

Worldwide Satellite Magazine – October 2018

SatMagazine INNOVATION II

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AtlanTecRF
AvL Technologies
Cog
CRP Technology
Crystal
DEV Systemtechnik GmbH
ETL Systems
Fleet Space Technologies
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"Innovation" is far more than just a term that's being bandied about by industry and marketing mavens and actors... "Innovation" is an agency of change, of solidifying dreams into a reality, of bringing the future into today.

Innovation is also an action... Satellite Innovation (satinnovation.com) drives technology into areas never before realized, where a look ahead becomes a current possibility, where a cognizant thought can be cemented into a positive enhancement for satellite and space market segments to the delight of users, companies, organizations, nations, agencies, militaries, and students.

With innovations for the space and satellite market segments increasing in scope, with more and more deliverables arriving on market that possess heretofore "impossible" and now amazing technical capabilities, there are an ever increasing number of eyes and dollars attuned to the "how to" monetize this arena than has ever been witnessed before in the history of the space and satellite industry.

Every few days, it seems as though another space startup emerges, with the hopes of fitting and satisfying a niche that will be a successful part of this explosive market. For years, experts have been questioning what market segment the world's first trillionaire will emerge from to step onto the world stage — with the potential that the space industry offers, most major venture capital firms are eying this industry as the segment that will see this occur.

Satellite communication (SATCOM) is the basis for most of the revenue for current, privatized space. Satellite Innovation is focused on the business of satellite communications, and the leaders and innovators participating in this event will be focused on exactly where the next growth segments are likely to develop and will also accurately determine business potentials with realistic timelines. Attendees will become participants in the future... **today.**

One of the company executives who will be participating as a speaker at **Satellite Innovation** is the CEO of **Eutelsat Americas** (www.eutelsatamericas.com/),

Mr. **Mike Antonovich**. He will be addressing attendees at the **"New End User Markets — The Next Generation of Satellite Customer"** session, which is being held at 2:30 p.m. on Tuesday, October 9.

The session will point out that, with broadband services costing more than \$2 per megabit/second per month, and fiber or cable being less than \$1, new point to multi-point services may be the next market.

With vertical integration disrupting the established marketplace at an increasing pace, new users will provide an opportunity for growth and for service providers and operators alike, a means of survival.

This panel aims to identify important strategies to secure new markets which will be of significant importance to all satellite industry players in the future. Techniques to identify new partnerships, how to connect with new customers and an emphasis on the unique advantages of SATCOM over alternative technology will be discussed.

SatMagazine queried Mr. Antonovich as to his thoughts regarding why is innovation important to the industry and, in particular, to Eutelsat Americas?

Mike replied, *"Innovation has been a cornerstone of Eutelsat's success through the years. The company has always embraced new technologies to improve satellite performance and reliability for our customers. One domain where Eutelsat has been a leader is in the design of all-electric satellites, which allows for improved service life for our spacecraft, reduced fuel mass and more efficient payloads for our satellite deployments. EUTELSAT 115 West B was actually the world's first all-electric satellite."*



"Looking at in-flight connectivity, EUTELSAT 172B has also been iconic for this market, due to its innovative High Throughput Ku-band payload designed for in-flight broadband with multiple user spots optimized to serve densely-used Asian and trans-Pacific flight paths."

"Given Eutelsat's leadership in the video sector, we have also been a pioneer in HD and Ultra HD as viewers continue to push for higher quality formats. We are currently broadcasting nearly 20 UHD channels on our fleet, leading the way as the format continues to develop."

When talking about the innovative projects Eutelsat have underway, Mike said, *"For starters the new EUTELSAT QUANTUM satellite will be the first to feature the unique ability to change uplink and downlink coverage on orbit, via software, allowing customers to use satellite bandwidth and power with far greater flexibility than ever before."*

"Moving closer to the ground, we are developing a entire range of new video solutions under the Eutelsat CIRRUS brand name. Eutelsat CIRRUS provides a turnkey content delivery solution via satellite and OTT to operators seeking to launch or upgrade their service, offering the benefits of rapidly deployed video services, low operational costs, high image quality and consistent end-user experience. It will improve the workflow and efficiency of video transport across the wide spectrum of Eutelsat video customers."

"Finally, taking advantage of satellite's unique 'one to many' and 'any to any' capabilities, we are developing Internet Of Things solutions using our SmartLNB, designing cutting-edge offers to enable real-time live communication with thousands, tens of thousands and potentially millions of low cost devices and appliances to relay information to and from virtually anything."

