity, network policy, link performance and the type of end-user profile. The innovation lies with the ability to set up connections for downloading content with the DASH Enabled Network Element (DANE) collocated with UPF, which can now handle both satellite and terrestrial links simultaneously.

The University of Oulu demonstration jointly defined with Thales Alenia Space shows that with some modifications, it is possible to apply 5G NR over satellite links for future satellite systems. As listed in 3GPP TR 38.811, the key issues that need addressing include higher latency and increased Doppler shift. The demo concentrates on the uplink random access process.

The Ekinops demonstration showcases how a standard 5G User Equipment (UE) leverages a hybrid backhaul and validates the performance required by 5G services, including packet loss mitigation and remediation. The solution provides tangible measurements of very high QoE achieved by combining satellite-terrestrial links bandwidths for fast upload and download traffic and the terrestrial link low latency for interactive traffic. The demonstrated 5G-hybrid backhaul relies on state-of-the-art multipath protocols and shows satellite as a viable backhaul link for 5G service.

Indran Sivarajah, Project Director of SaT5G, said SaT5G is a bold project and the goal is to ensure that with the roll-out of 5G networks, the gap between the unconnected and connected world does not widen any further. For mobile operators, these underserved markets are seen as key to accessing the last remaining 1.6 billion subscribers and SATCOMs are well positioned to play a major role here. We want to build an attractive plug-and-play SATCOM solution with 5G for telcos and network vendors to accelerate 5G deployment and at the same time creating new and growing market opportunities for the SATCOM industry.

Mike Fitch, Technical Manager of SaT5G said: that SaT5G is about integrating satellite links with heavy emphasis on standardization to allow trusted operation and to facilitate industry adoption. The focus is on eMBB to fixed and mobile networks, including support for orchestration and slicing, with the satellite links providing backhaul connectivity either alone or in parallel (multi-link) connectivity with terrestrial links. Innovations from the project include satellite modem VNFs, business process modeling including brokers, and improved multicast and multi-link algorithms for use with satellite.

www.eucnc.eu/

www.avantiplc.com/

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www.idirect.net/

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www.gilat.com/

www.tno.nl/en/

www oulu.fi/yliopisto/

www.thalesgroup.com/en/global/activities/space

www.ekinops.com/

Please visit the SaT5G website link for a detailed description of the demonstrations.



Artistic rendition of Avanti's Hylas-4 GEO satellite.



Lacuna Space has successfully concluded their first phase of testing in the company's mission to provide complete global coverage for LoRa® devices and wireless radio frequency technology (LoRa Technology) to anywhere in the world, no matter how remote.

Lacuna Space is engaged in satellite IoT connectivity, with low-cost and high-scalability as its fundamental tenets in its system design. Over the course of the last two years, Lacuna has been collaborating with Semtech Corporation to extend

LoRa Technology connectivity to the entire world.

Lacuna Space has been developing satellite gateways and working with Semtech to evolve LoRa Technology to enable direct communication from LoRa-based devices to satellite gateways using the LoRaWAN® protocol.

Lacuna's first satellite launch of the year was on April 1, 2019, from the Satish Dhawan Space Center in India, where the satellite shared a ride to LEO with EMISAT and 27 additional satellites.

Lacuna's LoRa-based Space Gateway was hosted on a 6U cubesat satellite provided by Nano Avionics and Lacuna has revealed that the satellite and the Space Gateway are out-performing expectations during the initial commissioning phase.

An additional three satellites are set for launch in Q3 and Q4 of this year to complete Lacuna's initial demo constellation.

Lacuna is aiming to be ready to perform more extensive demonstrations with a select group of potential users toward the end of

the year, thanks to part funding and support from the European Space Agency and UK Space Agency.

Rob Spurrett, the Lacuna Space CEO, remarked that the company is eager to get these next satellites launched so the firm can increase the performance of the whole system, including the fine tuning of this novel, adaptive, radio approach that enables Lacuna Space to detect tiny signals directly from battery powered sensors in remote locations.

Nicolas Sornin, CTO, Semtech, added Lacuna's expanding LoRaWAN-based network coverage to the most remote regions is an incredible technical achievement. More users will develop LoRa-based applications that need long range, low power and flexible capabilities.

lacuna.space/

www.semtech.com/lora

To strengthen collaboration and integration across its portfolio, Boeing is relocating the headquarters of its Space and Launch division to Titusville, on Florida's revitalized Space Coast.

Space and Launch, a division of Boeing Defense, Space & Security, currently has its headquarters in Arlington, Virginia.

In announcing the relocation of the headquarters to a region that includes Kennedy Space Center, Cape Canaveral Air Force Station and Patrick Air Force Base, Boeing leaders said the timing of the move makes sense for multiple reasons:

- *The Boeing-built X-37B uncrewed, reusable space vehicle continues to perform record-setting, long-duration missions for the U.S. Air Force.*
- *Boeing's satellite programs anticipate increased tempo in local payload processing and launch activity.*
- *The company is enhancing its focus on mission integration and launch system operations in collaboration with Air Force partners nearby at Cape Canaveral Air Force Station and the 45th Space Wing at Patrick Air Force Base, and strengthening relationships with Air Force Space Command in*

Colorado and Vandenberg Air Force Base in California.

- *The CST-100 Starliner commercial spacecraft is preparing for two flight tests later this year ahead of operational missions to the International Space Station beginning in 2020.*
- *Boeing continues to achieve milestones toward delivery of the first two core stages of the world's most powerful rocket, NASA's Space Launch System, for uncrewed and crewed missions to the Moon's orbit leading to the first crewed lunar surface landing in 50 years, and then to Mars.*
- *The International Space Station is poised to follow NASA's road map for commercialization of LEO, even as this national laboratory is positioned for continued scientific and technological research until at least 2030.*
- *The United Launch Alliance joint venture continues to meet vital launch needs for national security, scientific and telecommunications missions through its Atlas and Delta rockets, while entering the formal qualification phase for the new Vulcan Centaur launch vehicle.*

- *Boeing is studying and advancing future space capabilities in collaboration with the Defense Advanced Research Projects Agency (DARPA).*

The headquarters move will have no impact on Boeing's space operations in other states, including California, Texas, Alabama, Colorado and Louisiana.

Boeing Defense, Space and Security President and CEO *Leanne Caret* said that the company is looking to the future and this storied Florida space community will be the center of gravity for Boeing's space programs as the firm continues to build the company's leadership beyond gravity.

Caret noted that the time is right for them to locate the Boeing space headquarters where so much of the nation's space history was made over the past six decades and where so much history awaits.

Jim Chilton, SVP of Space and Launch, added that Boeing has been a dominant presence on the Space Coast for six decades and this move represents a continuation of that legacy and future commitment.

He remarked that expanding the Boeing presence on the Space Coast brings tremendous value for the company's commercial and government space programs through focused leadership, strategic investment, customer proximity and additional contributions to the vitality of the region.

Chilton added that Boeing will continue to be a dynamic space presence in its existing locations, contributing to the vitality of those aerospace hubs, collaborating with our regional partners, and inspiring future generations of space engineers, technicians and innovators.

twitter.com/BoeingSpace

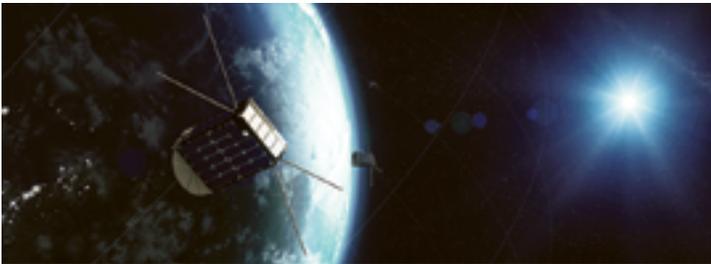




GomSpace A/S has been selected by UnseenLabs SAS to develop and deliver their second-generation space system.

The collaboration will result in further enhancement of the capabilities to provide disruptive spectrum monitoring services from space, featuring unique hardware and software.

Under the ATP, signed at the Paris Airshow, the parties will complete work to define the scope and specifications of the new space system to be finally contracted within the fall of 2019.



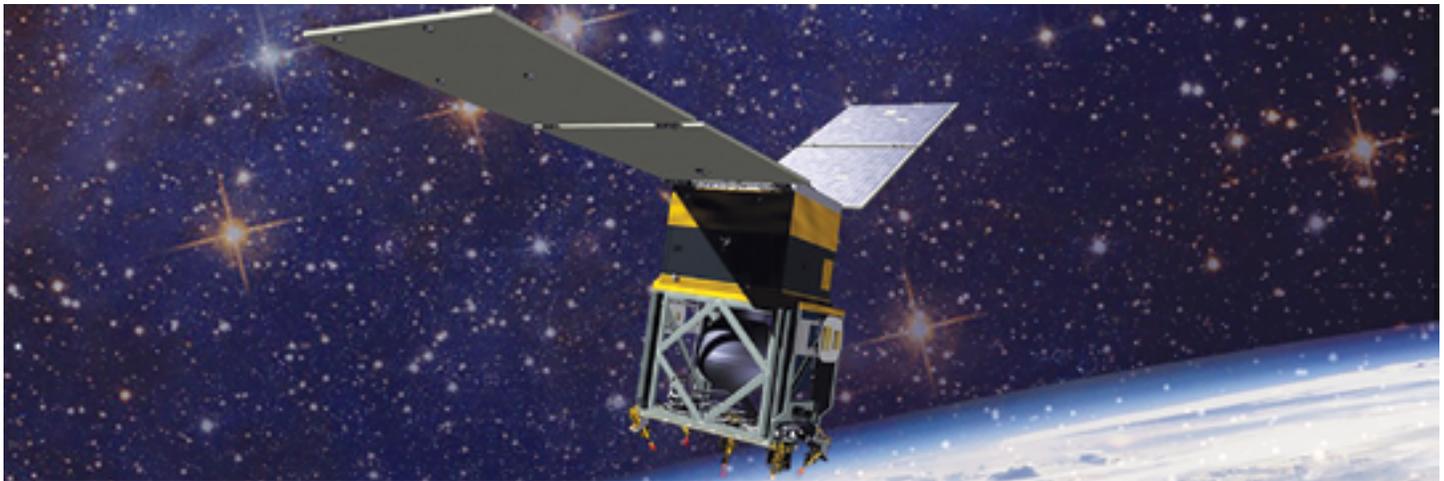
Niels Buus, the CEO of GomSpace, said the company is excited to continue the collaboration with UnseenLabs. With this project, the firm believes that UnseenLabs will continue to provide a disruptive capacity to their customers for maritime surveillance services provided by LEO satellites.

Jonathan Galic, CEO and Co-Founder of UnseenLabs, remarked that working with GomSpace during the development of the company's first-generation space system has convinced the firm that they are the correct choice for the firm's continued roadmap.

Galic added that GomSpace's flight proven hardware and software products are a major source of confidence, allowing UnseenLabs to focus the company's expertise on payloads, missions and services.

gomspace.com/

unseenlabs.space



Artistic rendition of the GPIM spacecraft.
Image is courtesy of Ball Aerospace.

A Ball Aerospace satellite used for NASA's Green Propellant Infusion Mission (GPIM) is ready for launch, scheduled for no earlier than June 24 on board a SpaceX Falcon Heavy rocket.

Ball built the smallsat, which contains NASA's first opportunity to demonstrate a new "green" propellant and propulsion system in orbit — an alternative to conventional chemical propulsion systems.

As the prime contractor for GPIM, Ball Aerospace is responsible for system engineering; flight thruster performance verification; ground and flight data review; spacecraft bus; assembly, integration and test;

and launch and flight support. The spacecraft bus is the smallest of the Ball Configurable Platform (BCP) satellites, which is about the size of a mini refrigerator, and was assembled in just 46 days.

The BCP provides standard payload interfaces and streamlined procedures, allowing rapid and affordable access to space with flight-proven performance.

There are currently two BCP small satellites performing on orbit: STPSat-2, which launched in November 2010, and STPSat-3, which launched in November 2013.

The two STP satellites were built for the U.S. Air Force Space Test Program's Standard Interface Vehicle (STP-SIV) project.

GPIM is part of NASA's Technology Demonstration Missions program within the Space Technology Mission Directorate (STMD), and *Christopher McLean* of Ball Aerospace serves as the principal investigator.

The mission will demonstrate the practical capabilities of AF-M315E, a Hydroxyl Ammonium Nitrate fuel and oxidizer monopropellant developed by the Air Force Research Laboratory.

In addition to STMD and Ball Aerospace, the GPIM team

includes: Aerojet Rocketdyne; U.S. Air Force Research Laboratory at Edwards Air Force Base; the Air Force Space and Missile Systems Center at Kirtland Air Force Base, New Mexico; and three NASA field centers — NASA's Glenn Research Center in Ohio, NASA's Kennedy Space Center in Florida, and NASA's Goddard Space Flight Center in Maryland.

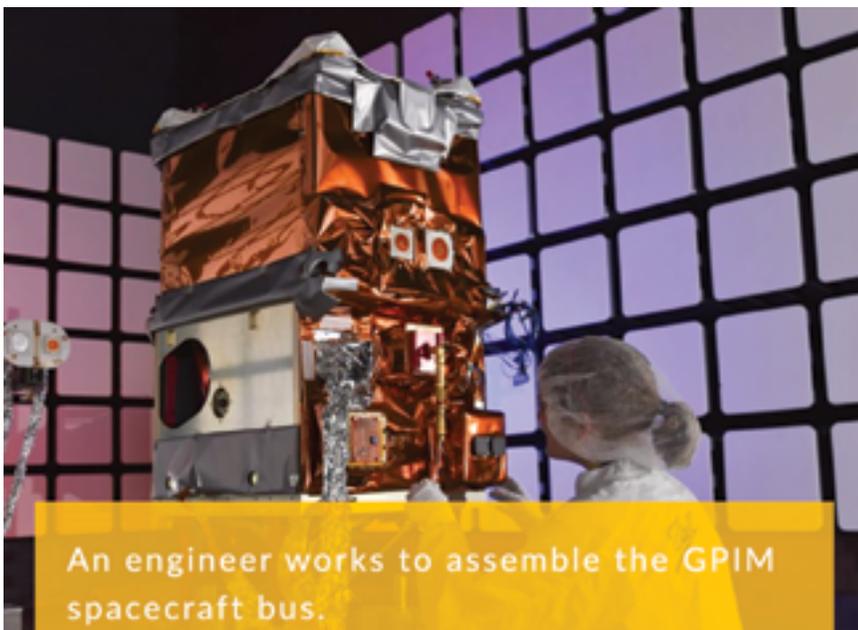
GPIM is one of several payloads launching as part of the Department of Defense STP-2 mission managed by the U.S. Air Force Space and Missile Systems Center. Another payload, the Constellation Observing System for Meteorology, Ionosphere, and Climate-2 (COSMIC-2) satellite, carries five Ion Velocity Meters built by Ball and designed by the University of Texas at Dallas (UTD) that will measure one parameter of the space weather environment as part of a successful technology transfer program.

COSMIC-2 is a joint mission including the National Oceanic and Atmospheric Administration, U.S. Air Force, Taiwan's National Space Organization and the University Corporation for Atmospheric Research.

Dr. *Makenzie Lystrup*, VP and GM, Civil Space, Ball Aerospace, said that GPIM has the potential to inspire new ideas and new missions, which could mean smaller spacecraft, faster and easier ground processing, longer design lives and more.

Dr. Lystrup also noted that Ball is developing smallsats for two other NASA missions — the Imaging X-Ray Polarimetry Explorer (IXPE) and the Spectro Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer (SPHEREx) missions.

www.ball.com/aerospace/programs/gpim



An engineer works to assemble the GPIM spacecraft bus.

Speedcast International Limited (ASX: SDA) and XipLink Inc. have combined tech forces to develop comprehensive technologies to maximize efficiencies in data transfer across Wide Area Networks (WAN).

As the technology convergence between the network and application layers speeds up, Speedcast and XipLink see the importance in developing next-generation solutions that are flexible and scalable across different environments. The partnership is focused on the two companies' strengths across three main areas:

- *Speedcast will integrate XipLink into cellular backhaul solutions to improve network efficiencies, which will be especially important in the 5G era.*
- *XipLink will be hosted on Speedcast's award-winning SIGMA Gateway network management device with the capability to be activated remotely as a Virtual Machine (VM).*
- *Speedcast and XipLink operational and software personnel will integrate network management interfaces and leverage machine-driven analytics to simplify operational processes, increase network visibility and enhance customer experience.*

Tim Bailey, EVP, Products, Marketing and Business Development, Speedcast, said the company recognizes the important role that network optimization plays in managing critical communications. The XipLink partnership gives the firm the ability to expand the scope of offered services and provide innovative technologies to customers across the industries Speedcast serves.

Bailey add that XipLink's WAN optimization solutions will improve network efficiency and deliver increased throughput for the firm's customers' business-critical applications.

Jack Waters, CEO, XipLink, noted that this partnership agreement with Speedcast will deliver network efficiency, ease of deployment, and reduced complexity for end customers in Maritime, Cellular Backhaul, Government and other markets where Speedcast is a leader.

www.speedcast.com/

xiplink.com/

The Scottish Highlands are undergoing environmental impact studies for a proposed Space Hub in Sutherland.

Preparatory work is getting underway to agree the scope of environmental impact studies that should be carried out in relation to the site of a proposed space center in Sutherland. Highlands and Islands Enterprise (HIE) is currently developing plans for Space Hub Sutherland, which is expected to begin vertical launches of small satellites from the A'Mhoine peninsula, near Tongue, early in the next decade.

The project has attracted support from the UK Space Agency, which is also funding two launch companies that plan to set up in Sutherland — Lockheed Martin Space Systems and Orbex.

Space Hub Sutherland is planned as a key component of Scotland's growing space sector. The development agency expects 40 high quality jobs will be created locally, part of a total of more than 400 across the wider Highlands and Islands. Orbex has already opened a new manufacturing facility in Forres.

The potential launch site at A'Mhoine is next to the Caithness and Sutherland Peatlands Special Protection Area and Special Area of Conservation, and the Ben Hutig Site of Special Scientific Interest.

Understanding the environmental impacts of satellite launches, as well as the economic benefits, will be crucial factors in determining the outcome of a future planning application to the Highland Council for design and construction of the space hub.

That application is currently being prepared by HIE and will be accompanied by an extensive round of public consultation so that local people have opportunities to view the plans and put questions to the developer.



Scotland's enterprise agencies have launched ambitious plans to help build a more economically vibrant country.

As a first step toward determining environmental impacts, HIE now seeking agreement on the scope of environmental issues that will need to be examined. The development agency is consulting the Highland Council, statutory consultees Scottish Natural Heritage, the Scottish Environment Protection Agency and Historic Environment Scotland, and a wide range of other interested parties.

Scotland's enterprise agencies have launched ambitious plans to help build a more economically vibrant country. In line with the EU's environmental impact assessment directive, HIE is proposing to examine potential impacts on the local area, specific habitats and the marine environment.