Mike's response as to what he sees as the innovative technologies that will drive the space and satellite industry over the next year or so prompted him to say, *"It is quite clearly that we are living in a "wireless world" and satellites will continue to be an essential part of it. When you think "cloud"...you should just think of massive data centers, but you should also consider how you can collect and disseminate data and intelligence to anybody, anywhere. And satellites remain uniquely positioned to do that. So when you look up and think "cloud"...think of what is above those clouds! Satellites!"*

<http://www.eutelsatamerica.com/>



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InfoBeam

ICESat-2 launch, Delta II adieu

After several delays, the United Launch Alliance's (ULA) Delta II rocket was launched for the final time carrying NASA's weather satellite, ICESat-2. This is the end of an era for the Delta II rocket that was first launched on February 14, 1989.

Gary Wentz, ULA vice president of Government and Commercial Programs, said, "This vehicle has truly created a legacy throughout its history launching NASA, critical U.S. military satellites and commercial clients."

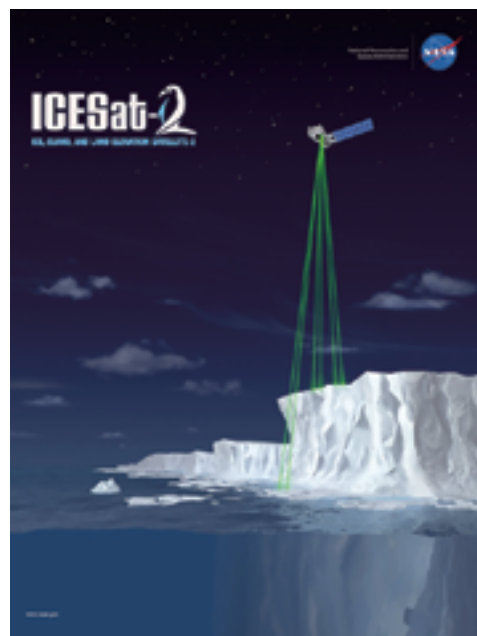
NASA's satellite, ICESat-2, with its single instrument — the Advanced Topographic Laser Altimeter System (ATLAS), manufactured by Northrop Grumman — will provide scientists with height measurements to create a global portrait of Earth's third dimension, gathering data that can precisely track changes of terrain including glaciers, sea ice, forests and more.

In addition to ICESat-2, this mission includes four cubesats that will launch from dispensers mounted to the Delta II's second stage.

This mission was launched aboard a Delta II 7420-10 configured rocket, which includes a 10 foot in diameter payload fairing (PLF). The booster for this mission is the Aerojet Rocketdyne RS-27A engine — the second stage is powered by that company's AJ10-118K engine.

To date, ULA has a track record of 100 percent mission success with 129 successful launches. With more than a century of combined heritage, United Launch Alliance is the nation's most experienced and reliable launch service provider.

ULA has successfully delivered more than 125 satellites to orbit that aid meteorologists in tracking severe weather, unlock the mysteries of the solar system, provide critical capabilities for troops in the field and enable personal device-based GPS navigation.



ULA Summary

United Launch Alliance (ULA) also revealed that the last Delta II rocket will join a lineup of historic rockets in the Rocket Garden on display at NASA's Kennedy Space Center Visitor Complex at Cape Canaveral, Florida.

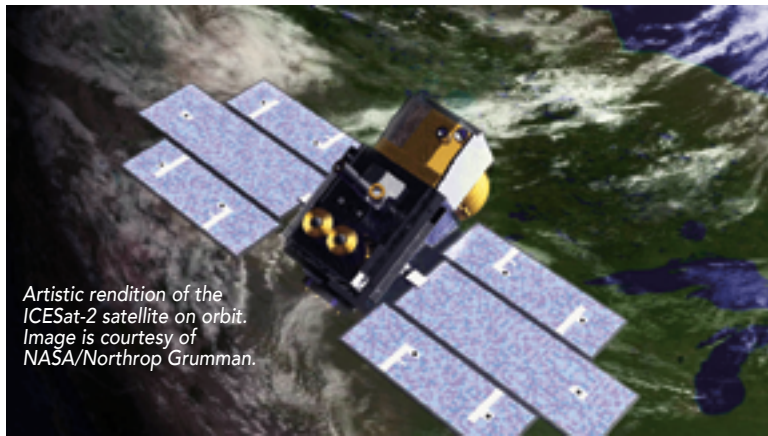
"The Delta II rocket has been a venerable workhorse for NASA and civilian scientists, the U.S. military, and commercial clients throughout its almost 30 years of service," said **Tory Bruno**, ULA president and CEO. "This program comes to a close with the final launch of NASA's ICESat-2, but its legacy will continue and the Visitor Complex will help us keep the story of the success of this much-revered rocket in the hearts and minds of the public."

The maiden Delta II flight occurred on Valentine's Day in 1989 and successfully delivered the first operational GPS satellite to orbit.