Roy Kirk, Space Hub Sutherland Project Director with HIE, said, "As our plans develop, it is absolutely vital that we gain a thorough understanding of the potential environmental impacts that a launch facility could have, including around the location of the site itself. We have been carrying out bird studies, for example, for well over a year now, so there is already a stock of robust data regarding that aspect.

"The new proposal will help us scope out the full range of environmental issues that we need to examine and that will inform the development of the project as we head towards a future planning application.

"Space Hub Sutherland is an evolving project and the plans need to be very forward-looking. For the purpose of the scoping exercise, we've used figures that range from current expectations to the absolute extreme end of any potential activity that could take place there. This will make sure that environmental assessments are as robust as possible, by being based on maximum possible impacts."

Papers associated with the initial scoping exercise are available online at The Highland Council website. "It is very positive to see the first scoping documents for the launch site at Sutherland Spacehub, representing the work of dozens of people and numerous industry and environmental experts over the past years to examine the challenge of taking Britain back in to space," said Kirk.

This document is a first, giant step toward a formal planning application. It's a very detailed and careful alignment between the project and planning stakeholders on what aspects might have environmental or other impacts. However, it is very important to note that there is still a lot of design work and refinement ongoing to finalize requirements to ensure minimal impact.

Those that are unfamiliar with planning procedures may not be familiar with the rigor of the environmental impact assessment required, and which has been ongoing at Sutherland since 2017. It's important that this understanding is based on facts rather than speculation or misinformation. This is a multi-year process involving dedicated studies from dozens of industry and agency experts, as well as engagement with multiple stakeholders and authorities.

As an example, a two-year study detailing the local bird populations at the A'Mhoine site is now nearing completion. It's worth noting that any launch site of this nature — including those in other regions of Scotland near sensitive areas of natural heritage — will face similar requirements to present multi-year studies to Scottish National Heritage and the Scottish Environment Protection Agency, among other stakeholders.

The economic impact of the spaceport in the Highlands and Islands region is expected to deliver around 400 jobs in various activities, and around 40 locally at the spaceport, including roles in administration, finance, licensing, insurance, maintenance, fueling, engineering, communications, public relations, housekeeping, security and community relations.

Orbex stated the company is committed to operating the A'Mhoine site in a compatible and "green" manner and will be using a site-compatible small launch vehicle with an ultra-low carbon bio-propane fuel. Orbex is already investing in the Highlands region at Forres, and will be making some more announcements about developments at other locations in due course.

wam.highland.gov.uk/wam/centralDistribution

<https://www.lockheedmartin.com>

InfoBeam

Aerojet Rocketdyne has been busy building eight auxiliary engines for integration into the European Service Module (ESM) of NASA's Orion spacecraft.

Aerojet Rocketdyne delivers eight engines for Artemis 2

in-space trajectory and position, as well as serve as backup to the main engine.

The eight 110-pound-thrust bipropellant engines will be coupled into four pairs on the bottom of

prior to Orion's re-entry to Earth's atmosphere, provides propulsion, power, temperature control, air and water for crew members.

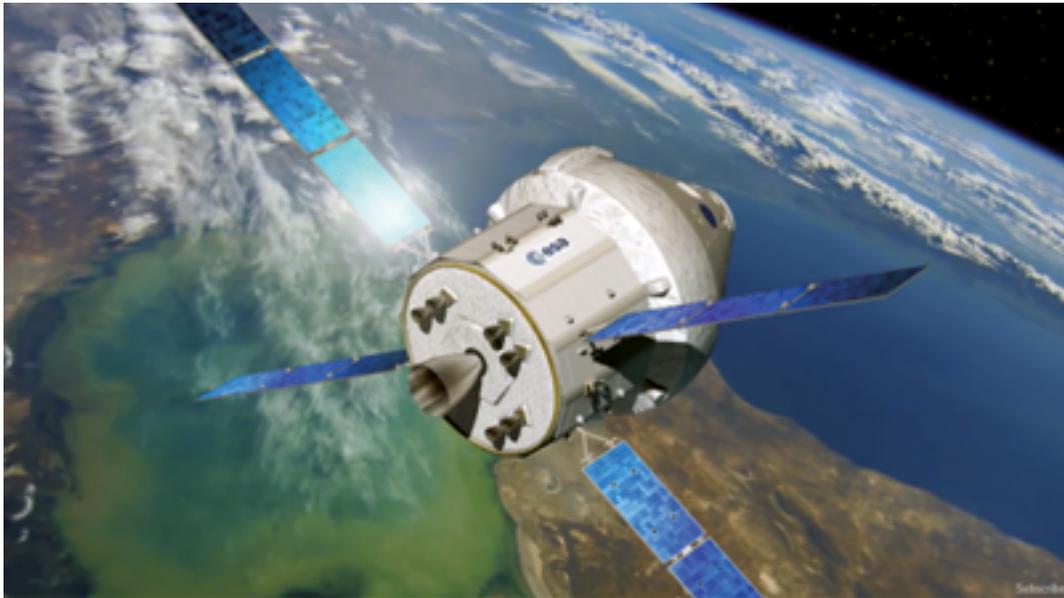
Orion's goals are to be capable of taking crews into deep space

Space Launch System (SLS) heavy-lift rocket, Orion is designed to carry people farther into space for longer periods of time than ever before, withstanding higher levels of radiation and re-entry speeds than any previous human-rated spacecraft.

Aerojet Rocketdyne CEO and President *Eileen Drake* stated that based on the flight-proven R-4D engine, their auxiliary engines will provide critical maneuverability and propulsive support to Orion throughout its mission.

The auxiliary engines for Orion are manufactured, tested and qualified at Aerojet Rocketdyne's Redmond, Washington facility under a contract to Lockheed Martin, NASA's prime contractor for Orion.

Aerojet Rocketdyne also provides the service module main engine components, Launch Abort System jettison motor, crew module reaction control system and composite overwrapped pressure vessels for the Orion spacecraft.



Artistic rendition of the European Service Module

Artemis 2 is Orion's first mission to carry astronauts, and Aerojet's engines will ensure the spacecraft's

the ESM. The ESM, which remains connected to the spacecraft throughout the mission until just

destinations and returning them safely to Earth.

Launched on NASA's new

www.rocket.com

InfoBeam

Airbus has increased their high-resolution imagery portfolio following an agreement to leverage capacity from the S1-4 satellite built by Surrey Satellite Technology Limited (SSTL) — this new imagery offer, called Vision-1, delivers full end-to-end imaging operations to Airbus' customers.

Vision-1 provides 0.9 meter resolution imagery in the panchromatic band and 3.5 meter in the multi-spectral bands (NIR, RGB), with a 20.8 km. swath width. These specifications are ideal for defence, security and agriculture applications, while this extra revisit opportunity further strengthens Airbus' satellite fleet.

Airbus enhances Vision-1 imagery capabilities via SSTL's S1-4 satellite



A VisionOne image capture of Melbourne, Australia. Image is courtesy of Airbus.

Vision-1 operations will be coordinated by Airbus in the UK, following integration into the UK Mission Operation Center, which already operates the commercial imaging of the DMC Constellation.

This is an important step for UK sovereign imaging capability, adding sub-meter data to the existing UK imaging capabilities.

As Vision-1 was launched in September 2018 together with NovaSAR, this opens significant opportunities for applications

combining optical and radar satellite imagery.

Along with Vision-1, Airbus offers commercial access to the largest fleet of EO satellites: Pléiades, SPOT 6/7, DMC Constellation and the weather-independent radar satellites TerraSAR-X, TanDEM-X and PAZ.

François Lombard, Director of Intelligence Business at Airbus Defence and Space, stated that this new asset will reinforce the company's monitoring capabilities for sub-meter imaging and feed the Airbus OneAtlas digital platform to provide increased freshness.

www.airbus.com/

www.sstl.co.uk/



The Solution

Satellites are a particularly cost-effective way to reach large numbers of viewers, particularly in regions with widely dispersed populations and challenging environments.

Satellite covers all households within the footprint, including those unable to access OTT services due to insufficient internet bitrates. This enables the service provider to supply all customers with a similar instantaneous service across regions.

While OTT costs rise with the number of viewers, satellite costs remain fixed, making it a more cost-effective solution for broadcasters.

We're seeing strong growth in satellite TV, with a recent Digital TV study of Sub-Saharan African payTV subscribers showing satellite and terrestrial television are the two infrastructures driving digital migration, with 19 million homes receiving via satellite; a number that will increase by another 7 million by 2022.

There are also changes on the horizon. We are also noting a move toward hybrid solutions involving both DTH and OTT, with OTT often used in addition to traditional services, for viewers seeking on demand content as well as specific live programming.

Combining the best of both worlds, a hybrid offering of linear TV via satellite and on-demand services via OTT offers the most viable, future-ready solution to deliver a rich portfolio of video content.

By enabling broadcasters to reduce the complexity and cost of their operations in a new digital world, they continue to enhance satellite efficiency, enabling clients to maximize their service potential while minimizing the complexity of doing so.

Hybrid satellite OTT solutions will deliver an enriched viewer experience through live channel broadcasting, channel numbering, program information, content security, subscriber and set-top box management.

Furthermore, the seamless and integrated multi-screen user experience service that comes with the hybrid satellite-OTT solution has a complementary element that brings together the strengths of the traditional DTH broadcast service simultaneously with OTT streaming.

The feature allows the audience to receive content on mobile devices, tablets or laptops with access to multiple programs that can be recorded and rewound as well provide an array of program information.

www.eutelsat.com

Using Geospatial AI...

to improve Indonesia's urban green spaces

By Nadine Galle, Co-Founder
and Chief Executive Officer,
Green City Watch

Parks and other urban green spaces used to have two simple functions: to please the eye and to provide a place to relax. However, changing lifestyles, population growth, overcrowding and climate change call for a radically new approach to urban green space management. Today, parks and lakes are an important extension of urban life.

Despite the importance to our quality of life, urban green spaces are routinely consumed by lucrative development. A lack of comprehensive and updated data remains a bottleneck for mainstreaming ecological considerations in sustainable urban development. Data gaps are often attributed to the high costs and time-consuming nature of land-based surveying. Without actionable insights into the current state of urban ecosystems, governments and policymakers remain powerless to make the right decisions and improve livability in cities while protecting green and blue spaces.

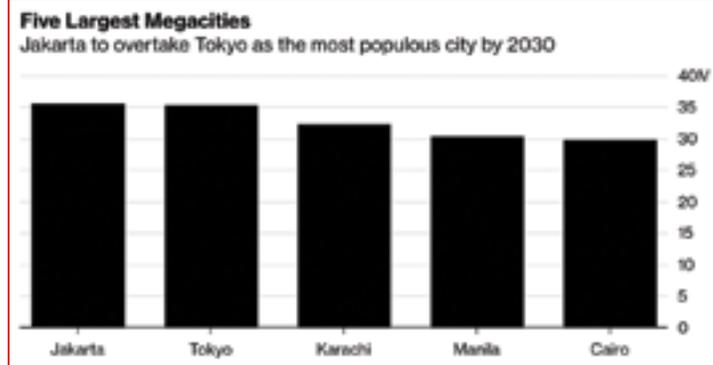
Green City Watch Monitors Urban Green Space — From Space

Green City Watch taps into Maxar's high-resolution satellite imagery and the latest advancements in a new field called 'geospatial artificial intelligence' (geoAI) to map the quality of urban green space. Previously, satellite imagery and GIS had mainly been used to map the quantity of green space, or perform land use/land cover change analyses. But we are taking the analysis further.

Collaborating with the World Bank in Indonesia

Green City Watch's method of mapping the quality of urban green space was showcased at a World Bank-hosted event, where we met the World Bank's Geospatial Operations Support Team (GOST), which helps operational teams apply geospatial technology to development problems. Facilitated by GOST, we were honored to collaborate with the World Bank's City Planning Labs (CPL) team, whose mandate is to enhance evidence-driven urban planning in Indonesia.

To establish a proof of concept, we analyzed 26 of Indonesia's most populated cities, including Jakarta, a 'megacity' and the largest city in Southeast Asia, with an estimated population of over 10 million people. Jakarta is set to surpass Tokyo as the world's largest city with 35.6 million people by 2030.

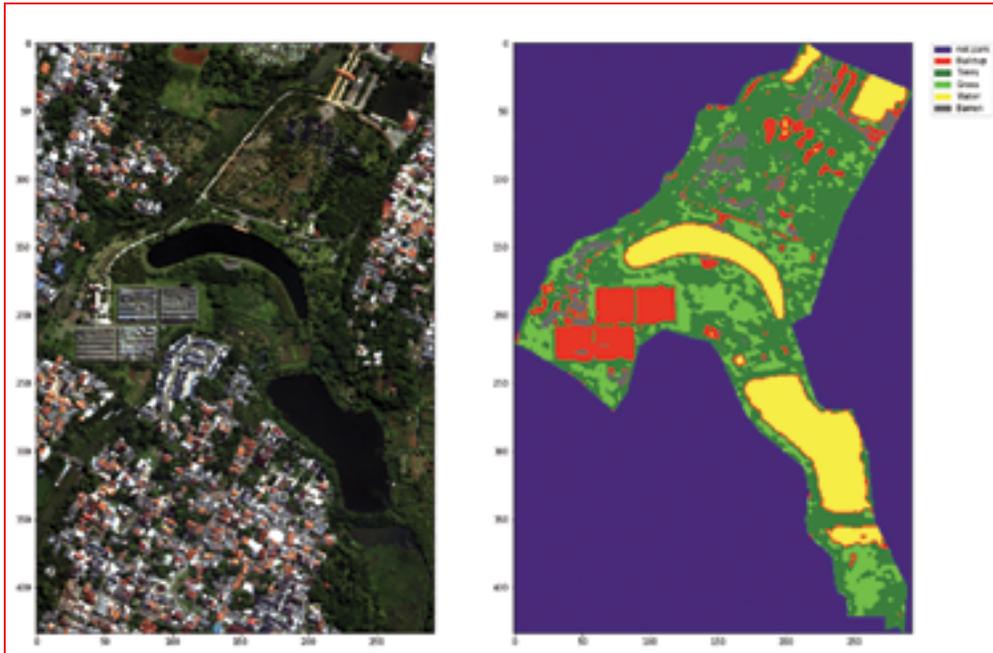


Tokyo will lose the crown of being the world's most populous city to Jakarta by 2030. Source: Euromonitor International

Within three months, the initial proof of concept managed to successfully identify 531 parks within the 26 cities. Taken all together, this represents 1,817 hectares of green space in Indonesia. To put that into perspective, the city of Amsterdam (The Netherlands) has about 1,476 hectares of green space in total — almost as much as Indonesia's major cities combined.

Although Indonesia has some ways to go in terms of expanding its urban green space, quantity was not the only thing that the World Bank's CPL team was concerned about. In addition to mapping the geographical extent and locations of the green space, our proof of concept also measured the park's infiltration capacity (the maximum rate at which soils can absorb rainfall), ratio of permeable versus impermeable land (where water can percolate into the soil to filter out pollutants and recharge the water table versus where it's blocked by concrete, buildings or other materials), the number of trees within the parks, the availability of amenities and recreational facilities. The latter leveraged crowdsourced data from the OpenStreetMap (OSM) initiative.

Using Maxar's high-resolution satellite imagery allows us to analyze any city's parks and forests, anytime.



Green City Watch classification of Agrowisata Park, Jakarta (beta). Source: Green City Watch.

For example, in Jakarta, Green City Watch calculated these statistics using our algorithms on Maxar’s imagery in GBDX:

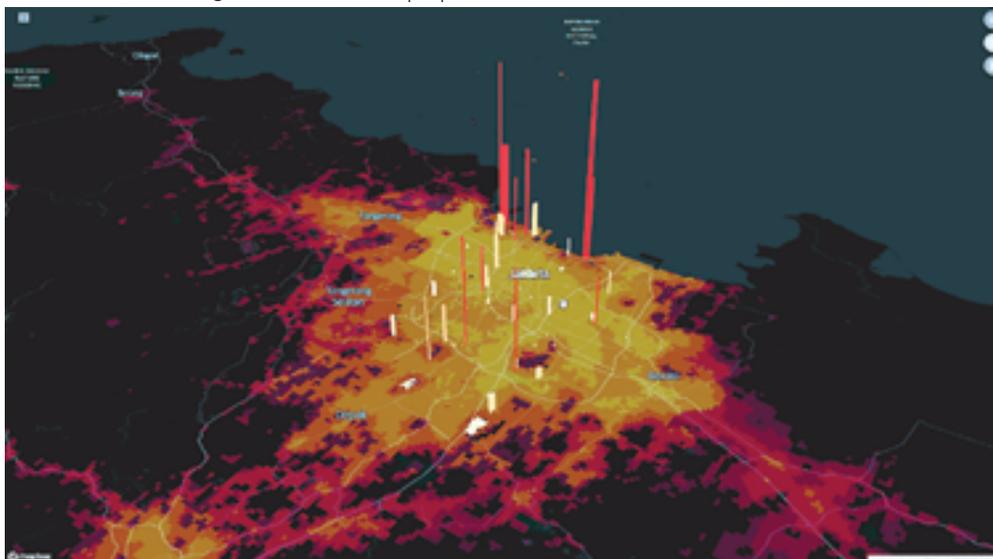
- Parks cover 825 hectares
- 43 parks over 2 hectares in size
- Over 300 hectares of trees, 90 hectares of grass and 20 hectares of water within parks
- 225 hectares of high-quality green space, according to the Green City Watch index
- Monas Park, one of the biggest city parks in Asia, has 8 public toilets, 6 sport pitches and 5 historic monuments

Most recently, the CPL team has won the World Bank’s “Disruptive Technologies for Development (DT4D)” Challenge Award for their proposal to

work collaboratively with Green City Watch to develop a “Green and Blue Footprint Tool” that builds upon the initial green area mapping proof of concept in Indonesia and extends it to include water bodies, in addition to taking it to scale to create a global public good.

Maxar’s GBDX for Urban Green Space Monitoring

Green City Watch helps monitor these restored environments, while reducing the observer bias that can typically plague ground-based measurements. Our method is highly reliant on Maxar’s 30 cm resolution satellite imagery. Accessing the 19 year imagery library through GBDX is mission critical when monitoring the ecological and social impact of urban green space improvements and infrastructure interventions.



Green City Watch data visualization of the impermeable ground in Jakarta, Indonesia. Source: Green City Watch; Data visualization made with Kepler.gl, a web-based geospatial data analysis tool.

But GBDX goes beyond imagery. For our analysis we used the GBDX Catalog service to automatically filter out the best possible image, which enabled us to automate our workflow. We also used the GBDX vector services alongside overpass API to extract OpenStreetMap polygons and points of interest. This helped us identify amenities, which have been mapped out by local communities.

Since winning the GBDX for Sustainability Challenge in mid-2018, we have been developing our #UrbanGreenprints, or baseline assessment, about the quality of a city’s green spaces — while simultaneously producing an effective monitoring tool for cities to track the progress of these spaces, old and new.

Using Maxar’s high-resolution satellite imagery allows us to analyze any city’s parks and forests, anytime. The imagery coverage is global, and in most places, updated monthly — or even weekly. High-resolution imagery is warranted yet underutilized in green space management. Imagery-based approaches can be used to monitor and evaluate urban forest loss and conversion and better understand city dynamics spatially.