Since that first launch, Delta II rockets have launched 154 successful missions. Its resume includes several trips to Mars as well as the planet-hunting *Kepler*, the twin lunar-orbiting *GRAIL* spacecraft, 48 GPS satellites and numerous commercial imaging and communications satellites.



The launch of ICESat-2 aboard the final blast-off of the United Launch Alliance Delta II rocket family.



Artistic rendition of the ICESat-2 satellite in orbit. Image is courtesy of NASA/Northrop Grumman.

NASA Summary

NASA's Ice, Cloud and land Elevation Satellite-2 (ICESat-2) successfully launched from California at 9:02 a.m. EDT on Saturday, September 15, embarking on a mission to measure the ice of Earth's frozen reaches with unprecedented accuracy.

ICESat-2 lifted off from Space Launch Complex-2 at Vandenberg Air Force Base on United Launch Alliance's final Delta II rocket. Ground stations in Svalbard, Norway, acquired signals from the spacecraft about 75 minutes after launch. The satellite is performing as expected and orbiting the globe, from pole to pole, at 17,069 mph from an average altitude of 290 miles.

"With this mission we continue humankind's exploration of the remote polar regions of our planet and advance our understanding of how ongoing changes of Earth's ice cover at the poles and elsewhere will affect lives around the world, now and in the future," said **Thomas Zurbuchen**, associate administrator of NASA's Science Mission Directorate.

ICESat-2 carries a single instrument, the Advanced Topographic Laser Altimeter System (ATLAS). ATLAS will be activated approximately two weeks after the mission operations team completes initial testing of the spacecraft. Then ICESat-2 will begin work on its science objective, gathering enough data to estimate the annual height change of the Greenland and Antarctic ice sheets to within four millimeters – the width of a pencil.

"While the launch today was incredibly exciting, for us scientists the most anticipated part of the mission starts when we switch on the laser and get our first data," said **Thorsten Markus**, ICESat-2 project scientist at NASA's Goddard Space Flight Center. *"We are really looking forward to making those data available to the science community as quickly as possible so we can begin to explore what ICESat-2 can tell us about our complex home planet."*

The high-resolution data will document changes in the Earth's polar ice caps, improve forecasts of sea level rise bolstered by ice sheet melt in Greenland and

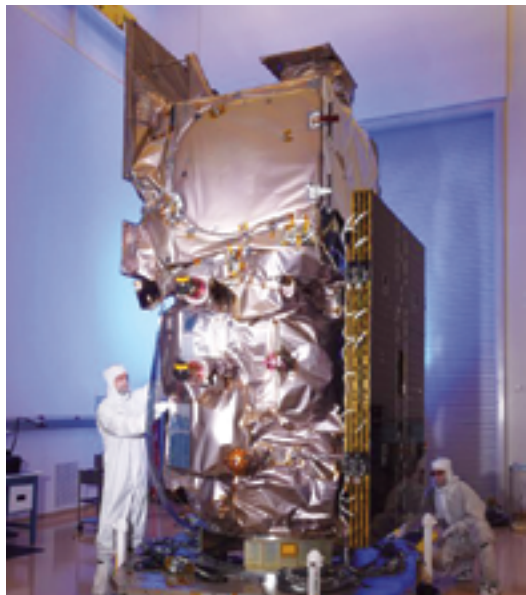


Photo of ICESat-2 upon completion of manufacturing. Image is courtesy of Northrop Grumman.

Antarctica, and help scientists understand the mechanisms that are decreasing floating ice and assess how that sea ice loss affects the ocean and atmosphere.

ICESat-2 continues the record of ice height measurements started by NASA's original ICESat mission, which operated from 2003 to 2009, that were continued by the agency's annual Operation IceBridge airborne flights over the Arctic and Antarctic, which began

in 2009. Data from ICESat-2 will be available to the public through the National Snow and Ice Data Center.

Goddard built and tested the ATLAS instrument, and manages the ICESat-2 mission for NASA's Science Mission Directorate.

Northrop Grumman designed and built the spacecraft bus, installed the instrument and tested the completed satellite. NASA's Launch Services Program, based at Kennedy Space Center in Florida, is responsible for launch service acquisition, integration, analysis and launch management.

Northrop Grumman Summary

Northrop Grumman Corporation (NYSE: NOC) built the Ice, Cloud and Land Elevation spacecraft (ICESat-2) for NASA and the satellite was successfully launched aboard a United Launch Alliance (ULA) Delta II rocket from Vandenberg Air Force Base, California.

In addition to manufacturing the spacecraft, Northrop Grumman also provided propulsion, key composite structures, a space navigation system and other components on the Delta II launch vehicle. This event marks the final launch of the Delta II rocket.

ICESat-2 will provide precise measurements of the changing height of Earth's glaciers, ice sheets and sea ice. The satellite is carrying the Advanced Topographic Laser Altimeter System (ATLAS), built at NASA's Goddard Space Flight Center, which will measure the height of a changing Earth one laser pulse at a time. The instrument will enable scientists to measure the topography of the Greenland and Antarctic ice sheets in unprecedented detail. With 10,000 laser pulses per second, the fast-shooting laser technology allows ATLAS to take measurements every 28 inches along the satellite's path.

"ICESat-2 demonstrates the company's expertise in delivering high-quality Earth science satellites that help scientists gain a better understanding of the changes that can affect the planet's frozen and icy areas," said **Steve Krein**, Vice President, science, environmental and weather programs, Northrop Grumman. *"As a key focus of NASA's Earth science research, ICESat-2 paves the way for scientific discoveries that will yield new data on the potential effects of a changing Earth."*

Northrop Grumman designed and manufactured the ICESat-2 spacecraft at its Gilbert, Arizona, satellite manufacturing facility and will provide mission operations at its Dulles, Virginia, site.

The company built the satellite on its flight-proven LEOStar-3™ platform, which will be also used for the upcoming Landsat-9 and JPSS spacecraft.

Company facilities in California and Maryland provided numerous subsystems, including the satellite's diaphragm propellant tank, pressurant tank, solar arrays and heat pipes for two components on the spacecraft.

Northrop Grumman also supplied its Scalable Space Inertial Reference Unit (Scalable SIRU™) navigation system for the satellite to enable spacecraft attitude control and sensor pointing/stabilization. The Scalable SIRU is the industry standard for high-precision, long-life attitude control solutions supporting commercial, government and civil space missions.

Northrop Grumman also manufactured the Delta II rocket's four Graphite Epoxy Motors 40 (GEM 40), which provided an additional 460,000 pounds of maximum thrust during today's launch. Northrop Grumman has been supplying solid propulsion motors to ULA and its predecessor companies for a variety of launch vehicles since 1964 and is ULA's largest legacy supplier of solid propulsion.

"As the Delta II program finishes its long, successful run, we note that 1,003 GEM 40 strap-on boosters have helped launch 132 Delta II missions, including today's," said **Charlie Precourt**, Vice President and General Manager, propulsion systems, Northrop Grumman. *"The Delta II rocket enjoys the longest consecutive success record in commercial rocket motor history."*

Northrop Grumman manufactured the GEM 40 motors in Utah, the Delta II rocket's 10-foot diameter composite fairing in Mississippi and the rocket's second stage helium and nitrogen pressurization bottles in California.

www.ulalaunch.com/rockets/delta-ii

www.nasa.gov/feature/goddard/2018/counting-on-nasas-icesat-2

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InfoBeam

Payload delivered

Orbital Micro Systems (OMS) has delivered their first ever commercially owned and operated, space-based, passive microwave radiometer for atmospheric observation to

Clyde Space in Glasgow, Scotland, for satellite integration.

Employing proven technology used in many larger weather monitoring platforms, such as the Advanced Technology Microwave Sounder (ATMS) aboard the Joint Polar Satellite System, the innovative OMS radiometer will deliver highly-accurate temperature, humidity, and precipitation data critical for business decisions at a fraction of the cost of heritage government programs. The mission is part of the In-Orbit Demonstrator (IOD) Program, funded by Innovate UK and managed by the Satellite Applications Catapult. OMS is on track to launch six to eight satellites in 2019 to establish its Global Environmental Monitoring System (GEMS) constellation.

The payload, consisting of a 10x10x15 cm. sized instrument in a 3U cubesat, will be launched and put into LEO via the NanoRacks CubeSat Deployer (NRCSD) on the International Space Station (ISS) — via NanoRacks' Space Act Agreement with NASA's U.S. National Lab. The launch is planned for early 2019.

OMS established its UK-based organization under the guidance of the UK Global Entrepreneur Program in 2017. The expansion has enabled the company to accelerate its business plans through projects such as the IOD and other UK-funded initiatives.