Green City Watch is on a mission to renature cities as quickly as possible, and in turn spreading the message that by planting trees, protecting public nature reserves and restoring the ecosystems that underpin cities, the welfare of its inhabitants —and (in a small way) the planet they live on — could be radically transformed for the better.

Learn more at www.greencitywatch.org

Editor’s note

Green City Watch’s new approach to urban green space management won first place in the Maxar and Amazon Web Services’ GBDX for Sustainability Challenge out of 70+ submissions. The challenge gave finalist teams access to Maxar’s Geospatial Big Data platform (GBDX) and its 100+ petabyte optical imagery library to develop a machine learning solution for one of the United Nations’ Sustainable Development Goals/ This article is republished from the Maxar Blog with permission of the company.

www.maxar.com

Nadine Galle is a PhD Candidate in Ecological Engineering and Co-Founder and CEO of Green City Watch, the award-winning geoAI platform for monitoring urban nature. Her recent work includes defining the “Internet of Nature” in her TEDx Talk, co-developing #UrbanNatureAmsterdam, and founding the world’s first intensive summer course on ‘circular cities’, for which she still serves as Academic Director.



A Kratos Constellations Podcast Excerpt

The explosion in VC funding — following the money to space



Constellations interviews Chad Anderson, CEO of Space Angels, one of the most active investors in the space industry, with a portfolio that includes a who's who of the emerging new space players. Chad discusses changes in the space industry, its investment, key trends, and attributes that separate the winners from the losers.

The original interview was edited for length and format.

John Gilroy, Moderator for Constellations

Welcome Chad. It's unusual to see an investment portfolio focused exclusively on the space industry. How did Space Angels come about and why?

Chad Anderson (CA)

That's correct, all we do is space. We're early stage investors, so we focus on seed and Series A investments, and that means that we're often the first check-in to a company.

I joined and took over Space Angels in 2012 and basically re-founded the company before there was much entrepreneurial activity to speak of. Today we're a \$15 million angel fund, and a \$25 million venture capital fund that co-invests together.

If you look back, 2012 was when SpaceX first worked with the International Space Station, which was a key milestone in the industry. The previous key milestone was in 2009 when they successfully launched their first customer. They brought the price down of launch, but they also published their pricing and brought transparency to the market for the very first time. This allowed for entrepreneurs to enter the space market for the first time, to understand the cost to build a business plan, and to go out and raise funding and start businesses.

For example, pioneering companies like Planet and others that were using small satellites to disrupt the satellite market. That was the genesis. We recognized that there were lots of new companies that needed funding. There was a huge opportunity to not just disrupt the large

\$350 to 400 billion space economy that existed, but also to play an integral role in the new markets that were developing.

Constellations

It looks like you got in at the right time, and that there's never been a better time to invest in space.

CA

Timing is everything. In 2012, we were still early, and it took some vision. Getting investors to put money into space companies still took a bit of selling in terms of helping them to understand the opportunity that was emerging, to help them understand the real risks.

Yes, it is rocket science in many cases, but they face a lot of the same business challenges that most other companies face. At the end of the day we are investing in businesses. We did a lot of work educating the market, helping them to understand the trends, that barriers had come down, and that the paradigm had shifted. There was now an opportunity for them to play a part in the new entrepreneurial Space Age.

Constellations

I'm thinking of an investor with some money looking at different options. They go to your website and you talk about meaningful impact and a 30X return — that's quite appealing.

CA

Absolutely. If you look back on all the most successful entrepreneurs, often the founder has a big vision for how they're going to change the world. They have an inspiring mission to rally around, and they're able to attract the best talent. Especially in space, there's only so much technical talent to go around, and so it's often the entrepreneurs with the biggest, boldest vision, the most interesting imagination that are the most successful.

...we've gone from a dozen or so privately funded space companies globally in 2009 to 435 as of today accounting for over \$20 billion in investment.



They're able to get everyone on board, from the employees, to the board members, to the advisors, to the investors. If you assemble the right team, there's no telling what you can accomplish.

Constellations

You say that only 5 percent of the space investment opportunities are even considered, which is a pretty small number. What are the criteria?

CA

The actual number is more like 2 percent. We run this number quite often, and we see every space company that's looking for funding at the early stage. They know to come to us because we're sector specific.

Last year we looked at 500 space companies and we're investing in about 2 percent of them. At the first check-in at seed and Series A, a lot of times it's a lot more art than science than if it was a Series C or D later stage investment. You can do analysis on discounted cash flows and back into what you think the value is, how risky it is, and put a value on that company. But the earlier you are in the company's life, the more art it is.

You don't have it all figured out. You may have a big, bold vision, and a general idea for how you're going to carry that out. You've done the homework, you understand the input cost, what you think you can get it for, what the market looks like, what the competitive landscape is. All that is really important, but in the end it really boils down to the team that you're investing in. Do they have the right vision? Do they have the necessary skill set on the technical and the business side to be able to handle the unexpected situations that will inevitably occur? Do they have the right temperament? Are they coachable? Are they the type of people who go out and seek advice? Are they realistic in their key assumptions? That's really what we're looking for.

When you see as many business plans as we do, you would be surprised at how many come across our desk where just the basic physics don't close. You've got to get the fundamentals correct first.

We're living and breathing space every day so we're able to identify the gaps in the market. If we see a company that fits that gap, that understands the market, great, we take a look at their technology. If it's feasible then we move on to the team. The earlier you are, the more important the team is and their ability to navigate uncertainties.

Constellations

I'm going to drill down a bit more on space investment opportunities. You've spoken about the satellite value chain. What that is?

CA

I'll start with GPS and then move onto some more contemporary topics. When GPS started in the '70s it was purely a government initiative that was then transitioning to the private sector. People were saying, "Oh, GPS is fantastic ...but what are you going to use it for?" These experts would struggle to answer this because the use cases are infinite. They'd struggle to put their finger on the key one, or the one that fits in a sound bite. And so they would say, "Of course, it's going to be used in everything."

Today you see it in all the location-based services that we use, on our phones, Lyft, Uber, food delivery, you name it. So GPS is a great analogy for what's happening in Earth observation at the moment. Affordable launch and transparent pricing allowed companies like Planet and others using a distributed network of small satellites to generate an unprecedented amount of new data. Instead of having one monolithic satellite, Planet is operating 180+ satellites, the largest constellation in the world, and they're taking an image of every corner of our planet on a daily basis.

This is a great start, but we're going to even have more data going forward, and different types of data that fill different needs. So we've got all this disruption happening on the data sourcing hardware side of things. Then, how do you bring this unprecedented amount of new data down to the ground? And so now there's innovation on the ground segment in terms of commanding and controlling all of these new satellites, mission control services, downloading that data and getting it to where it needs to go.

That's where investment is going. But if you go a layer deeper, there's an opportunity for data aggregation and a distribution platform that's source agnostic. A company won't just try to sell their own data, but rather to answer the market need or question with whatever the appropriate data is.

A shipping customer may want to know the number of ships in port in Singapore yesterday versus last week, or going forward for the next six months. You can take that query out to market to see which companies have the right data for that need. It might be optical imagery. Or if there's cloud cover, you might need radar. And if that data is accessible now through an API, you can get to the end solution with a Google type search without the end customer needing much capital. They can hop on the internet to find out 'What is the corn stock in the Western U.S. today versus six months ago?'

Using a sort of basic language question, an answer will pop up for you, with a bit of advertising around it, but it will be basically free to the end user. We're finally getting to this place, and we're investing way down deep into that value chain, where there's some really interesting things happening.

Constellations

You're covering a lot of territory. Speaking of which, don't you have a report that comes out quarterly? Tell us about that.

CA

Yes. We began pulling together all the investment transactions to get a sense of what was being funded, and who was funding them. Now we release the Space Investment Quarterly, which goes through the key milestones in what we call the Entrepreneurial Space Age from 2009 until present.

It shows how we've gone from a dozen or so privately funded space companies globally in 2009 to 435 as of today accounting for over \$20 billion in investment. It includes which regions, the type of industries, which are early stage or late stage, and more.

Constellations

Whereas, 20 to 30 years ago, it was the government providing funding, now we have iconic figures like Jeff Bezos, Elon Musk and Richard Branson. The whole demographic of investors in space has changed hasn't it?

CA

Absolutely. In 2016, it was primarily corporate investors, basically the incumbents that had been in space the last few decades, and now we have a new crop of entrants. We saw a lot of that in 2016 and 2017 driven by individuals. Jeff Bezos famously revealed that he would sell a billion dollars in Amazon stock each year to fund Blue Origin. He then sold \$2 billion.

And then in 2018 we saw investment driven by private equity and retail investors, a lot of them flocking to SpaceX for the success that they've seen in their Falcon Nine reusability, the Falcon Heavy, and also the Starlink constellation. So, you have Government that transitions to private investment, with early investment by incumbents that know the space well, and then individuals, angels, VC funds, and then private equity and retail coming in later. It's amazing to see how fast it's come together over the last three or four years.

Constellations

You did well predicting things in 2012, so what are the key investment trends that you see happening in the next few years?

CA

We predicted that 2018 would be the year of small launch, and we watched that come true. Last year, we saw the first small launch vehicle begin operations, and a number of others reached advanced stages of technical development, with over \$1.5 billion of equity investment to help fund these companies.

We'll see some more small launch vehicles coming online, but with multiple crew spacecraft coming online, 2019 will undoubtedly be the year of commercial space travel. In fact, with SpaceX, Boeing, Virgin Galactic, and Blue Origin all inching closer to being the first privately funded space companies to launch commercial passengers into space, we definitely think that this is going to be true.

In communications, OneWeb is launching hundreds of satellites to provide internet to remote areas. The big name obviously is SpaceX's Starlink launching thousands of satellites in lower orbit to be able to provide connectivity to everywhere on the planet. And Amazon is getting into the game as well, with plans to launch 3000+ of their own satellites for the same purpose.

Constellations

We have lots of satellites up there, so the hardware may not be the hard part, but rather this data aggregation.

And when you said Amazon, I'm thinking of Amazon Web Services, the amount of data storage they have along with artificial intelligence. With all that experience will Amazon be the one to dominate in the long run?

CA

They've certainly got a leg up in a few areas. They're a commonly owned company that can launch it, they have lots of experience handling the data, and they can also price in the revenue from the consumer business as well. But you're right, there are a lot of software solutions when it comes to intelligence and information.

Space situational awareness is another great example of new companies coming in and doing things that were historically done only by governments. They're able to do it for a fraction of the cost, and much higher fidelity. We're seeing some companies really start to shape that. Knowing where things are in space is really important when you're going from 1,500 satellites in orbit today to tens of thousands in the very near future.

But I wouldn't say hardware is out. With NASA's push to go back to the moon, and their commitment to work with new commercial partners on programs like Commercial Lunar Payload Service there's opportunity in lunar transportation too.

Constellations

It seems public-private partnerships are a direction that NASA is going, where they're providing the best practices and know-how, and trying to pick partners that will be able to take advantage of that.

CA

Yes, they've found a lot of success with commercial cargo and now commercial crew. It's becoming incredibly obvious with commercial crew, they made a safe bet in the contractor that they knew in Boeing, and they made a risky bet in a relatively new up-and-comer when they invested in and they pre-purchased flights with SpaceX very early on.

I think we're starting to see that materialize now with SpaceX being months ahead of schedule and doing it for a fraction of the cost. This is really starting

to inform some opinions, meaning why would you not do this type of partnership going forward?

The Eclipse Program that I mentioned looks very similar to commercial cargo and commercial crew. It's very encouraging to see that NASA sees the value in these types of partnerships where they act as a customer versus a benefactor or a development funder. They're now acting as a customer to purchase services from private companies, and allowing them to come up with the solutions, and do so at high quality and a low cost.

Constellations

Chad, we're on the two-minute drill here. What groundbreaking technology do you see coming in the next four or five years? Will it be laser communication with satellites? Will it be ground systems? Or maybe data aggregation?

CA

That's the golden question and every day we're trying to figure that out. But I think we've got a pretty good idea, and it's really in this area in the satellite value chain, and the EO, Earth Observation side of the house. I think that we're going to see that incorporated into our everyday lives on a scale similar to GPS, and that's going to happen very soon, a year and a half, two years' time scale, so that's exciting.

I'm also excited about the lunar side. Again, all of this initiative, and all of this push, and all of this ambition to get back to the moon and working with private companies. With all these new satellites in orbit I think we're going to start to see a lot more networks, constellations, and the efficient way to do that, the most feasible way to do that, and the optimal way to do that is through a mesh network with laser links.

We'll start to see a lot more optical come into play, intersatellite links and also to ground links. It's just a better way. And when you're talking about the sums of data that we're talking about I think there's a lot of opportunity, but we've still got more work to do.

Constellations

I'd like to thank our guest, Chad Anderson, the CEO of Space Angels.

www.spaceangels.com

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Airspace Internet Exchange Inc. (AirspaceIX) wireless technology company, founded by Thomas Choi, which launched Curvalux, has launched Saturn Satellite Networks Inc. (Saturn), a U.S. Delaware Corporation that is building a space qualified, small, GEO satellite platform named Nationsat.

Built entirely in the USA with heritage-based payload and bus components, Nationsat features a full-digital payload and 2.5 kW bus design that enables complete frequency agility and bandwidth channelization for users that demand wide-beam C- and Ku-band capacity as well as an HTS version that provides more than 80 Gbps.

Saturn is led by one of the most senior and experienced teams of satellite engineers.

The top three members of the executive team have more than 100 years of experience and have manufactured over 60 GEO satellites at Boeing, Hughes, Lockheed Martin and Intelsat.

The Nationsat satellites are designed to be low cost and highly flexible, enabling users to save over 70 to 80 percent of current market pricing for bent pipe GEO satellites — the company's HTS models will cost less than \$1 million per Gbps delivered on-orbit.

Tom Choi, the Executive Chairman of AirspaceIX and Saturn, said the company is extremely proud to announce Saturn's Nationsat project. The firm has been quietly working on this since the end of 2017, to deliver the most advanced, flexible and cost optimized, GEO satellite platform in the world.

He added that more than 95 percent of satellite capacity users in the world use their satellites for domestic applications and, for the first time ever, the firm has a satellite that has been designed and optimized for these end users and nations.

The company hopes to serve as a vital cog in the global effort to bring affordable, satellite connectivity to the emerging markets of the world and to over 150 nations that have not been able to afford satellites in the past. This will change with the introduction to the market of Nationsat, by Saturn.

Vern Smith, the Managing Director of Saturn, added that the company is making history with the most affordable and innovative GEO satellite solutions. The firm has already executed an early development contract with our first customer, valued more than \$10 million and recently passed a rigorous Preliminary Design Review (PDR) on the firm's path to delivering the Nationsat systems in 2020.

Jim Simpson, the CEO of Saturn states it has been very rewarding and an honor, teaming up with Tom and leading this incredibly talented and innovative Saturn team as its CEO.

Simpson continued that this unique satellite system and service enables nations that previously could not afford their own satellite systems the ability to take advantage of the economics of ownership at a fraction of the cost of a traditional satellite system.



Thomas Choi
Executive Chairman

Via Satellite Satellite Executive of the Year 2012, Satellite Hall of Fame 2017, Founded Spacenet and ABS, Hughes and Rockwell, Creative and Disruptive, MBA & BSAE



Richard Pak
Group CEO

Internet, telecom and media veteran, Broadcast.com, Yahoo! and ABS, Business Development Genius, BSME



Nir Barkan
Group CTO

Telecom and RF communications expert, Satisfy, Orbit, Novusat, Makes Tom's vision a reality, MBA & BSEE



Jim Simpson
CEO Saturn Satellite Networks

Extraordinary satellite and space systems engineer, Former President Boeing Satellite Systems & Aerojet Rockwell, ABS, MBA, BS & MS



Vernon Smith
Managing Director

Leading visionary in digital satellite communications, Former Lockheed Martin, Echostar, SES Global, DirecTV & Hughes, MBA, BS & MS in Aero & Astronautics



Ken Betaharon
CTO Saturn Satellite Networks

The world's most experienced satellite engineer having procured more than 51 satellites, Former CTO Intelsat & ABS, BS and MS Electrical and Communications Engineering

He also noted that the company's ability to use a very small satellite platform, that efficiently uses power, and takes advantage of the theory of the microcosm, with digital payloads, provides a revolutionary approach to delivering on-orbit reconfigurable broadband capacity.

www.airspaceix.com/

saturnsatellite.net/



The JUICE launcher contract being signed by (left) Günther Hasinger, Director of Science Programs at ESA, and (right) Stéphane Israël, CEO of Arianespace.

Arianespace and the European Space Agency (ESA) have announced the signature of a launch services contract with an Ariane launch vehicle for JUICE (Jupiter ICy moons Explorer).

JUICE — the JUPiter ICy moons Explorer — is the first large-class mission in ESA’s Cosmic Vision 2015-2025 program.

Its mission is devoted to complete a unique tour of the Jupiter system. JUICE will spend at least three years making detailed observations of the giant gaseous planet Jupiter and in-

depth studies of three of its largest moons as well as the potentially ocean-bearing satellites, Ganymede, Europa and Callisto.

The JUICE mission will use an Ariane 5 or an Ariane 64 launch vehicle, with the launch period starting in mid-2022 — depending on the final launch slot from the Guiana Space Center, Europe’s Spaceport in French Guiana (South America). With the currently-nominal launch window in May 2022, the mission would end in June 2033.

The satellite will have a mass at liftoff of approximately six tons and will be placed in an Earth escape orbit toward Jupiter initiating a journey of 600 million kilometers.

After a 7.5-year cruise toward Jupiter — which includes gravitational assists from Earth, Venus and Mars — the spacecraft will enter orbit around the giant planet in October 2029.

The Jupiter tour includes several flybys of each planet-sized world, and it ends with orbit insertion around Ganymede, the largest moon in the Solar System.

JUICE will carry the most powerful scientific payload ever flown to the outer Solar System consisting of 10 state-of-the-art instruments plus one science experiment that uses the spacecraft telecommunication system with ground-based radio telescopes.

JUICE’s instruments will enable scientists to compare each of these icy satellites and to investigate the potential for such bodies to harbor habitable environments such as subsurface oceans. They will also

carry out observations of Jupiter, its atmosphere, magnetosphere, satellites and rings.

Airbus Defence and Space is developing and building the JUICE spacecraft. As prime contractor, for design, development, production, and testing of the satellite, Airbus will lead a consortium of more than 80 companies covering more than 110 contracts.

Following the contract signature, Günther Hasinger, Director of Science Programs at ESA, said JUICE is the first ‘large-class’ mission in the Cosmic Vision program and of prime importance for investigating the habitability potential of ocean-worlds beyond our own. The ESA is delighted to confirm it will have a flying start with an Ariane launch vehicle, setting it on course to fulfill its scientific goals in the Jupiter system.

Stéphane Israël, CEO of Arianespace, added that the company is honored to be awarded this new scientific mission from ESA, which will advance the understanding of the Universe. Less than a year after the launch of BepiColombo to Mercury, the company has won the launch contract for the JUICE mission to Jupiter’s moons, a further confirmation of Arianespace’s ability to ensure Europe’s independent access to space for all types of missions.

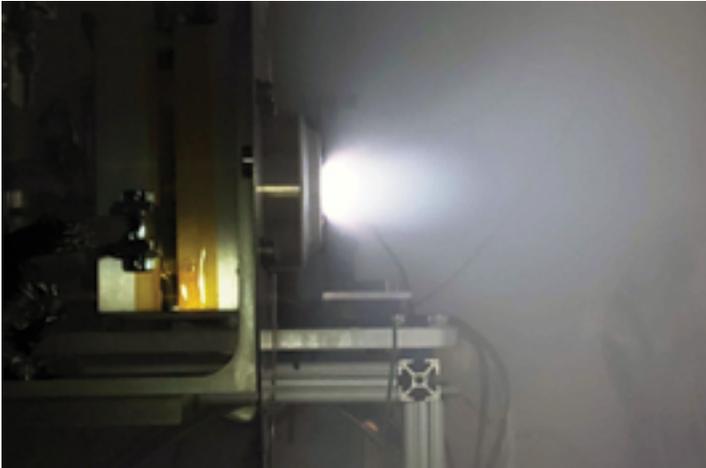
Israël added that Arianespace is, once again, marshaling all of the firm’s strengths and capabilities to support Europe’s spaceborne ventures, with a launch services offering based on Ariane 5 and Ariane 6 so we can deliver the availability and flexibility needed by ESA for its latest emblematic mission.

www.arianespace.com/

www.esa.int/ESA



Artistic rendition of Jupiter exploration. Image is courtesy of ESA.



Phase Four has introduced Maxwell, the first turnkey plasma propulsion solution for smallsats.

Maxwell combines a complete propellant management system and Phase Four's proprietary RF (radio frequency) plasma thruster into a

compact form factor.

Maxwell expands what's possible for smallsats and combines simplicity with the powerful performance of complex traditional electric engines.

Maxwell eliminates bulky, high voltage components and electrodes, simultaneously reducing cost and removing supply chain barriers that have long plagued traditional satellite engines.

According to the company, Maxwell is the most powerful electric propulsion system of its size, delivering up to 10 mN of thrust and up to 1,400 s of specific impulse, with total impulse of up to 14,000 Ns.

Maxwell is ideal for smallsats (20 to 500 kg.) with 300 to 500 W power budgets.

Maxwell is an instant startup propulsion unit with no delays and no need to warm and condition cathodes. Equipped with a flexible interface, Maxwell can finely tune thrust parameters on-orbit to accommodate changing mission needs.

With a full 1 kilogram tank of xenon, Maxwell weighs in at just 8.4 kilograms and takes up a modest volume of 7.5 x 7.3 x 5.3 inches.

First deliveries of flight-qualified Maxwell start in 4Q19.

Beau Jarvis, Phase Four CEO, said the company believes that customers shouldn't have to decide between thrust and efficiency when it comes to propulsion. Maxwell provides the best of both worlds, delivering simple plug and play ROI for LEO smallsat constellations looking for four to six year operational lifetimes.

phasefour.io/maxwell/

NASA has selected Bechtel National, Inc. to design and build a second mobile launch platform, known as Mobile Launcher 2 or ML2, for Exploration Ground Systems at the agency's Kennedy Space Center in Florida.

The cost-plus-award-fee end item contract has a total value of approximately \$383 million.

Bechtel National will complete the design, build, test, and commissioning of the mobile

launcher within a 44 month period beginning July 1.

ML2 is the ground structure that will be used to assemble, process, and launch NASA's Space Launch System (SLS) Block 1B rocket and

Orion spacecraft from Launch Pad 39B at Kennedy for missions under NASA's Moon to Mars exploration approach.

It will consist of a base structure, the platform for SLS, and a tower equipped with a number of connection lines called umbilicals, as well as launch accessories that will provide SLS and Orion with power, communications, coolant, fuel, and stabilization prior to launch.

www.nasa.gov/centers/kennedy/home/index.html

www.bechtel.com/



Photo of NASA's Kennedy Space Center.

A Failure To Communicate

can result in lives lost...

By Henrik Nørrelykke, Vice President, Land Mobile, Cobham SATCOM

As citizens, we sometimes take the role of first responders for granted. Although we may only face an emergency once or twice in our lives, paramedics, emergency medical support, police officers, firefighters, and rescuers risk their lives daily to ensure we can all live safely and peacefully.

Their dedication goes a long way to ensuring the best possible result in an emergency. But in order to guarantee their quick and efficient response, technology has a key role to play in improving the support we all receive. This includes ensuring the right services arrive to any call in the fastest way possible. Upon arrival, and as an emergency unfolds, it is also vital that teams have access to clear, consistent and uninterrupted interagency communications that facilitates continual discussion between first responders and their respective headquarters.

While many expect communications in an emergency to be a “given”, the reality is that reliable radio coverage remains a significant issue across the globe. This is particularly the case in rural areas with so called “white spots” where little or no radio reception constrain first responders’ abilities and cause major delays when every second counts. The consequences of this can be serious: when there’s limited access to healthcare and law enforcement, research consistently shows that lives are put in danger.

Investment in Developed Countries

In recognition of the need to improve emergency communications, great strides and investment have already been made in many developed

To preserve safety and protect as many lives as possible, rural first responders should be supported by satellite enabled Push-To-Talk extensions to their LMR radio



countries including the U.S., UK, Australia and South Korea. These improvements have been driven by the ongoing transition of traditional digital mobile radio (DMR) and land mobile radio (LMR) radios to Long Term Evolution (LTE). This has brought huge advantages to first responders, including the ability to use 4G wireless broadband technology, increased network capacity and speed to mobile device users.

However, 4G is restricted in its coverage to mainly urban areas, much like we are all used to when using 4G on our mobile phones. This is a huge anomaly for a first responder community that is tasked with providing vital support in any location — no matter how remote — at any time.

Taking the U.S. as an example — the country has recently embarked on the ambitious roll out of its nationwide FirstNet emergency management network, which is designed “to develop, build and operate a nationwide broadband network that equips first responders to save lives and protect U.S. communities.” The system is being established with considerable investment in LTE Mission-critical-push-to-talk (MCPTT).

FirstNet is commendable in terms of driving interoperability and encouraging the use of MCPTT systems. However, it will fall short of its mission to deliver nationwide coverage unless additional provisions can be made to address “white spots” in remote areas which have little or no LTE coverage.

This issue is universal and is being experienced by other LTE MCPTT first movers. If other countries also choose to invest in new LTE MCPTT systems, then their first responders operating in far-flung locations will experience similar issues. Areas including Australia, New Zealand, Canada, parts of Europe and the Middle East with large rural and remote communities are likely to be particularly exposed.

Enabling Interoperability via L-Band

Fortunately, there is a strategic solution that enables seamless and continuous connectivity between first responders and the public that is available today. This solution enables interoperability between DMR, LMR, LTE and MCPTT systems.

The solution works by harnessing L-band satellite technology to provide continuous, uninterrupted connectivity regardless of geographical location. In addition, it operates seamlessly with LTE

MCPTT, LMR or DMR, consistently ensuring that the public service purse is getting the most cost value for its connectivity investment.

Applying a combined L-band satellite and LTE communications systems to MCPTT also delivers a continuous interface between the user’s data device (computer, tablet or mobile data terminal) back to the central IT systems.

“On the ground” support can access this technology by extending VHF/UHF based trunk radio systems with push-to-talk (PTT) solutions such as Cobham’s PRISM PTT+. The combination of radio, LTE and satellite provides users with Beyond Line-of-Sight voice and data communication that systematically routes communications between the most reliable terrestrial (2G/3G/LTE) and satellite (L-Band) networks (multiple bearers).

This network agnostic, user friendly solution provides a failsafe solution that enables users to make mission critical and often life-saving voice calls, as well as sending and receiving important data in all conditions. This means, for example, that first responders can discuss and update trauma doctors on a patient’s condition and vital signs during their journey to hospital.

Avoiding a Radio Investment Dead End

While LTE MCPTT systems have enabled first responders to realize great benefits, particularly in urban areas, with regards to 4G wireless broadband technology, increased network

capacity and speed to mobile device users, it’s important that those considering updating their radio communications networks do not lose sight of the limitations of LTE MCPTT systems — particularly in rural and remote areas

By ignoring the capabilities gained by adding L-band satellite accessed via network agnostic PTT solutions, global communications systems will not fully benefit from disruptive radio technologies — and huge tracks of investment may head up a dead end.

www.cobham.com

Henrik Nørrelykke is the Vice President, Land Mobile, with Cobham SATCOM.



Tapping Satellite Technology

The EU Horizon 2020 innovation project and a vision

By Anders Brandter, Global Marketing and Sales at Forsway

Swedish SATCOM solutions provider Forsway was recently awarded a development grant from the EU's Horizon 2020 flagship innovation project to further develop its vision to increase broadband availability around the globe.

With the H2020 grant, the satellite hardware and technology provider aims to attract a larger portion of the market, accelerate growth globally and achieve its vision to provide solutions that enable broadband for all.

What is Horizon 2020?

Horizon 2020 is the largest EU Research and Innovation program ever with nearly €80 billion of funding available over seven years (2014 to 2020). It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market and aimed at securing Europe's global competitiveness.

Background

Forsway has already developed and deployed broadband technology and satellite router solutions that tap the combined abilities of satellite and broadband networks, using its toolkit and ecosystem "Forsway Xtend." These solutions are aimed at connecting the large demographics of people in low service areas or regions previously lacking reliable internet access, considered too hard to reach or unprofitable.

The technology is developed to eliminate the need to deploy additional network infrastructure, creating significant time and investment saving for satellite operators and service providers and well-suited for regions with reduced infrastructure and capacity.

Already deployed in Europe, Africa, APAC and Latin America, these deployments, plus ongoing trials in Nigeria, Zimbabwe, Middle East, India and discussions with Latin American operators, provide an important source of feedback for the company. This feedback is systematically evaluated and used in Forsway's planning for how to develop Forsway Xtend.

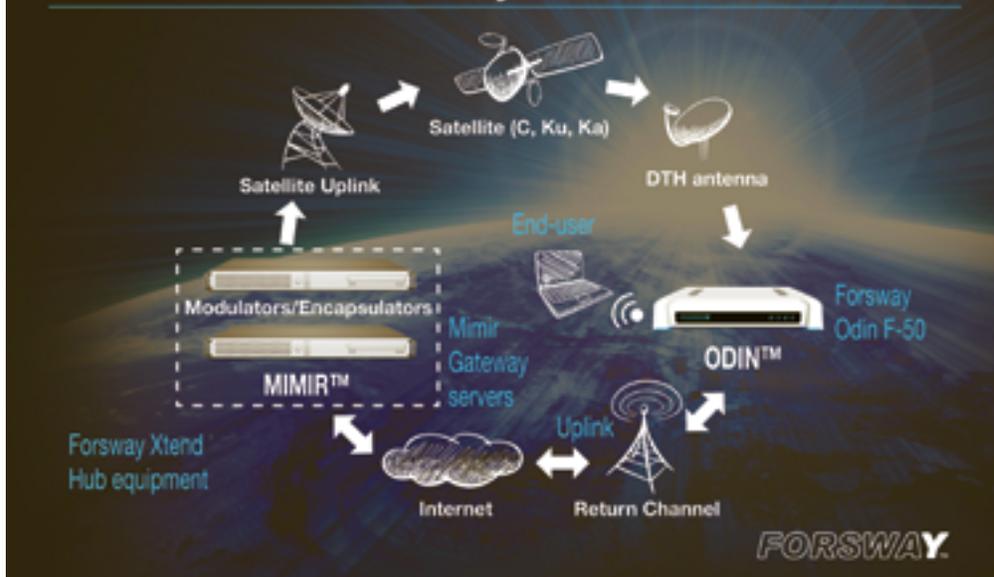
The purpose of the recently awarded EU grant is to carry out — over a pre-defined period of six months — a feasibility study to identify how the company shall develop Forsway Xtend, to better meet the requirements of their customers and further advance the solutions and products to attract a larger portion of the market and accelerate Forsway's growth globally.

Target Market

End-users of this technology are consumers, SME's, schools, government offices, internet cafes, WiFi Hotspots, village and community centers — all players who need a reliable internet connection for entertainment, work-related activities or access to public services.

To reduce the digital divide and to increase prosperity globally new low-cost broadband solutions are needed — now.

COMPLETE SOLUTION Forsway Xtend



Target customers are satellite operators who are provided with a new business model to reach untapped markets, cost-effectively, taking advantage of unused bandwidth. Local service providers can provide the reliable, affordable internet access that is critical to the development of previously underserved regions.

DTH players interested in adding broadband to their current TV offering, as broadband / internet is increasingly the preferred method of which video is delivered as most video is IP based OTT content. Thus, both DTH players and satellite operators who see the traditional TV viewing being eroded can find a new delivery method and revenue stream by adding Forsway's solution.

Other key players who acquire and benefit from the technology include local and regional Communication Services Providers, (governmental) Community Services entities and education establishments, making corporate social responsibility a key aspect of Forsway technology and development.

The Bigger Picture

Billions of people cannot access internet due to infrastructure deficiencies, mainly in emerging markets but also rural areas in Europe and USA. To reduce the digital divide and to increase prosperity globally new low-cost broadband solutions are needed — now. The deployment of fiber networks and the launch of new satellite systems is a matter of years.

Forsway aims at providing solutions based on existing technologies, taking advantage of the recent expansion of satellite capacity and the opportunities offered with a fast combination and integration with terrestrial technologies, primarily mobile.

Cellular technologies such as 3G and 4G are not cost-effective to provide broadband in areas with low population density or low ARPU. Satellite technology has for a long time been the most cost-effective technology to provide TV broadcast services. Combining these two technologies into a hybrid satellite-cellular solution combining the ubiquitous downlink coverage of satellite and low-cost uplink of mobile technology is at the heart of Forsway's broadband offering.

Work Within the H2020 Framework

The European Innovation Council (EIC) awarded 1 million euros to 20 Swedish companies in March of 2019. On the highest level, the companies are supported with a view to address a strategic challenge for Europe: The continent excels in science but needs to increase its output of market-creating innovation.

The world's biggest funding program (Horizon 2020) needs to achieve greater impact by supporting innovation that create new markets, so breakthrough innovation projects with the potential of scaling up in new markets are in focus.

Thus, Forsway's situation and solution is in pole position to meet the challenge. Forsway Xtend offers the necessary technical solutions for the main components of the system (i.e., the components have achieved TRL, Technology Readiness Level, of 8 or 9), the total system, including the relevant mechanisms to accelerate the contribution to bridging the digital divide, can be further enhanced. The complete solution can be improved in collaboration with customers, suppliers and partners to ensure it meets their evolving needs and future growth requirements.

Horizon 2020 Grant

Forsway's grant, 50,000 euros for the feasibility study (also called "Phase 1") will mainly be employed to finance consultations with and visits to customers and the customers' customers in order to capture requirements that can enable Forsway to make a stronger impact globally. This is in line with EIC's desire to see new market-creating innovations.

The Way Forward

The company was able to garner the support of one of the world's leading global satellite operators, a major Asian satellite operator, and an Asian communication services provider. During the feasibility study these players will provide their insights into how Forsway can enhance their offering. Participation will target both technical terms and key aspects of business modeling such as price structuring, how to aggregate demand from various end-users in typical emerging markets or distribution and partnering aspects. Further, they may act as test partners for new solutions in a potential Phase 2 project.

Regarding business modeling, Forsway has already started to discuss revenue share schemes with suppliers/partners providing satellite capacity in customer projects.

In the application process, Forsway also created a Board of Advisors consisting of four international experts coming from the academia and telecommunications / satellite industries active in the emerging markets.

A potential Phase 2 project could entail considerable development efforts and a significant grant and budget from the EU Horizon 2020 project. The application period opens in early 2020.

Anders Brandter heads up Global Marketing and Sales at Forsway. He has been active in the satellite industry for ten years and in telecoms for three decades, working primarily with emerging markets for leading innovative companies such as Ericsson, Telia-Sonera and tech start-ups. Having lived in Latin America and Africa, Anders has also spent considerable time in Asia, particularly in India, and has a special interest in matters related to the reduction of the digital divide in underserved regions.



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Your Space Startup

Tips for obtaining funding

By Jacqueline Bolton

Frequency Electronics Inc. (FEI) received a contract valued at \$5.9 million from Lockheed Martin to qualify FEI's Digital Rubidium Atomic Frequency Standard (DRAFS) for use on the new GPS III F satellites, according to *GPS World*.

GPS III F was designed and built by Lockheed to help modernize the U.S. Air Force (USAF) GPS satellite constellation with new capabilities.

Frequency Electronics is just one of the many space companies that benefits from the military's push to bring private companies into military space programs.

For any company to benefit from space program contracts from the military, significant seed funding is needed to build prototypes.

Getting Funding Using Prototypes

Funding for space is currently valued at \$3 billion according to an article in *Fortune*, which means that if you have a great idea, you are most likely going to require someone willing to fund your startup.

You will need a prototype to obtain funding from venture capital firms, tech companies and also on online fundraising platforms.

Your initial prototype is just to show proof of concept, as investors are more likely to be interested if they can see how your idea would actually work.

However, the initial funding may not be enough to get you to a stage where you cement an order into place for a complete product from a manufacturer.

Remember, it is this complete product that may increase your chances of winning a contract from a government agency or the military.



One important tip is to target investors that already know about space...

This means you have to go back to investors for more funding, but there is no guarantee that you will obtain that additional financing.

However, there are a number of actions you can take during the initial stages of creating your startup to sidestep bankruptcy proceedings in the event that investors lose interest in your product.

One important tip is to target investors that actually know about space.

Investors Should Already Know About Space

These types of investors are preferable, as you will not have to spend hours explaining how your product works and why you need more funding.

Investors who are familiar with the space sector will only be convinced if you truly believe in your product's ability to change the industry — also known as "disruption".

They are more interested in the problem your tech is meant to solve — not the tech itself. You must show that you understand the problems and that you want to solve those challenges.

If they detect that you are more in love with the tech instead of the problem, you can forget about gaining funding.

However, this should not discourage you as many opportunities are opening up, especially with the USAF.

The Opportunities

USAF officials have been quite vocal about building a connection between the military and private companies that develop cutting edge-technology that the government needs.

In fact, the USAF is working on creating what they refer to as a "space enterprise", which may involve sending large and small satellites into space.

This gives an opportunity to companies or startups that build large and small satellites to support future USAF missions.

The main idea behind this move is to make access to space more affordable as well as easier to modernize space infrastructure.

However, commercial satellites and space electronics will have to pass the resilience capacity test to be accepted.

This test involves gauging how well these technologies can be defended against the full range of known threats.

The space enterprise will give businesses and startups in the space sector access to the billions of investment money from the government should those firms demonstrate their expertise in those crucial areas to be addressed for militaries and governments.

It is not just big companies such as Boeing or SpaceX that are getting all of the military or government contracts anymore.