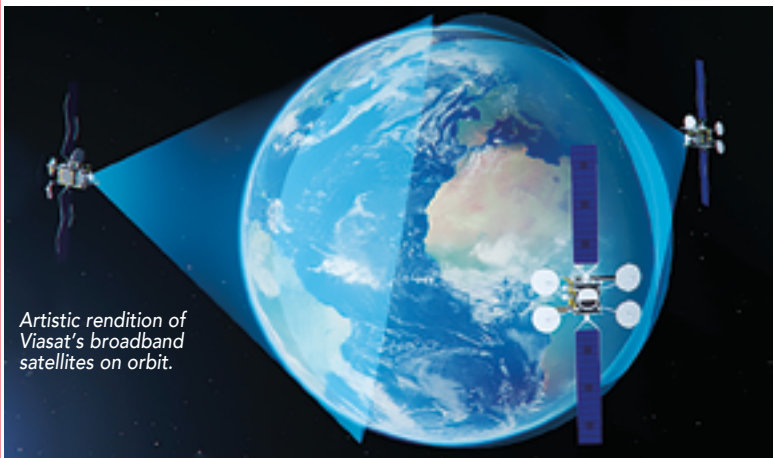
Michael Hurowitz, CTO for OMS, said that the IOD mission is the first member of the GEMS constellation that will pave the way for never-before-possible temporal coverage of global weather conditions. In addition, the OMS data scientists at the International Center for Earth Data (ICED) are developing advanced analytics to integrate the data generated from the firm's satellites with public and private data streams that will provide a much more complete and accurate view of weather conditions in near real time.

www.orbitalmicro.com

InfoBeam

Viasat names ULA to launch their Viasat-3 satellite

Viasat Inc., (Nasdaq: VSAT) has selected United Launch Alliance's (ULA's) proven Atlas V vehicle to launch one of their ViaSat-3 satellite missions — this is the first commercial contract ULA has directly signed since assuming responsibility for the marketing and sales of the Atlas V launch vehicle from Lockheed Martin Commercial Launch Services earlier this year.



Artistic rendition of Viasat's broadband satellites on orbit.

The Viasat mission will carry one of the ViaSat-3 series spacecraft and is scheduled to launch in the 2020 to 2022 timeframe from Space Launch Complex-41 at Cape Canaveral Air Force Station in Florida. This mission will launch aboard an Atlas V 551 configuration vehicle, the largest in the Atlas V fleet. The 551 configuration provides the performance to deliver a ViaSat-3 satellite into a high-energy geostationary transfer orbit where it can begin on-orbit operations faster than with other available launch vehicles.

The selection of Atlas V for one of the ViaSat-3 missions is the next step in implementing Viasat's integrated launch strategy which is designed to ensure the on-time launch of 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.

Atlas V has launched 78 missions with 100 percent success including 17 successful commercial missions. The workhorse rocket also delivered critical science missions for NASA such as Mars Science Lab, Pluto New Horizons and Mars InSight, and critical missions for the Department of Defense including Space-Based Infrared System (SBIRS) and Wideband Global SATCOM (WGS).

Dave Ryan, the President of Space Systems at Viasat, said that ULA continues to demonstrate schedule certainty and flexibility, as well as be a trustworthy and reliable business partner. This coupled with unmatched Atlas V launch vehicle reliability and tailored mission design capabilities made ULA a strong partner for a ViaSat-3 launch mission. ULA is known for providing an innovative launch solution that is focused on mission success, which will allow ViaSat to meet the company's business objectives to bring high-speed, high-quality broadband connectivity to meet end-user demand.

Tory Bruno, ULA's President and CEO, added that ULA's Atlas V launch vehicle is the most reliable launch vehicle in the world and the company is pleased that Viasat has recognized the value the Atlas V can offer and has decided to select this rocket to launch their commercial communications satellite.

www.viasat.com

www.ulalaunch.com

Kudos to Arianespace with the September 25 successful 100th launch of Ariane 5 from the European spaceport in Kourou (French Guiana).

This event was the result of the efforts of an enormous network of specialists and employees whose common goal was to see this mission's success of placing two telecommunications satellites Horizons 3e and Azerspace-2/Intelsat38 into orbit weighing a total of 9,940 kg... and they did.

An archive video of the launch may be viewed at https://www.youtube.com/watch?v=A3rBUie9RIw&feature=player_embedded.

Arianespace

In 22 years of service, the Arianespace Ariane 5 has launched more than 170 satellites to GTO as well as the Rosetta probe, five transfer vehicles (ATV) to resupply the International Space Station (ISS) and 12 satellites for the European Galileo navigation service.

This Ariane 5 ECA brought a net total of 9,940 kg. in total mass for the two satellites and 10,827 kg. gross mass (including the ACU, payload adapters, the SYLDA, which is the Ariane dual launch system, and the LVA 3936 Launch Vehicle Adaptor) to the launch. Since 2016, the net performance gain for Ariane 5 has increased by 150 kg.

Alain Charneau, CEO of ArianeGroup stated, "Launching 10 metric tons into orbit is now normal business for Ariane 5, and this 100th lift-off is an opportunity to celebrate the expertise of the teams at ArianeGroup, Arianespace and all of their industrial partners across Europe, who are working constantly to improve their capabilities and the performance and competitiveness of our launcher, while at the same time preparing the arrival of Ariane 6 in just two years from now."