However, it is still difficult to make money from outer space for companies or startups that are focused more on offering satellite-based services instead of government contracts.



Enhancing LandViewer

Change detection now runs in a browser

The major use of remote sensing data has been to compare images of an area taken at different times and identify the changes it underwent. With a wealth of long-term satellite imagery currently in open use, detecting such changes manually would be time-consuming and most likely inaccurate.

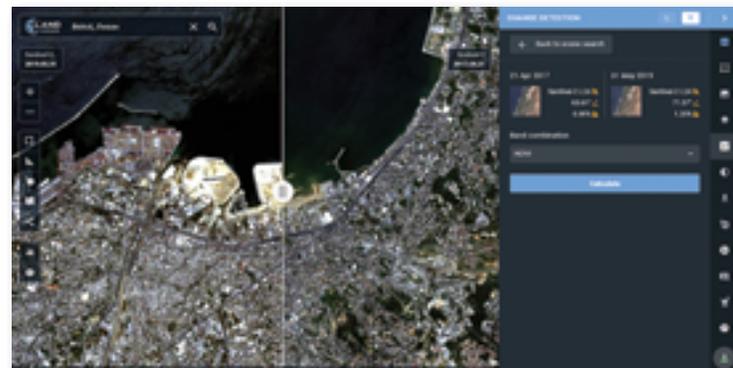
EOS Data Analytics stepped in by introducing the automated Change Detection tool to its flagship product — LandViewer — which ranks among the most capable of cloud tools for satellite imagery search and analysis in today's market.

Unlike the methods involving neural networks that identify changes in the previously extracted features, the change detection algorithm implemented by EOS is using a pixel-based strategy, meaning that changes between two raster multi-band images are mathematically calculated by subtracting the pixel values for one date from the pixel values of the same coordinates for another date.

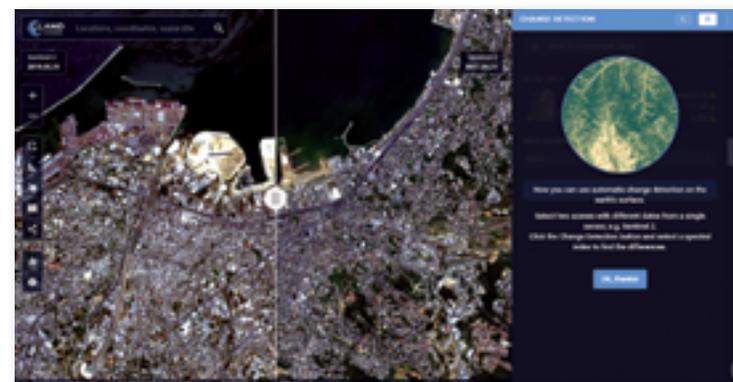
This new signature feature is designed to automate your change detection task and deliver accurate results in fewer steps and in a fraction of the time needed for change detection with ArcGIS, QGIS or another image-processing GIS software.

Unlimited Applications Scope

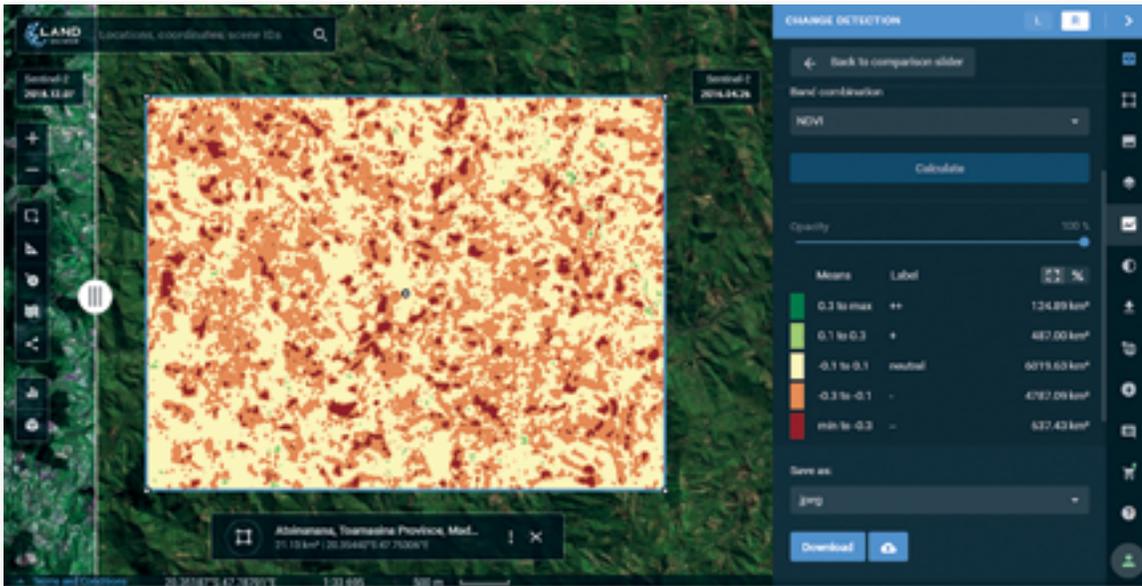
One of the main goals set by EOS team was to make the complex process of change detection in remote sensing data equally accessible and easy for non-expert users coming from non-GIS industries.



Change detection interface. Images of Beirut city coastline selected for tracing the developments of the past years.



With LandViewer's change detection tool, farmers can quickly identify the areas on their fields that were damaged by hail, storm or flooding. In forest management, satellite image detection of changes will come in handy for estimation of the burned areas following the wildfire and spotting the illegal logging or encroachment on forest lands.



The surviving forest cover will have positive values, while the cleared areas will have negative ones and be shown in red hues indicating there's no vegetation present.

Another widespread use case for change detection would be agricultural flood damage assessment, which is of most interest to crop growers and insurance companies. Whenever flooding has taken a heavy toll on your harvest, the damage can be quickly mapped and measured with the help of NDWI-based change detection algorithms.

A difference image showing the extent of deforestation in Madagascar between 2016 and 2018; generated from two Sentinel-2 satellite images.

Observing the rate and extent of climate changes occurring to the planet (such as polar ice melt, air and water pollution, natural habitat loss due to urban expansion) is an ongoing task of environmental scientists, who may now have it done online in a matter of minutes.

By studying the differences between the past and present using the change detection tool and years of satellite data in LandViewer, all these industries can also forecast future changes.

A picture is worth a thousand words and the capabilities of satellite image change detection in LandViewer can be best demonstrated on real-life examples.

Forests that still cover around a third of the world's area are disappearing at an alarming rate, mostly due to human activities such as farming, mining,

grazing of livestock, logging, and also the natural factors like wildfires.

Instead of massive ground surveying of thousands of forest acres, a forestry technician can regularly monitor the forest safety with a pair of satellite images and the automated change detection based on NDVI (Normalized Difference Vegetation Index).

How does it work? NDVI is a known means of determining vegetation health. By comparing the satellite image of the intact forest with the recent one acquired after the trees were cut down, LandViewer will detect the changes and generate a difference image highlighting the deforestation spots, which can further be downloaded by users in .jpg, .png or .tiff format.

Running Change Detection in LandViewer

There are two ways to launch the tool and start finding differences on multi-temporal satellite images: by clicking the right menu icon "Analysis tools" or from the Comparison slider — whichever is more convenient.

Currently, change detection is performed on optical (passive) satellite data only; addition of the algorithms for active remote sensing data is scheduled for future updates.

For additional details, [the LandViewer's change detection tool guide is located at this direct link](#).

Select this direct link to learn more about LandViewer.



Results of Sentinel-2 scene change detection: the red and orange areas represent the flooded part of the field; the surrounding fields are green, meaning they avoided the damage. California flooding, February 2017.

Seamless Radio

Ensured by ETL Systems and Pippin Technical

By Andrew Bond, Sales and Marketing Director, ETL Systems

Missinipi Broadcasting Corporation (MBC) Radio is a Canadian radio station with the mission of protecting and preserving aboriginal languages, while allowing indigenous people to control their own communications.

Initially Government-run and established to address issues to local fisherman, it is now self-



MBC Radio

CJLR-FM

sufficient, generating its own revenue through bingos and advertising.

People in more than 70 communities tune into MBC, including many southern cities where thousands of 'Urban Aboriginals' still wish to be kept informed of what is going on in the north.

The Task

With a mission as critical as connecting indigenous people, one thing clear for MBC is the need for a continual and consistent connection. In the transition from government-backed to self-sufficient, getting the right equipment in place has remained important throughout the radio's lifetime.

However, having been originally established in the early 1980s, it is not surprising that the existing setup had become obsolete. Therefore, the station decided it was time to look at upgrading its equipment to prevent any potential issues.

MBC turned to Pippin Technology, a leading Canadian broadcast system design and integrator. With a wealth of experience delivering turnkey solutions, shared management, and product solutions for all kinds of broadcasters in every part of the chain, Pippin was well placed to both advise on this project and to ensure the delivery of high quality products and service.

Gord Irvine, Project Manager, Pippin Technology, said, "MBC's listeners rely on the Broadcasters to deliver culturally relevant programming that ties them to their routes. Pippin wanted to ensure that the Corporation could continue to do that without risk of failure and signal loss. MBC has always placed a great deal of importance on having the most reliable equipment in place for that very reason."

With a mission as critical as connecting indigenous people, one thing clear for MBC is the need for a continual and consistent connection.

The Design

MBC has a 3-channel audio uplink via satellite. As well as needing full redundancy in case of power outage or other issues, it needed to be able to remotely switch the receivers to different audio streams throughout the day.

Pippin Technology approached designer and manufacturer of radio frequency equipment, ETL Systems, for a solution that would be easy to use, enable full redundancy and the ability to switch to other receivers.



After discussing the project and requirements, ETL Systems recommended their Griffin Redundancy Switch.

The Griffin Redundancy Switch offers three switch module types, which can be mixed and matched within the unit to provide flexibility for different application types.

It includes an automatic redundancy switch for selecting between two ASI sources where the modules can be switched independently or together.

Switching can be triggered by front panel, RF level detection, alarm contacts or NMS.

Bill Pryle, International Sales Manager, ETL Systems, commented, "It was clear that MBC places a great deal of importance on ensuring a good quality of service and we were keen to make sure it could continue to do so. Working with Pippin Technology made the process extremely simple as it has a great deal of experience and understanding of satellite networks."

The Result

Ultimately, ETL's Griffin Redundancy Switch gave MBC the confidence that in the event of an encoder or modulator failure it can switch between the different audio signals.

Gord Irvine, Project Manager, Pippin Technical, added, "This was a challenging project, being able to have full redundancy at the same time as remote switching. ETL Systems worked hard to listen and respond to the specific requirements and the result is a great unit that is providing a flawless service for MBC."

MBC radio can continue connecting with the aboriginal population across Canada, while keeping control over its connections and ensuring full redundancy should anything fail.

For the listeners, that means a continuous and high-quality listening experience that can keep them engaged.

The combination of flawless products from ETL Systems and the expertise of Pippin Technology have helped keep this radio station on air.

www.etlsystems.com

pippintechnologies.com

Andrew Bond manages the Sales & Marketing team at ETL, which covers four global offices in Hereford, Washington DC, Dubai and Bangalore. He is also responsible for the sales to several Tier 1 customers and system integrators, as well as overseeing the technical sales support and training of ETL's sales team.



Prior to joining ETL in 2005, Andrew was Sales Manager for Park Systems, a Smart Home Technology company. He also held roles in the fundraising sector.



The Future of Connectivity

Polar telecommunications with smallsats

The Earth's polar regions present significant challenges for individuals, enterprise, scientists, and governments that operate within them. While variations in geography, climate, and infrastructure make it difficult to broadly characterize the poles, one key challenge of these regions that remains unsolved is access to reliable and affordable connectivity.

Polar activity has been steadily increasing across a variety of industries. With this increased interest comes the question of whether existing infrastructure can support an ever-growing demand for connectivity.

Tourism

Arctic tourism is a mature and substantial industry, because it includes those traveling to the high latitude regions of the eight Arctic Member States (U.S., Canada, Norway, Iceland, Sweden, Finland, Denmark, and Russia). Arctic tourism includes everything from stays in 5-star hotels in Reykjavik, to boat cruises to view glaciers in Alaska.

Tourism in Antarctica is more nascent but growing. More than 500,000 people visited in 2017, with 17 percent yearly growth.¹ It consists primarily of adventure tourism on vessels, allowing travelers the chance to disembark to explore the landscape and wildlife.

Polar activities have been steadily growing across a variety of industries, prompting concern on the ability for existing infrastructure to keep up.



In Short

The Problem

Increased polar interests has cast doubt on the ability for existing telecommunications infrastructure to support activities

The Why

Remote populations, difficult geography, and an extreme climate make it very challenging to deploy new infrastructure

The Solution

A new class of low-cost nanosatellites focused specifically on the poles can alleviate the connectivity woes

¹IAATO (2017). Tourism Statistics. Retrieved from <https://iaato.org/tourism-statistics>

Resources

Although the last few years have seen a decline in resource exploration activities in the Arctic as a result of lower commodities pricing, it is generally accepted that the Arctic is poised to be a major site of resource exploration in the coming years. This will include exploration both on and offshore.

Shipping

Receding ice has opened the possibility of new Arctic shipping lanes that would dramatically reduce travel time and fuel consumption. A trip from London to Tokyo, for example, would be shortened to 8,000 miles if routed through the Northwest Passage, instead of the nearly 15,000 mile current route through the Suez Canal.

Science

Scientific activity in the Arctic is incredibly diverse, with hundreds of permanent and semi-permanent research stations already established. These stations are actively studying everything from the atmosphere and cryosphere to marine life, as well as human activity and society. The vast

majority of human activity on Antarctica is scientific. Dozens of research stations are operated by the more than 50 countries that are signatories to the Antarctic Treaty, with most scientists focusing on environmental studies.

Why is Connectivity Tough?

Finding a provider of robust and affordable connectivity in the poles is a considerable challenge. Outside of the more densely populated regions in Iceland, Scandinavia and parts of western Russia, communications infrastructure is either exceptionally poor, or completely non-existent. This reality is not surprising, owing to the following factors:

1. Remote and Sparsely Populated

Large distances between subscribers and a low subscriber volume make it uneconomical to deploy fixed infrastructure. Lower cost DSL connectivity (*i.e.*, copper wires) is limited to only a few 10s of kilometers, making it unsuitable for backhauling.

2. Extreme Climates

Extreme cold, high winds, and heavy snow make it hard to maintain infrastructure. Cell towers, fiber cables, or backhaul stations are easily damaged. Equipment installations can be affected by permafrost, such as with underground fiber lines.

3. Geography

The highly mountainous terrain of many parts of the polar regions presents two key challenges to establishing communications infrastructure. First, the cost of deploying fiber optic backhaul skyrockets in this geography. And second, microwave backhaul can be impeded by mountains since it requires line-of-sight to neighboring towers.

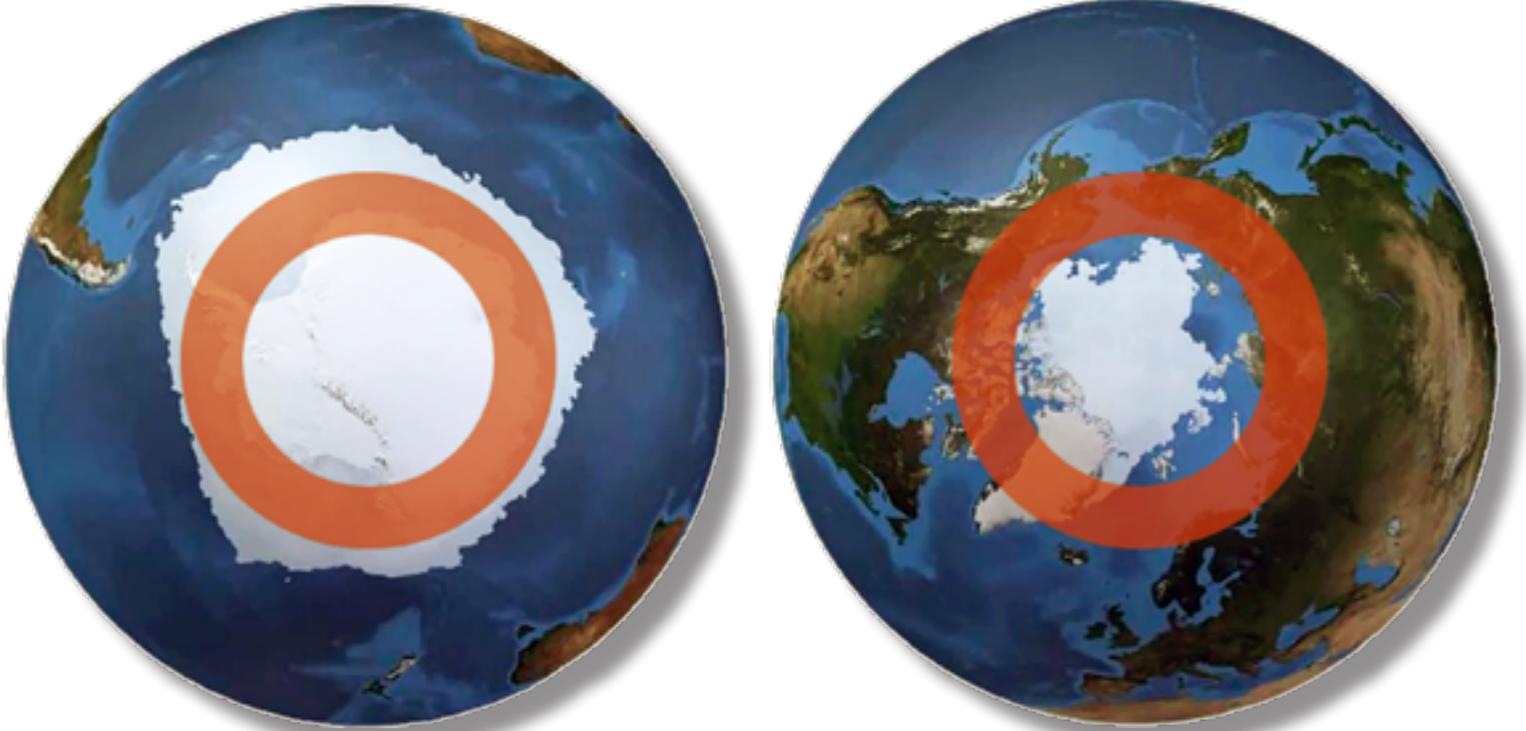
4. Offshore Activities

Although not unique to the polar regions, the considerable offshore activity in these areas leaves a multitude of vessels and offshore platforms particularly limited by connectivity, since they have no means of acquiring fixed line access to land when far from shore.

Looking to Satellites

When terrestrial infrastructure cannot provide reliable and affordable connectivity, users turn to satellite systems to support their communication needs. Satellites provide a broad range of connectivity options, including broadband internet to entire communities via fixed antenna, mobile connectivity for maritime applications through VSAT (Very Small Aperture Terminal) systems, as well as satellite phone services. However, when it comes to polar connectivity, a





Beyond the Horizon: Above 80 degrees latitude, the curvature of the Earth completely blocks visibility of traditional geostationary satellites. Between 70-80 degrees, shown below, local obstructions such as hills or canopy can limit visibility.

significant challenge for satellite services is that it becomes unreliable at high latitudes.

Most communication satellites operate in geostationary orbit (GEO), which is about 35,000 km. in altitude and fixed on the equator. At high latitudes, the view from ground to a satellite is blocked by the curvature of the Earth. Local phenomena can also create significant problems for satellite communication. Mountainous terrain can block the view of satellites from many locations. On ocean vessels, rolling waves can intermittently block the view of satellites, which will cause disconnections that render the service unreliable. And we can't forget that satellites are exceptionally expensive, with data costs exceeding terrestrial by 10 or even 100 times.

NewGen Satellite Services

Communications in the poles is complex. There is no single solution that can address all the challenges faced by those who operate in these regions. Instead, a number of solutions will be needed, combining the strengths of traditional fixed infrastructure, as well as contemporary and new satellite systems. A new generation of satellite technology will be a critical component of the overall solution for communication in the polar regions. Constellations of low-cost, breadbox-sized nano- satellites, flying in Low Earth Orbit, will provide affordable data services for those situated at the polar extremes.

Why Kepler's LEO Satellites?

Low Earth Orbiting (LEO) polar satellites have significantly higher coverage at the poles, making them uniquely positioned to provide communication services in these latitudes. A single low-Earth-orbit satellite, at no more than 2,000 km. from the planet, circles the Earth every 90 minutes. Weighing less than 5 kg., and with a 10cmx10cmx34cm shape, Kepler's satellites are far less expensive and faster to launch and they can also be replaced every three years — meaning they can rapidly incorporate new technologies.

While a single satellite is sufficient to provide global coverage including the poles, capacity is augmented with every satellite added to the constellation.

Kepler's satellites are capable of providing high-data-rate store-and-forward services through the use of Ku-band where signals from the user terminal on the ground are decoded and stored digitally on the satellite. Thereafter, the same information is downlinked to Kepler's gateway at northern Canada. This allows for an effective use of bandwidth and reduces the need for multiple ground station sites in order to provide a global service (unlike in the case of a bent pipe type of communication service).

This also increases the speed with which large amounts of data can be transferred across the network, as portions of data can be uplinked to multiple satellites as they pass over a given user terminal (rather than waiting for the return of a single satellite).

With a shoebox sized satellite, Kepler's network is capable of moving upwards of 5 GB of data per 10 minute pass from a single location. This means a total of 75GB/day can be transferred from the poles with a single satellite. Now imagine a constellation of these satellites.

Let's Talk Applications

Kepler's non-geostationary satellite network and high-capacity store-and-forward backhaul service gives polar customers the ability to shift their delay-tolerant data to a more economical connectivity service. This will reduce congestion on users' real-time links, increase available bandwidth for their activities, and reduce the overall cost per GB of connectivity.

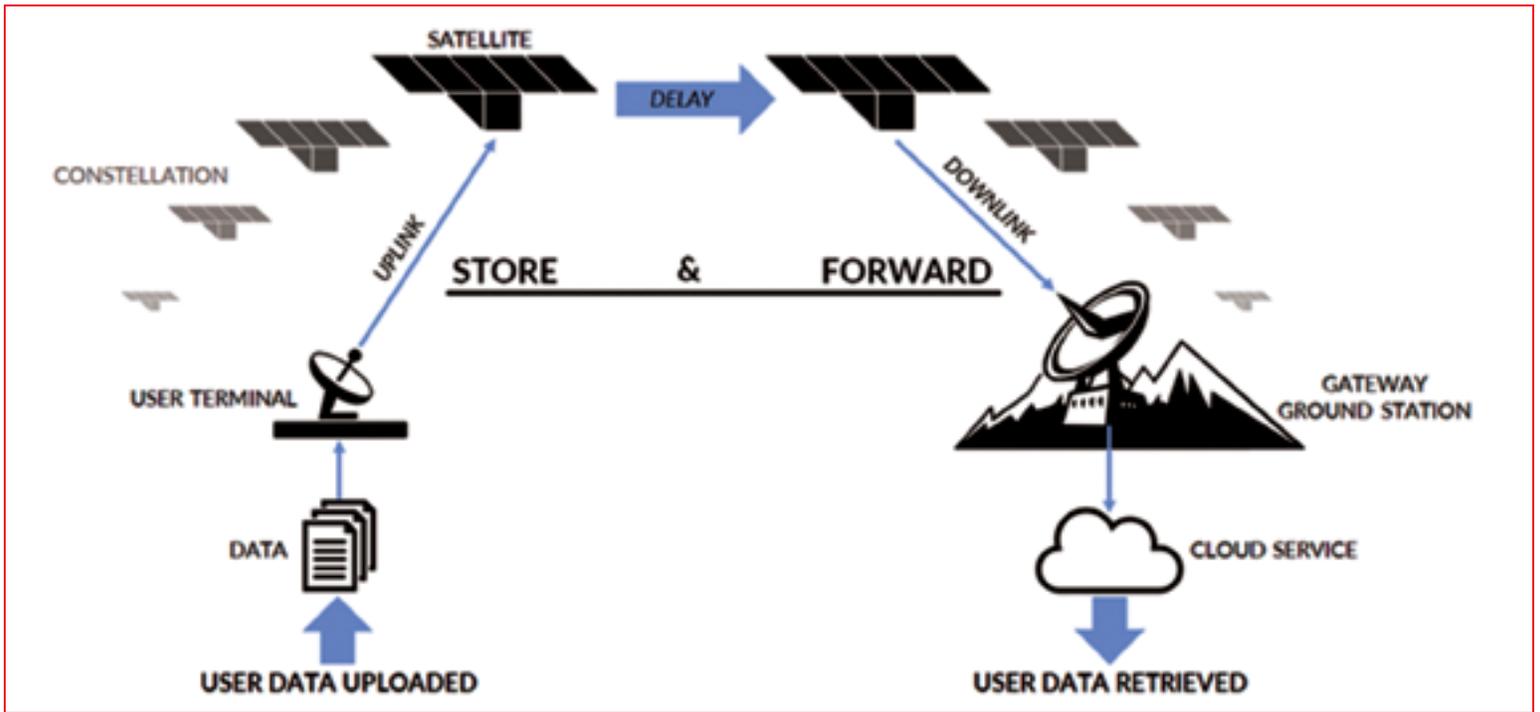
Applications for store-and-forward services offered by Kepler include:

1. Scientific Data

Send and receive large quantities of scientific data such as undersea mapping data, environmental logs or meteorological data.

2. Media Vaults

Transport high bandwidth media content (e.g., Netflix) to a local server, giving access to passengers on cruise vessels, small communities, remote mines, or offshore platforms.



3. Local Drop Boxes

Provide your community, cruise ship passengers, or mining personnel a means of sharing large, bandwidth-intensive files without clogging your real-time links.

Customers access the service using user terminal systems. A customer will have the option of either moving data from their terminal to a standard, Internet-accessible gateway, or to another user terminal of their choosing.

Service plans are available in two tiers: basic access and priority access. The latter option is available to customers who pay a premium to move their data through the network at a higher priority, thus being able to move more data faster.

Innovation

Modem

Kepler's Software Defined Radio (SDR) offers flexibility in center frequency and channel size, allowing for a more versatile modem that is compatible with multiple service devices. This technology can be

partnered with other service providers to deliver a multi-layered, comprehensive telecommunications service to customers using a single rack-mounted modem.

Antennas

Thanks to Kepler's custom designed modem — compatible with any off-the-shelf mechanically steerable dish-customer can use their existing antennas eliminating switching costs.

When considering cold-weather deployments, electronically steerable antennas provide a key advantage over their mechanical counterparts. A typical mechanically steerable antenna's gears and lubricants limit its ability to perform in cold weather, as the moving parts run the risk of freezing up when the ambient temperature drops below -25C.

By contrast, electronically steerable antennas have no moving parts and in fact benefit from cold ambient temperatures.

The work on this technology that Kepler is doing with its partner, Phasor Solutions, will bring to market an integrated antenna and modem terminal that will be ideally suited for deployments in polar environments.

Kepler is expecting alpha prototypes to be available in late 2018 for early customer testing and beta prototypes to be available in 2019. With a single fully integrated unit, the unit cost of these terminals will be less than \$5,000 US dollars.

Wrapping Up

While a wide variety of activities in the polar regions continue to gain interest, connectivity has remained a significant challenge, and oftentimes a deterrent, to those activities being undertaken more broadly.

New satellite technology, combined with existing infrastructure and contemporary satellite systems, offers the promise of reliable and inexpensive communications in all parts of the globe. Kepler is leading the industry in making this solution available in the polar regions.



www.kepler.space

Kepler's SDR is already capable of modulating and demodulating to the DVB-S2 standard up to 32-APSK with adaptive modulation encoding.



Photo of the Cobbett Hill Earth Station.

CETel has acquired UK-based Cobbett Hill Earth Station Limited (“Cobbett Hill”) in terms of an asset purchase transaction for an undisclosed amount.

This acquisition is a further milestone in CETel’s growth and diversification strategy alongside its continuing customer base expansion.

The acquisition further strengthens CETel’s position as a leading global end-to-end communications solutions provider.

Alongside CETel’s strong presence in the mining, energy and oil & gas markets, this acquisition will now significantly increase CETel’s presence and activities in the marine and broadcast markets.

Cobbett Hill offers an extensive range of satellite communication services to both marine and terrestrial clients in the corporate, media, O&G, NGO, military and government sectors.

Core service provisions include, but are not limited to, Internet, voice, data, broadcast, DTH, enterprise, TV & radio, iDirect, SCPC, network design, network management, co-location, data center, occasional use and bandwidth.

Cobbett Hill is located 25 miles from central London in the UK, and occupies a seven acre secure compound on 200 acre of land. Currently, it houses more than 25 antennas with active operations on 13 satellites plus spare capacity enabling quick turnaround times on even short-notice customer requirements.

Due to the locations historical use by the British Ministry of Defence it has blanket planning permission for unlimited antenna installations within the 200 acres and operate within an RF exclusion zone preventing any local interference.

Cobbett Hill presents the sixth merger and acquisition activity led by CETel over the last years.

Guido Neumann, CEO of CETel stated that the company is extremely happy to complete this transaction that ideally fits into the firm’s growth strategy. CETel has grown significantly over the past years. Their data services, especially in the maritime sector, present a perfect opportunity to grow this vertical — additionally, and with the existing services and experiences at Cobbett Hill, the company is now entering the broadcast market where excellent opportunities exist to develop this business further.

He added that CETel’s existing and prospective customer and partner base will ultimately benefit from this acquisition technically and commercially.

Paul O’Brien, Managing Director of Cobbett Hill, added that in CETel, the firm has found the perfect fit in a buyer for the teleport and satellite-based operations. Their long-term expertise in the market will assure that the implementation will run smooth and the two companies will merge and grow into an even greater company.

www.ce-tel.com/



To bridge the digital divide... to connect the unconnected... here are the dreams of satellite HTS constellations. With more than half the planet currently unconnected, the addressable market and potential revenues look enormous.

Thus, the race to space, with operators chasing this opportunity, driven by the belief that Non-GEO HTS, specifically LEO constellations, will be able to provide unprecedented global coverage and market penetration at significantly lower price per bit. Excitement is rampant, spurring industry-wide developments, such as assembly line-like satellite manufacturing, more competitive launch options, and even unexpected incumbents.

However, to date, only two operators have begun launching, with service not set to commence for another few years at the earliest. End-user terminals do not exist and are expected to lag behind satellite deployment. Customer channels, landing rights, and spectrum

allocation remain serious, and unresolved, obstacles.

Given the amount of funding, at least \$4 billion in committed investment and capital estimated by NSR, and efforts invested, coupled with these challenges, the industry should be asking, "Are we sure the future of SATCOM lies in LEO constellations? Can they really connect the connected, or are we all making a leap of faith?"

NSR's Satellite Constellations: A Critical Assessment, 2nd Edition report forecasts the cumulative revenue opportunity for Non-GEO HTS capacity and service will amount to \$43.6 billion, between 2018 and 2028. The Consumer and Enterprise Broadband Access segments drive the forecast, responsible for 79% of these revenues.

However, despite the potential of LEO constellations, NSR estimates that only 14 percent of the total HTS SATCOM market will be served by Non-GEO by 2028. To put it another

way, Non-GEO HTS revenues will be 4x smaller than GEO, the majority of the addressable market will not be captured by Non-GEO, and the dream begins to look more like a financial nightmare.

Primarily, the driving force behind constellations is the belief that not only is the entire telecom business addressable by satellite, but that these future networks will greatly expand the addressable market. In short, virtually every person who could use these services, will be served by Non-GEO HTS. NSR heard from one large LEO HTS constellation player that the entire telecom spending ecosystem was "in play" for addressable business, and a quick top-down estimate of penetration of this market yielded a large LEO revenue play. Suffice it to say, this top-down logic could be met with a heavy dose of skepticism.

In reality, there are reasons why satellite has always been a niche market. Terrestrial services have established vendors, customers, equipment, and infrastructure, and while the satellite industry is excited about reaching 21 Tbps of global capacity by 2028 for Non-GEO HTS, people are signing up for Google Fiber and getting Gbps to their homes, today. And those that remain unconnected globally most often present challenges from an ability to pay standpoint, further limiting the potential for classic B2C access distribution.

Next, NSR believes that, despite the potential for global coverage, constellations will face severe challenges in reaching customers. End-user terminals, flat panel antennas (FPAs), necessary for delivering Non-GEO HTS, are in development, but expected to remain expensive, with little incentive on manufacturers to lower prices. Securing landing rights in all target markets also represents a sizable challenge since LEOs will compete against incumbents in all markets, which is not necessarily an easy battle to fight.

Pricing pressure on Non-GEO HTS capacity and service will also likely force a LEO to race to the bottom to compete with GEO and other constellation players, limiting the revenue opportunity unless the subscription base expands dramatically.

Of course, not all is doom and gloom for satellite constellations. Innovations throughout the value chain have made mass production and launch of satellites easier, though not "easy", nor "cheap". Partnerships and technology development for FPAs have increased greatly in recent years, with over 20 manufacturers now on the market. Access to space has also never been as open as today, with launch costs declining as more options are available for constellation players.

Bottom Line

The excitement for satellite constellations shows no sign of slowing down, especially due to the efforts of notable industry champions such as Greg Wyler, Elon Musk and now Jeff Bezos. However, realizing the dream of connecting the unconnected is more than building a dam of capacity in the sky. There are clear obstacles regarding CAPEX costs, launch delays, under-developed terminal equipment, and difficult to establish customer channels and pricing that have to be overcome to realize it.

To deny the risks, give in to the hype and excitement of LEOs, and believe that "if you build it, they will come", is not charting a clear, strategic path to success, but making a leap of faith.

www.nsr.com/research/satellite-constellations-a-critical-assessment-2nd-edition/

Article by
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NSR Senior
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The New Race for Space

There is a new race for space, which requires greater connectivity, more reusability and higher functionality, but above all else, lower cost.

By Adam Arnold, European Division Lead, Optisys, LLC

A number of countries are looking to explore and physically mine other planets with either manned or unmanned systems. These systems require larger and more complex platforms in order to allow such multifaceted missions. However, with a drive to reusable and lower cost launch systems, and privately funded projects, this poses a dichotomy for mission planners. How can we get extra functionality and lighter weight, for less money?

Optisys is a company that was born out of a group of engineers and their frustration with the market controlling leaders in the Antenna and Radar industry.

These large companies are reluctant to turn their back on the previous 60 years development of antenna structures using traditional manufacture methods, and for obvious reasons, in their view, if it is not broke, don't try and fix it. However, the founders of Optisys saw a giant inefficiency in RF solutions that Additive Manufacturing (AM) could solve.

"When we started on this process," explained founding member and CEO Clinton Cathey, "and we knew we would have a better product for satellite applications, but the more we delved into the design, and developed generation after generation of new structures, we realized we truly had a disruptive solution too big for the industry to ignore."

Traditional antenna manufacture requires lots of components to be separately developed and assembled in a long chain, the accumulation of which leads to degradation in performance. Plus, due to the manufacture tolerance of each block, the same assembly can have a great variance in performance, a real problem when new constellations of smallsats require thousands of the same antenna. These structures are large, and heavy. Both of these are highly undesirable for the new flux of space missions.

Optisys, using AM, went back to the drawing board, and asked one simple question, "Where do we need the material to be?"

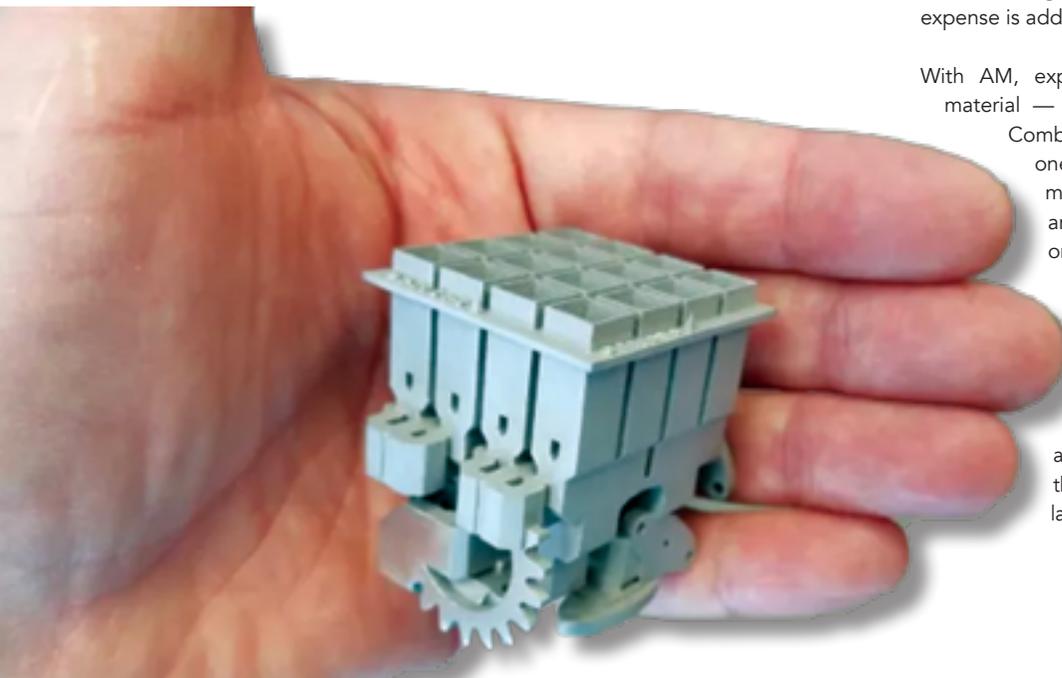
Such a simple question and one that can only be answered with AM. In all other traditional manufacturing methods, such as machining, expense is added when material is removed.

With AM, expense is added when you add material — complexity is not a cost driver.

Combining lots of the RF feed chain into one single component is the correct mix of performance, lighter weight and better cost. In many cases, one part replaces as many as 100 separate ones.