"I warmly thank them and the European Space Agency, CNES and all our partners in European space, with whom we celebrate this success. Without the interest and constant support of the political powers in Europe over these two decades, this success would not have been possible. During the course of these 100 flights since 1996, Ariane 5 has not only supported the development of the European and global space industry in the field of telecommunications, but has also contributed to exploration and to science."

"Soon, Ariane 6 will take up the torch. Until that time, other impressive missions await Ariane 5, whose next flight is a very important one: BepiColombo which will head for Mercury next month. Ariane 5 has not yet written the final page of its space legend."

In addition to the 170 telecommunications satellites placed in GEO over the past 22 years, Ariane 5 has also launched payloads to a number of various orbits: The second flight of the recoverable ARD capsule; the XMM, Herschel and Planck telescopes; the Rosetta probe; the ENVISAT Earth observation satellite; two HELIOS remote-sensing satellites; five ATV automated freighters to resupply the International Space Station and, more recently, 12 navigation satellites for Europe's Galileo constellation. Ariane 5 thus confirms its reputation as the world's most reliable commercial launcher.

In celebration of this 100th launch, more than 7,000 people around Europe virtually launched Ariane 5 themselves via social media. This successful joint campaign by ArianeGroup, Arianespace, CNES and ESA was launched on July 25 to raise awareness about Ariane 5 among the citizens of Europe.

Finally, the various ArianeGroup sites in France (notably in Kourou) and in Germany celebrated this 100th launch by sharing memories and future ambitions with their 9,000 employees and all of their partners.

As the industrial lead contractor for development and operation of the Ariane 5 and Ariane 6 launchers, ArianeGroup coordinates an industrial network of more than 600 companies in 13 European countries, including more than 350 Small and Medium Enterprises. ArianeGroup oversees all the industrial activities, from the performance improvements and studies necessary for Ariane 5 up to its production, the provisioning of data or software specific to each mission, without forgetting the global marketing activities by Arianespace. This chain includes equipment and structures, engines manufacturing, integration of the various stages and finally launcher integration in French Guiana.

Additional statistics pertaining to Ariane 243's launch include...

- 75th consecutive success by a launcher fitted with a Vulcain® 2 engine
- 100th success by a launcher fitted with the solid propellant strap-on boosters (EAP)
- 140th consecutive success by a launcher fitted with the HM7B engine

This launch sent two satellites to orbit, the Horizons 3e and the Azerspace-2/Intelsat 38.

Horizons 3e/Intelsat

Horizons 3e was deployed from Ariane 5's upper payload slot and is owned by a joint venture of Intelsat and SKY Perfect JSAT Corporation.

Built by Boeing using Intelsat's EpicNG® design, it will provide coverage for aeronautical and maritime mobility, fixed and wireless operators, as well as mobility and government customers. In addition, Horizons 3e is the first satellite in Intelsat's EpicNG spacecraft series to feature entire Ku-band spot

The 100th launch of the Ariane 5 for flight VA243.
Photo is courtesy of Arianespace.





Artistic rendition of the Horizons-3e satellite.



Artistic rendition of the Azerspace-2 / Intelsat 38 satellite. Image is courtesy of SSL.

beams using multi-port amplifiers that optimize power across the spacecraft.

As Ariane 5's upper passenger on Flight VA243, Horizons 3e is owned by a joint venture between Intelsat and SKY Perfect JSAT, marking this as the fourth collaboration between the two companies.

Horizons 3e completes the Intelsat EpicNG® network's global coverage, bringing the next level of high-throughput services to the Asia-Pacific region and expanding coverage in the Pacific Ocean.

The all-digital Horizons 3e payload represents a continued evolution of the award-winning Intelsat EpicNG® platform. It features full beam interconnectivity in C- and Ku-bands and also includes a multi-port amplifier that optimizes power across the satellite, enabling a power adjustment of each spot beam to better meet a customer's throughput demands.

This feature brings additional efficiency and flexibility to address regional and application requirements for broadband, mobility and government customers operating in the Asia-Pacific and Pacific Ocean.

The 6,441 kg. satellite will provide 30 gigabits per second of bandwidth for fixed and mobile customers, and it is to be stationed at the 169 degrees East orbital location to replace Intelsat 805.

Horizons 3e is the 60th Intelsat satellite, as well as the 20th for SKY Perfect JSAT, to be launched by Arianespace — and as such, it embodies more than 35 years of shared success in the unique partnership between Intelsat, SKY Perfect JSAT Corporation and Arianespace.

Boeing is the prime contractor of Horizon 3e and this is the 56th satellite from this manufacturer to be launched by Arianespace.

Azerspace-2/Intelsat 38

Azerspace-2/Intelsat 38 is a multi-mission satellite to be located at 45 degrees East.

The Azerspace-2/Intelsat 38 co-passenger to be orbited by Flight VA243 from Ariane 5's lower passenger position was produced by SSL and is designed to provide a range of telecommunications relay duties at the service of its two operators — Intelsat and Azercosmos, the latter being a company owned by the government of the Azerbaijan Republic.

This is Azercosmos' second telecommunications satellite and it will expand on the current capacity of Azerspace-1. Azerspace-2 will also increase the coverage area and spectrum of services provided by Azercosmos.

The satellite's planned orbital position is only one degree away from the current Azerspace-1 orbital location at 46 degrees East, which creates favorable opportunities for existing and new customers to start expanding their current satellite solutions.

The satellite will offer enhanced capacity, coverage and service offerings to support growing demand in the region for Direct-to-Home (DTH), government and network services in Europe, Central and South Asia, the Middle East and Sub-Saharan Africa.

The satellite is ideally designed for smaller antennas and has cross-connectivity between East Africa, West Africa and Central Africa, Europe and Central Asia.

Intelsat 38 will provide Ku-band capabilities and deliver continuity of service for the Intelsat 12 satellite located at 45 degrees East. The satellite will host leading Direct-to-Home television platforms for the fast-growing Central and Eastern Europe and Asia-Pacific regions.

The satellite will support the growth objectives of customers operating in these regions. Intelsat 38 will also provide critical broadband connectivity for corporate network and government services in Africa.

Built by California-based SSL, a Maxar Technologies Company, Azerspace-2/Intelsat 38 offers 35 active transponders in Ku-band. Its designed lifetime is more than 15 years. This is the 65th satellite based on an SSL platform to be launched by Arianespace.

SSL

The Azerspace-2 / Intelsat 38 satellite is performing post-launch maneuvers as expected, stated SSL, a Maxar Technologies company (formerly MacDonald, Dettwiler and Associates Ltd.) (NYSE: MAXR) (TSX: MAXR), following launch on September 25 aboard an Ariane 5 launch vehicle from the European Spaceport in Kourou, French Guiana.

The satellite deployed its solar arrays shortly after launch and will fire its main thruster on September 27 to propel the craft toward final orbit at 45 degrees East.

The satellite design is based on the highly reliable SSL 1300 satellite platform that provides the flexibility for a broad range of applications and technology advances. Azerspace-2/Intelsat 38 is designed to provide service for 15 years or more. SSL has built more than 275 satellites over the firm's 60 year history. With this launch, there are now 90 satellites built by SSL in geostationary orbit.



The SSL-built Azerspace-2/Intelsat 38 satellite was successfully launched on September 25 and is performing according to plan.

Photo of the satellite post-manufacturing is courtesy of SSL.

Dario Zamarian, Group President of SSL, said that SSL-built satellites such as Azerspace-2/Intelsat 38 help to build a better world, making information and communications more accessible. He thanked Azercosmos and Intelsat for their trust in SSL, as well as the company's teams at SSL and Arianespace for the excellent teamwork and commitment making this launch a success.

Rashad Nabiyeu, Chairman and Chief Executive Officer of Azercosmos, added that SSL proved to be an excellent and reliable partner to help the company make Azerspace-2 a reality. Now that the satellite has successfully launched, the firm looks forward to providing enhanced service offerings to customers.

Ken Lee, Intelsat's SVP of space, noted that SSL has been a trusted and valued manufacturing partner of Intelsat's for many years. The company's customers have benefited from their innovative designs and the new Intelsat 38 satellite payload is no exception. The satellite will enable Intelsat's media customers in Central and Eastern Europe and Asia to grow their business and deliver fast, reliable broadband connectivity to corporate enterprise and government customers in Africa.

arianespace.com

www.sptvjsat.com/en/

azercosmos.az

www.intelsat.com

www.sslmda.com

INNOVATION



COMTECH EF DATA

Bringing innovative ideas to fruition can be a daunting task and requires the efforts of many specialized professionals within a company to deliver a final product that features advanced technologies in combination with reliable performance. One firm that has constantly been able to deliver on innovative technologies is Comtech EF Data.

A recent example is Comtech EF Data Corporation's new Durostream AHA725 and AHA723 WAN Optimization appliances with packet protection from the firm's AHA Products Group. The AHA725 model is packaged in a 1RU rack-mountable chassis and supports WAN data rates up to 1 Gbps. The AHA723 is the compact form factor model that supports WAN data rates up to 50 Mbps.