The benefit this gives to the payload engineer is increased capability, advanced functionality, lower size and weight, plus lower cost for their system and the subsequent launch costs.

The advent of Additive Manufacturing in general, and in antenna design in particular, seems largely set to give the new space race the efficiencies needed to allow advanced missions to other worlds as well as the next generation of communication infrastructures.



In 2016, Optisys wanted to show off this capability. CBO Janos Opra said, "One of our early projects was to see what we could do for a UAV customer who wanted a monopulse tracking radar to go onto one of their smaller UAV platforms. The existing product was far too big, measuring 16"x6"x4", and weighing in at 14 lbs. We took four, 8 to 1 combiners, a monopulse tracking system, mechanical gimbal mount, 5 SMP connectors, heat management, and a 4x4 horn arrangement and shrunk those components into a package of 2x2x3 inches and weighing 1.4 ounces — now, that's a game changer for that customer."

Since then Optisys has been miniaturizing, perfecting and inventing procedures and process and now has a product for every antenna type that operates from 1 to 100 GHz.

"We are gradually incorporating more and more of the passive RF chain into one component," said Cathey. "We now have assemblies that include a

This amalgamation of components is of great interest for the new space race. The unrivaled integration of components is allowing weight reductions that give advanced functionality for a fraction of the launch cost.

CTO Michael Hollenbeck explained, "When we include all these advanced separate features into one component, the overall weight of the system typically can be reduced by an order of magnitude, and in some cases has come down 100 times. Especially when we start to use the antenna as the mounting structure for all the other components, and as the thermal heat sink, its one big aluminum mass after all, then we really see the biggest benefits."

He continued, "With our IMSAR customer, we just attached all the hot active components right to our

that is highly desirable in its surveillance operations on their high altitude UAV's."

Optisys is now emerging as a key player in the production antenna market for space and aerospace markets with a new product range of phased arrays, that are causing quite a stir, due to their performance and low power requirements when compared to their competition.

"Traditional phased arrays that use 2-axis electronic scanning are usually expensive, have reduced scan volume performance, and require extremely high power to operate," noted Hollenbeck. "Our solution balances the strengths of phased arrays and passive arrays in a 1-axis hybrid approach where we can add tiles to scale up our phased array to get the required gain easily, but also because we are dealing with all metal structures, we are very power efficient. A large array might normally need 3 to 4kW to feed, we only need 200W, and we can deal with the heat better as we have an all-aluminum construction."

All these added benefits are challenging the space market to come up with imaginative solutions that two years ago would not have been feasible. The current crop of advanced satellites, and exploration missions are uncovering challenges that Optisys seem well placed to solve.

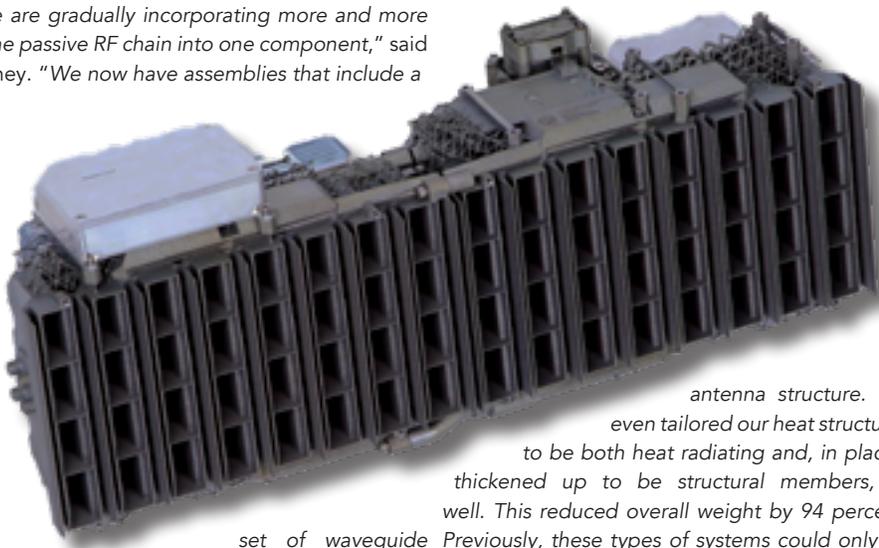
Opra added, "This year has seen an interest we hadn't expected in the space market. We are working very hard and expanding rapidly to keep up with demand. Fortunately our production process is quite simple, with short lead times."

The advent of Additive Manufacturing in general, and in antenna design in particular, seems largely set to give the new space race the efficiencies needed to allow advanced missions to other worlds as well as the next generation of communication infrastructures.

This is now the job of the systems and payload planners to understand and use their new found capabilities to extend humanity's reach further into the cosmos.

www.optisys.tech/

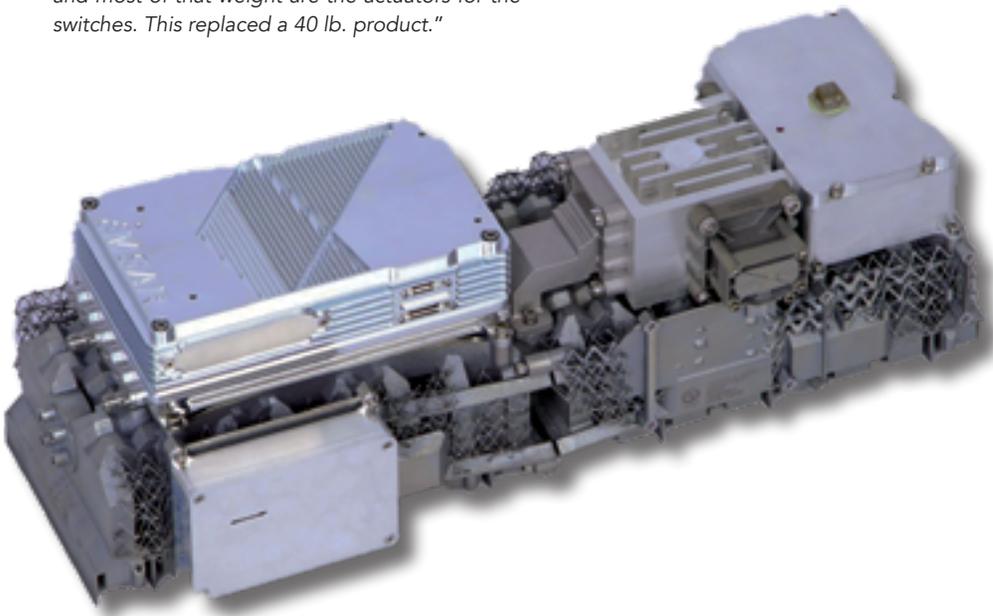
Adam Arnold is the European Divisional Lead for Optisys. After an initial career in Motorsport journalism, Adam turned to engineering where, after 15 years in the defence and aerospace antenna industry, he became a subject matter expert for mechanical design of metal 3D printed components. Ultimately, he was brought on board with Optisys to connect customers with their market leading solutions in the European region.



antenna structure. We even tailored our heat structures to be both heat radiating and, in places, thickened up to be structural members, as well. This reduced overall weight by 94 percent.

set of waveguide switches, filtering and multiple combiners in a part that weighs less than 2 lbs., and most of that weight are the actuators for the switches. This replaced a 40 lb. product."

Previously, these types of systems could only be fitted to satellites or large aerial platforms. This added agility to the customers mission planning



IMSAR waveguide antenna showing the level of integration possible using Optisys technology.

Space Debris...

Do we need stricter regulations, or, do we trust self-regulation

*By Hub Urlings, Founder of M2sat, and,
Alexandra Sokolowski, Business Development Manager, Hyperion Technologies*

The LEO space industry is in a hectic development phase. One after another constellation is launched, backed by generous funding by world billionaires. Their ambition and bank accounts seek equivalently ambitious large-scale programs looking at the sheer volume of spacecraft that are planned, creating scary visions of tens of thousands of satellites around the world, of which 15 percent potentially can become debris.

This reality is not as remote as we might wish to believe... when we look into the space market, we see operators such as Iridium or Globalstar as well as also companies like Spire or Planet, each having hundreds of satellites circling the Earth in low orbits.

Also, we see the new space industry preparing itself for business. With the broadband LEO's still in the planning phase, a number of smallsat IoT operators launched one or two demonstration satellites at the end of 2018 and are now preparing for additional launches during 2019. An expansion of their constellations combined could easily carry hundreds of satellites into orbit.

All these plans exceed the current satellite numbers by far. Recent forecasts (NSR) foresee around 5,500 smallsats launched during the coming eight years and the majority of them are populating constellations. People start to worry — about space debris.

Off-scale animations (see video URLs at the end of this article) play into these worries and feed them using state-of-the-art entertainment technology. Plus, the worldwide digital media coverage of the display of space capabilities such as the recent shooting down of a satellite by India is not removing those worries.

Existing LEO satellite operators with their fleets in space are already faced with an increasing number of questions regarding their responsibility. New satellite operators are questioned about their design and the manner in which they make certain space and, in particular, the LEO belt is not becoming a scrap yard.

We Depend on Satellites

Space debris worries are legitimate. The global economy depends on the ability to operate satellites safely in order to fly in planes, prepare for severe weather, communicate from sea or remote locations, broadcast television, study our changing climate or track goods, trucks, trains or vessels to manage our global logistic streams.

In order to continue using satellites in orbit around Earth for years to come, especially the low orbits as proposed in the NewSpace plans, we need to ensure that the environment around Earth is as free as possible from trash leftovers from previous missions. Currently, around 22,000 objects larger than 10 cm. are tracked by the U.S. Space Surveillance Network. Most of them are in orbits up to 2000 km., with the greatest concentration in the 800 to 850 km. belt.

This means that a serious consideration of the issue is needed. Gone are the days that space was a government and military domain that could not be held accountable for what they were doing. We see this concern reflected in two developments: there is increasing pressure through more regulations (e.g., from the FCC) and we also see a call for self-regulations from existing operators such as Iridium, Spire or Planet.

Increasing Pressures

Currently, the internationally accepted guidelines as proposed by the Inter Agency Debris Coordination committee (IADC) is to de-orbit satellites within 25 years.

Constellations, especially those with satellites in lower orbits such as the 600 to 650 km. altitude, which is of particular interest to smallsats, have already claimed compliance with the guideline, meaning that their satellites de-orbit before the end of that 25-year period.

However, this approach is again leaving de-orbiting to a random uncontrolled process, risking collisions. Yes, the U.S. Space Surveillance Network can provide a collision warning, but what can the satellite operator do with such a warning when there is no propulsion on board the spacecraft, which is currently the standard in smallsats.

One of the first proposals to tackle this is being undertaken by the U.S. FCC to oblige satellites flying higher than the ISS (around 400 km.) to carry on-board propulsion. Although this proposal has not won universal support as of this writing, it is clear that this proposal is in the interest of all operators to pursue controlled de-orbiting — not only to avoid future fines, but also to make space safe and clean to use for everyone.

Self-Regulation in the Industry?

The existing LEO satellite operators propose self-regulation and self-imposed rules.

Planet and Spire (“*We are a responsible space actor*”) claim to be managing their fleets to prevent retired spacecraft from lingering in space beyond internationally accepted guidelines. That is not too difficult to accomplish when you look at the altitude in which they operate. Iridium also thinks this is a good time to bet outspoken about orbital debris — just after the launch of their next generation of their satellites.

With all of these companies having dozens of satellites already in space, the question is if this is a real concern or just clever PR with the eye on the growing concerns with space debris in the international opinion. The real question is can their claim that the debris issue in LEO will be “*a self-correcting problem*” be correct.

Meanwhile, a new initiative is launched: The Space Sustainability Rating (SRR), a voluntary system to encourage those who operate satellites to create as little debris as possible. The SRR will create an incentive for companies and governments operating satellites to take all the steps they can to reduce the creation of space debris. This will create a more equitable opportunity for new countries but also the commercial sector in space with less risk of collision with older satellites.

Does Mission Come Before Durability ?

When it comes to space debris and the maximum time it will stay in orbit, physics are easy: the higher the orbit, the longer the debris remains in space. For example, a satellite without propulsion in a 300 to 350 km. altitude de-orbits after two to three months, a smallsat in a sun-synchronous or polar orbit at 600 km. typically will de-orbit in, roughly, 15 years. Satellites at 800 km., however, enter orbital decay already measured in decades. Above 1000 km, debris will continue circling the Earth for a century... or more.

Ultimately, it is the satellite’s mission that defines the on-orbit altitude...

Earth Observation (EO) satellites, such as those planned by Black Sky (400 km.) and Capella Space (400 to 520 km.), operate at a relatively low altitude to capture better quality pictures; Spire (500 km.) is a bit higher in altitude and occupies a larger area where it can read out radio waves from AIS transmitters and GPS signals. A satellite IoT operator such as Hiber works around 600 km. to achieve large satellite footprints and efficient global coverage. Iridium operates at about 800 km. as does the future Sky and Space Global system. OneWeb plans to operate at 1200 km.

Each have their own technical and business reasons for their orbit. Smallsats, for example, have no influence (yet) on the altitude where they are released into orbit and will be slotted anywhere in the 600 to 800 km. Polar orbit belt, as they rely heavily on rideshare opportunities with larger satellites.

Extending Smallsat Capabilities

For new space operators, the challenge is to meet mission requirements and at the same time comply with de-orbit regulations, or even to self-impose regulations upon themselves. Orbital height is a main parameter for the commercial success of the mission, with major implications for the way the satellites are designed and launched.

The orbit question is also closely tied with the question whether one needs propulsion or not. Of course, ideally a rocket launcher will place your satellite exactly where you want it located, optimizing the lifetime and performance. However, if this is not the case, propulsion is currently the only way to bring smallsats into the higher target orbit.

Depending on the altitude, propulsion can extend the smallsat’s lifetime significantly, especially in LEO. With each performance increase of propulsion systems for smallsats, the cost per satellite will decrease dramatically.

Placing Windmills in the North Sea requires extremely accurate measurements as the mast needs to be installed 100 percent straight up. To monitor the exact position of windmill mast, a realtime satellite M2M connection was established from the construction vessel to the datacentre onshore and back. Challenges in the project were that machine interfaces are not all IP, transmission protocols are not designed for satellite, there were multiple machines using the same satellite link and the use of heterogeneous networks (GEO-sat, LEO-sat, 3/4G, radio...).



Alexandra Sokolowski is the Business Development Manager for Hyperion Technologies B.V. Alexandra has been in charge of space topics, ranging from ground segment to space segment, for the past eight years and has a solid experience in content management, storytelling and marketing. In early 2019, she joined Hyperion Technologies as Business Development Manager to continue telling exciting stories about the NewSpace market and connecting people.

[linkedin.com/in/alexandrasokolowski](https://www.linkedin.com/in/alexandrasokolowski)

...video URLs mentioned in the article...

www.youtube.com/watch?reload=9&v=JmVt92d5bd4

www.youtube.com/watch?v=k0ijEEivCbg

www.studioroosegaarde.net/project/space-waste-lab

In example, if the lifetime of a satellite is extended by an additional year using propulsion, the overall cost of a planned mission for a three year mission will be reduced by one third.

Do we use chemical propulsion or electrical propulsion? Having propulsion also translates directly into another must-have for smallsats: accurate knowledge of attitude and orbit (ADCS).

However, propulsion holds even more benefits: End-of-life management and space debris avoidance. It enables a controlled de-orbiting phase for smallsats, especially when looking at (self-) regulations. In particular, with regard to human spaceflight, it makes sense to cross the 400 km. orbit of the International Space Station as quickly as possible.

Also, for satellite fleets, a mechanism is required to manage the full constellation in regard to orbital position, fuel and lifetime management, as well as service quality. These mechanisms are crucial to determine the profitability of smallsat constellations, the reliability and validity of the data generated and communication services to users and customers on Earth.

With propulsion, operators are also finally able to respond to collision warnings from the U.S. Space Surveillance Network, using their propulsion for a collision avoidance maneuver, saving themselves and others for the harm of a collision and preventing an increase of space debris around Earth.

Hub Urlings and Alexandra Sokolowski are members of the Dutch smallsat eco-system of companies that work together in the Netherlands.

Hub Urlings is a SATCOM Consultant and the ESA and Innovation Manager at Hiber as well as the founder of EUsatcom and an M2sat Consultant.

He was one of the pioneers of Satellite M2M as Product Manager for Inmarsat-C at the famous KPN Station 12. The reliability and success of this "small data" satellite service, its global coverage and reliability made that the service, was used for a myriad of applications: from sending messages, to truck fleet management, to pipeline monitoring and bringing back data from all types of sensors. At that time, satellite was the only type of network that was able to offer global IoT coverage. Now, 25 years later, that has not changed and he is again involved in the development of a new generation of satIoT services, working as the Innovation Manager for the ESA program at Hiber. His company, M2sat, is a value-added service provider for satIoT services.

[linkedin.com/in/huburlings](https://www.linkedin.com/in/huburlings)



The Hyperion PM200 brings high thrust propulsion capability to 3-12U CubeSats and similar platforms. Low system complexity and zero propellant toxicity allow for simple and robust operations, both on the ground and when in orbit. The medium tank pressure and high storage density of liquid propellants enable high safety factor tanks to be used with little mass penalty.

The standard 1U configuration of the PM200 propulsion module can deliver in excess of 230 m/s of velocity increment to a 3U CubeSat of 4 kg at a nominal thrust level of 0.5 N.

The PM200 offers active thrust vector control to minimize disturbance torque on the satellite platform and can be seamlessly integrated with the iADCS400 to provide a fully integrated GNC and ADCS solution.

Implications for Smallsats

The space debris discussion is certainly triggering another approach in the NewSpace industry. The issue is taken seriously and parties, both in the industry and the regulatory field, are looking for ways to appropriately deal with it. Based on the reactions from the NewSpace industry and the regulatory field, it appears that — for certain missions (above 600 km.?) — propulsion is a good idea.

How can this be done, in particular with smallsats? So far, propulsion systems have been too large to be placed on a smallsat, which is why the market is looking more and more into miniaturization.



LeoLab's Midland Space Radar. Photo is courtesy of the company.

LeoLabs, Inc. has a broad-based agreement to build their next space radar in New Zealand — this establishes New Zealand as the site for the first radar of its kind in the Southern Hemisphere.

As the third radar in LeoLabs' network, the New Zealand radar will be the first to track debris as small as 2 cm. in LEO.

The company also announced an agreement with New Zealand's Ministry of Business, Innovation and Employment (MBIE) to promote the creation of applications and services that enhance New Zealand's contribution to the space industry.

In addition, LeoLabs is pleased to announce that the New Zealand Venture Investment Fund (NZVIF) participated in LeoLabs' recently completed Series A round of financing.

LEO is rapidly emerging as the focus of commercial activity in space, with thousands of satellites spawning new generations services, ranging from broadband internet to Earth imaging.

LEO represents a new economy and a critical ecosystem shared globally by governments, space agencies, regulators, commercial satellite operators and insurance. Against this backdrop is the risk to satellites and astronauts posed by space debris, especially from the estimated 250,000 dangerous objects which are untracked today.

LeoLabs' announcement is groundbreaking in two respects. First, establishing a unique presence in the Southern Hemisphere enables LeoLabs to more accurately track objects and provide earlier notification of important events in space. Second, the phased array radar LeoLabs intends for New Zealand will be capable of tracking objects as small as 2cm, and address 95 percent of the risk that has never been tracked.

LeoLabs and the Ministry of Business, Innovation and Employment (MBIE), which leads the Innovative Partnerships program, have signed a Memorandum of Understanding (MOU) that includes LeoLabs' commitment to locate its next debris-tracking space radar in New Zealand.

The MOU also expresses a mutual aspiration to expand New Zealand's capabilities in space-related R&D.

The phased-array radar announced for New Zealand will complement two existing LeoLabs radars in North America.

LeoLabs has been providing commercial SSA services since its founding in 2016. The company estimates completion of the New Zealand radar in mid-2019.

Dan Ceperley, LeoLabs CEO, remarked that New Zealand is a multi-decade strategic decision for the company. The threats posed to a viable LEO economy and a sustainable space environment escalate with every launch. The firm's goal is to build out the LeoLabs global space radar network at a pace to match that threat. New Zealand represents the ideal location and partner to take that next step forward. The New Zealand LeoLabs radar represents the future of commercial SSA.

Dr. Megan Woods, New Zealand's Minister for Research, Science and Innovation, noted that the nations is thrilled to welcome LeoLabs to New Zealand as part of the Innovative Partnerships program. Innovative Partnerships is all about helping future-focused companies collaborate, innovate and connect here in New Zealand.

Dr. Woods added that the nation's history is all about the ability to innovate and be at the forefront of change. New Zealand's flourishing space industry is absolute testament to that fact.

www.leolabs.space/

www.mbie.govt.nz/science-and-technology/space/

More information can be found about LeoLabs and the company's work in New Zealand by selecting this video link:

www.youtube.com/watch?v=z93SM1WlIXs

InfoBeam

HawkEye 360 Inc. has named Robert Cardillo to the firm's advisory board — Cardillo is the former Director of the National Geospatial-Intelligence Agency (NGA) and a highly experienced national security professional and geospatial expert.

During his tenure as the sixth Director of the NGA, Cardillo sought to leverage the growing commercial capabilities of the geospatial industry. Prior to the NGA, Cardillo served as the first Deputy Director for Intelligence Integration, Office of the Director of National Intelligence, where he was responsible for delivering the President's Daily Brief and overseeing the National Intelligence Council and the National Intelligence Managers.



Currently, Cardillo is president of The Cardillo Group LLC, founded in May 2019.

In addition to his extensive work in the intelligence community, Cardillo has been awarded the Presidential Rank of Distinguished Executive (twice), the Presidential Rank of Meritorious Executive, the Director of National Intelligence Distinguished Service Medal (twice), the Secretary of Defense Distinguished Service Medal (twice) and the Chairman of the Joint Chiefs

of Staff Joint Meritorious Civilian Service Award.

Cardillo becomes the 19th member of HawkEye 360's advisory board. The advisory board contains a wide breadth of leadership experience and knowledge, including members such as Advisory Board Chairperson Letitia Long (former fifth Director of the NGA), Doug Wolfe (former Chief Information Officer of the Central Intelligence Agency), Admiral James A. "Sandy" Winnefeld, Jr. (former United States Vice Chairman of the Joint Chiefs of Staff), Robert Work (former United States Deputy Secretary of Defense), and Douglas Loverro (former United States Deputy Assistant Secretary of Defense for Space Policy).

HawkEye 360 CEO John Serafini said Robert's work in the intelligence community and geospatial industry is highly regarded and extremely valuable. His counsel, combined with that of the firm's exceptional advisory board members, will provide great benefit to the company in its continued engagement and support of critical U.S. and international government customers.

Cardillo remarked that the potential of the commercial geospatial industry grows every day — especially in partnership with the intelligence community. He looks forward to working with the advisory board members on HawkEye 360's pioneering technologies and offerings.

www.he360.com/

InfoBeam

Inmarsat's Fleet One solution has been installed on more than 5,000 vessels as demand increases, due to growing awareness and partnerships with key boatbuilders, such as Groupe Beneteau.

Inmarsat's Fleet One satellite connectivity solution for the leisure and fishing markets has surpassed the 5,000-installation landmark as the rate of service uptake continues to increase. Reflecting a growing demand from leisure boat owners for Fleet One's flexible and reliable connectivity anywhere on the world's oceans, the 5,000-boat milestone has been achieved just three years after the launch of the Global service plan.

Inmarsat has introduced a range of Fleet One leisure plans, providing recreational sailors on any sized vessel with the reassurance of a consistent, simultaneous voice and data connection that enables them to stay in touch with family and friends back home, use email and social media, and access

Inmarsat's Fleet One SATCOM solution sailing on 5,000+ vessels



applications to assist with navigation.

To further boost performance of Fleet One as user numbers rise, Inmarsat has also announced an increase in the service's maximum data speeds. Effective immediately, all current and new leisure boat owners, or fishing and commercial vessel operators using the service, will benefit from reliable simultaneous voice and IP data at up to 150 kbps for even faster always-on connectivity outside MF/HG and GSM coverage.

Inmarsat has implemented the speed upgrade from a previous level of 100 kbps to enhance the user experience provided by the Fleet One Global and Coastal service plans, delivered through the proven reliability of Inmarsat's

global L-band coverage. All newly activated Fleet One terminals will automatically access the increased speed. Customers with active terminals can update their service to benefit by following a simple implementation procedure.

With a compact antenna, in-built safety services and flexible air-time plans, Inmarsat's Fleet One provides recreational sailors and a range of other seafarers with the reassurance of a reliable, simultaneous voice and data connection for business, support services and staying in touch with people at home from anywhere on the world's oceans. The Fleet One service also has a free voice distress (505) call service that connects leisure users directly to the nearest Search & Rescue team in case of an emergency. Easy to install and use, Inmarsat offers two service plans — Fleet One Global, offering flexible connectivity for any size of vessel for both seasonal and regular users, and Fleet One Coastal, which is aimed at occasional users looking for tailored airtime pricing to keep costs down.

Inmarsat, in partnership with terminal manufacturers Cobham, AddValue and Spaceon, is continuing to strengthen partnerships with boatbuilders and key resellers.

Groupe Beneteau recently extended Inmarsat's satellite communications solutions as a line-fit and retro-fit option on the manufacturer's leading brands Lagoon, CNB Yachts and Beneteau, enabling customers to benefit from Fleet One for a two to three year period during the purchase phase of a sail or motor yacht through a tick of the box in the options catalog of the yacht builder.

www.inmarsat.com/service/fleet-one

www.beneteau.com



The Spaceport America Cup's winning team from the University of Washington.

Spaceport America congratulated the University of Washington Society for Advanced Rocket Propulsion as the Champion of the Third Annual Spaceport America Cup.

Champions were selected in each category, and the University of Washington team was chosen by judges from the group of category champions as the overall winner.

From June 18 to 22, thousands of students and spectators flocked to



southern New Mexico from across the globe, creating an economic and tourism boost for surrounding communities as part of their attendance at the 2019 Spaceport America Cup.

This year's competition was the largest to date, with more than 120 teams registered including a large international presence from 14 different countries.

The week long event kicked off on June 18 at the Las Cruces Convention Center, where students displayed their rockets to judges and spectators, and had the opportunity to network with top commercial space companies and recruiters.

Then, from June 19 to 22, students competed, launching liquid, solid and hybrid rockets from Spaceport America's Vertical Launch Area.

With over 90 rockets launched, the majority reaching their intended altitudes, this year marked more successful launches and increasing ingenuity from students, as well as

continually improved experiences for spectators.

Dan Hicks, CEO of Spaceport America, said the company is honored to serve as the host site for the Third Annual Spaceport America Cup, the world's largest intercollegiate rocket engineering competition. This competition showcases some of the brightest minds of Universities from around the world — the rockets launched at the Spaceport America Cup are the result of months of hard work and planning. As evidenced by their teamwork, dedication, innovations, and tremendous successes this week, the future workforce of the world's space industry sector is in good hands.

Dan added congratulations are in order to all of the 2019 Rocketeers and Spaceport America extends gratitude to the sponsors, volunteers, and those who traveled to New Mexico to be a part of the Spaceport America Cup.

www.spaceportamerica.com



Student rocket launch of Day Five of the Spaceport America Cup contest. Photo is courtesy of Joe Najera.



Aerial photo of Spaceport America in New Mexico.

Very High Speed, Onboard Networks

The evolution of SpaceWire

By Stuart Mills, Chief Executive Officer, STAR-Dundee

STAR-Dundee was formed in 2002 to commercialize research performed by the University of Dundee while writing the SpaceWire standard on behalf of the European Space Agency (ESA), and the company has continued to innovate and to contribute to new standards.

SpaceWire was designed specifically for use onboard spacecraft. One of the main advantages of SpaceWire is its low complexity (hence, low gate count) and the fact that it can be implemented easily in ASICs and FPGAs.

SpaceWire is a packet switching network that uses worm-hole routing switches for routing packets across the network. Worm-hole routing was adopted because it minimizes the amount of buffer memory needed in the routing switches, an important consideration for implementation in radiation tolerant chips where memory is at a premium.

Providing high-speed (2 to 200 Mbit/s), bi-directional, full-duplex, data links, these connect together SpaceWire-enabled equipment.

It is able to support many different payload processing architectures using point-to-point links and SpaceWire routing switches. The data-handling architecture can be constructed to suit the requirements of a specific mission, rather than having to force the application onto a bus or network with restricted topology.

The SpaceWire standard was published by ESA's standardization body, the European Cooperation for Space Standardization (ECSS), in 2003 and was quickly adopted internationally by the likes of ESA, JAXA, NASA and Roscosmos and is now being widely used on scientific, Earth Observation (EO), commercial and other spacecraft.

High profile missions using SpaceWire include BepiColombo, Gaia, GOES-R, James Webb Space Telescope, Hitomi, Lunar Reconnaissance Orbiter and the Rosalind Franklin rover.

STAR-Dundee has grown with SpaceWire — the company now features a strong team of knowledgeable and experienced engineers who provide high quality products and support. Included within this expansion has been the establishment of a wholly-owned subsidiary in Barcelona, imaginatively titled STAR-Barcelona.

STAR-Dundee's product range has grown to now offer a comprehensive range of SpaceWire test and development products and IP cores that have been used on many of the missions flying SpaceWire.

These test and development products include interface devices, routing devices, link analyzers, recorders, conformance and protocol testers, device emulators and flight chip development kits.

The company's IP cores are widely used across the space industry, including in the SpaceWire 10X Router ASIC (AT7910E) and SpaceWire Remote Terminal Controller ASIC (AT7913E) radiation tolerant chips.

SpaceFibre offers much more than high data rates — the technology is capable of detecting, isolating and recovering from faults in the link where they occur and that prevents faults from propagating and causing further errors.





A selection of STAR-Dundee's SpaceWire test and development products.

SpaceFibre — The Next Generation of SpaceWire Technology

STAR-Dundee continues to innovate and develop new technologies. For the past decade, STAR-Dundee has been leading the development of the next generation of SpaceWire technology: SpaceFibre. These efforts were recently rewarded with the publication of the SpaceFibre standard, "ECSS-E-ST-50-11C – SpaceFibre – Very high-speed serial link", by the ECSS.

SpaceFibre provides data signaling rates of 6.25 Gbit/s in current flight technology, over electrical or fiber optic cables, while its unique multi-laning features allow up to 16 lanes to be combined into a single link, giving a theoretical link rate of 100 Gbit/s.

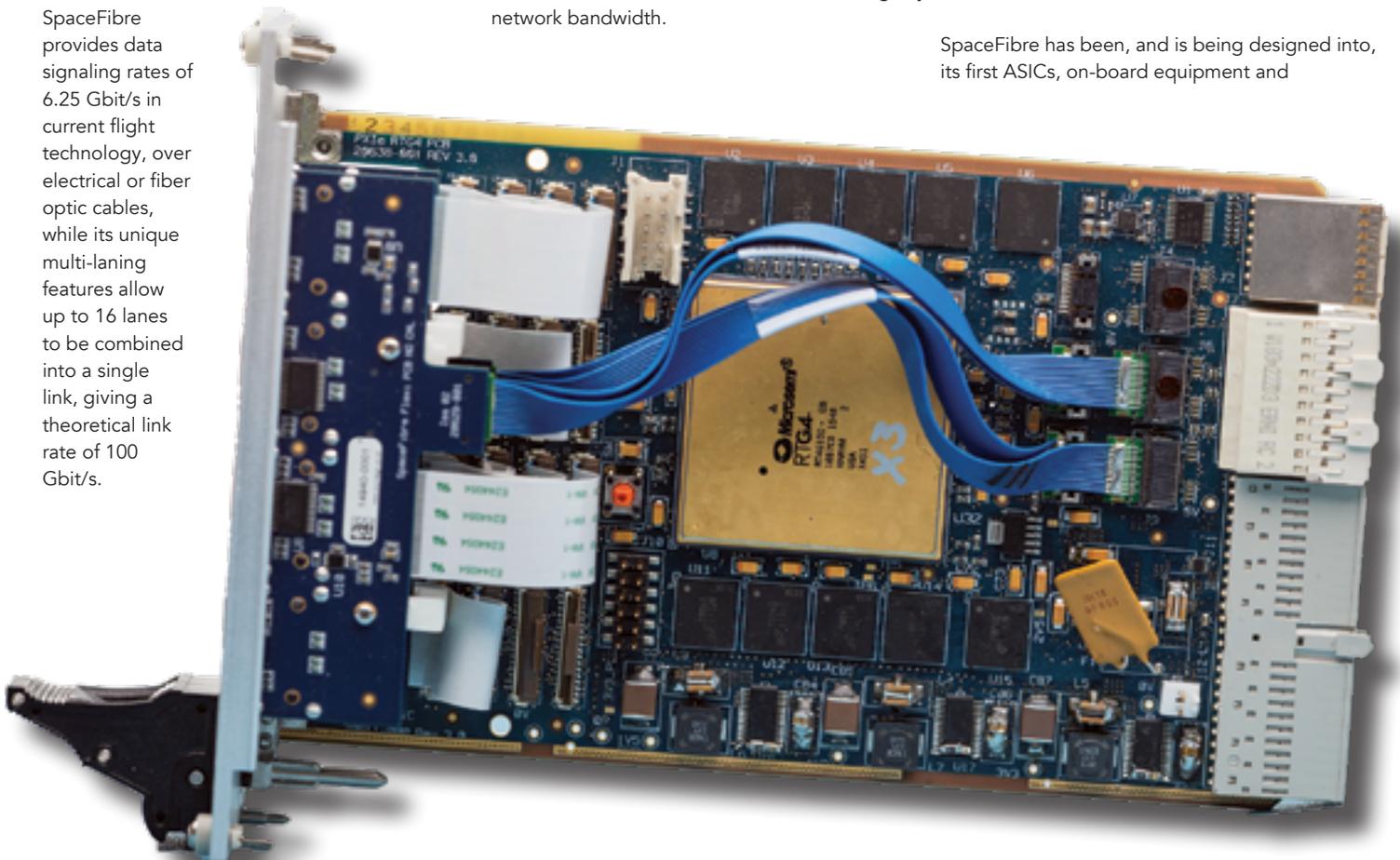
SpaceFibre offers much more than high data rates — the technology is capable of detecting, isolating and recovering from faults in the link where they occur and that prevents faults from propagating and causing further errors.

SpaceFibre provides galvanic isolation, transparent recovery from transient errors, error containment in virtual channels and frames, and "Babbling Node" protection. Very versatile quality of service mechanisms allow scheduled, deterministic communication without wasting any network bandwidth.

These powerful capabilities mean that SpaceFibre is suitable for very high data rate payloads, such as Synthetic Aperture Radar (SAR) and multi-spectral imaging instruments as well as be used for network and equipment management and for deterministic command and control type applications.

SpaceFibre allows each of these traffic types with different requirements to share a single network, with each traffic stream operating independently within its own virtual network.

SpaceFibre has been, and is being designed into, its first ASICs, on-board equipment and



STAR-Dundee's SpaceFibre PXIe-RTG4 board, providing 8 SpaceFibre ports, 4 SpaceWire ports and accessed from a Microchip RTG4 FPGA.

space missions. The powerful Ramon Chips RC64 many-core DSP features STAR-Dundee IP to provide 12 SpaceFibre ports each offering up to 6.25 Gbit/s data signaling rate.

SpaceFibre is being used in Europe, USA, Russia and Japan and has been incorporated in the latest revision of the ANSI/VITA 78 SpaceVPX backplane standard.

As with the SpaceWire standard, Steve Parkes, CTO of STAR-Dundee and formerly the Chair of Spacecraft Electronic Systems at the University of Dundee, wrote the SpaceFibre standard with inputs from international spacecraft engineers. STAR-Dundee has designed, implemented and tested:

- The first SpaceFibre interface
- The first SpaceFibre routing switch
- The first SpaceFibre multi-lane interface
- The first SpaceWire to SpaceFibre interface device
- The first experimental SpaceFibre interface ASIC (VHISSI)
- The first SpaceFibre interfaces in a many core processor (Ramon Chips' RC64)
- The first SpaceFibre interface in a radiation tolerant FPGA (Microchip's RTG4)
- The first SpaceFibre routing switch in a radiation tolerant FPGA
- The first SpaceFibre multi-lane interface in a radiation tolerant FPGA
- The first SpaceFibre link analyser
- The first SpaceFibre interface board.

In addition, STAR-Dundee has demonstrated the first complete SpaceFibre network representative of spaceflight applications and incorporating radiation tolerant technology.

STAR-Dundee owns a patent on the SpaceFibre multi-lane technology, which is being freely licensed for space related applications.

STAR-Dundee's SpaceFibre product range continues to grow. The recently released STAR Fire Mk3 test and development product can transmit and receive both SpaceWire and SpaceFibre traffic; it can interconnect SpaceWire equipment to a SpaceFibre network and it can operate as a SpaceFibre link analyser, capable of unobtrusively capturing and displaying SpaceFibre traffic.

Leveraging these capabilities, it is possible to emulate, stimulate, debug and validate SpaceFibre enabled equipment using the STAR Fire Mk3.

SpaceFibre IP cores available from STAR-Dundee now include a SpaceFibre Single Lane Interface, a SpaceFibre Multi-Lane Interface, a SpaceFibre Router and a SpaceFibre-to-SpaceWire Bridge.

The company is supporting several organizations as they include these IP cores in new missions requiring far higher data rates than were possible with SpaceWire, or which require the deterministic command and control capabilities offered by SpaceFibre's innovative quality of service mechanisms.

www.star-dundee.com/

Information regarding the SpaceWire standard is available at this direct link...

www.star-dundee.com/knowledge-base/overview-spacewire-standard

Stuart Mills is the CEO of STAR-Dundee and one of the company's founders. He has a First Class Honors Degree in Computer Science and a Ph.D. in Spacecraft Systems, both from the University of Dundee.



STAR-Dundee's STAR Fire Mk3 SpaceFibre Interface, Link Analyser and SpaceWire Bridge.