The Durostream WAN Optimization solution provides a resilient, full-duplex, point-to-point survivable tunnel that dynamically adapts to network conditions to maximize throughput and minimize latency. The products address the challenge of packet loss on unreliable networks when streaming video or transmitting time-sensitive data. At just 1 percent packet loss on a 1 Gbps WAN link, and 10 ms

round trip time, a normal unprotected link using TCP/IP will only achieve 2.8 percent of the theoretical throughput as opposed to 96.6 percent, if the same link is protected with Durostream. Forward error correction

(FEC) technology and header compression are employed to ensure protocol overhead and latency due to re-transmissions are minimized, while retaining the ability to overcome sustained packet loss rates of 75 percent.

Durostream is particularly suited to protecting VoIP traffic, streaming video, live event broadcasts, public safety and critical infrastructure communications, business continuity and disaster recovery operations, remote backups, and general data transfer. By placing a Durostream appliance at both ends of a WAN link, data loss and decreased throughput due to suboptimal network infrastructure can be avoided.

Joel Bifford, the company's Sales Manager for AHA Products, said that the company's Durostream product line enables the use of unreliable existing network infrastructure for broadcasters, enterprise and government users. Having two model options allows even cost-sensitive users with lower bandwidth and limited space applications to leverage the operational benefits of Durostream on previously unusable networks.

Satnews Publishers had the opportunity to hear from the company's Vice President, Cellular Backhaul Business Development, Mr. Michael DiPaolo — he offered the following regarding why innovation is important to the industry and, in particular, to Comtech EF Data.

"Innovation is the mechanism through which our industry achieves and maintains relevance and competition. In our remarkably fast-paced industry,

there is the constant need to demonstrate and create value for clients and the overall communications ecosystem, particularly as the world becomes ever more reliant on digital communications to satisfy industry and societal needs. This is particularly important when satellite communication is the only option that is capable of addressing the user requirements, such as reaching rural locations in both advanced and developing nations, and supporting mobility applications like Cruise and Aeronautical. The satellite communications ecosystem relies on innovation across all aspects, including in space, on the ground with ever-improving modem products, such as those offered by Comtech EF Data and even to the amazing pace of innovation in the LEO, MEO and launcher communities.

"For Comtech EF Data, our focus for innovation has always been to be the leader in delivering the highest spectral and transport efficiencies to ensure that satellite operators and service providers fully leverage capacity holdings. Years ago, Comtech EF Data demonstrated innovation by introducing high-performance Turbo Product Codes at a time when the majority of the market was still using Reed Solomon or other lower efficiency coding. Our offerings continued to evolve to include DoubleTalk® Carrier-in-Carrier®, advanced LDPC coding, and our current VersaFEC®-2 modulation, which provides DVB-S2X performance with minimal delay, and is ideally suited for applications at all data rates where users demand Quality of Experience (QoE). It may seem ironic that our innovations are intended to save on satellite utilization. You would figure the satellite service providers would not be supportive of these type of innovations as they are trying to sell more capacity. However, the reality is that users are starved for bandwidth and if they can get a lower price per Mbps, then they are more likely to deploy more Mbps and thereby more satellite capacity. Our innovations have led to a decade long positioning of Comtech EF Data as the premier supplier of SCPC across all markets and the most respected name in the industry.

"As such, I would say simply that innovation and service differentials are extremely important to Comtech EF Data. We pride ourselves that customers view our products as the premier quality products in the markets we serve."

Michael then added, "We see, today, that the satellite service operators innovating on their side to deploy HTS platforms which, if coupled with high-performance ground equipment, can significantly bring down the cost per Mbps making delivery of new services across satellite affordable and competitive.

"Our latest innovative product/solution is called the Heights Networking Platform, which has been designed specifically to complement the HTS environment. Heights is a point-to-multipoint (hub and spoke) platform with shared outbounds and shared return channels that are dynamically allocated with our Heights Dynamic Network Access (H-DNA) algorithms. As we see it, the principal benefit that HTS provides is highly powerful beams over defined limited coverage areas (versus lower power distributed across traditional wide beam coverage areas). Our Heights Networking Platform was designed to address the needs of operators, service providers and owner operators in mobility, government, premium enterprise and Mobile Network Operator (MNO) sectors where it simply must work matters most. An example of a key feature is the delivery of high modulation across HTS allowing users to benefit from the highest Mbps/MHz conversion rates in the industry while benefiting from on-demand shared bandwidth capacity. Our Heights solution essentially provides all the benefits of high modulation/availability/delay and jitter that we normally associate with quality SCPC solutions, while also providing the beneficial dynamic bandwidth management and sharing that makes TDMA services so attractive but without the inherent compromises of TDMA (excessive jitter, more latency and poor QoE).

"Comtech EF Data has some additional important innovations ongoing, such as our satellite hosted waveforms currently flying on a LEO constellation and our new load aggregation solution. The load aggregation is an appliance from our subsidiary, Memotec, which complements our modem offering and can be deployed to provide end users, service companies and satellite operators with a new type of flexibility that has previously not been available. For instance,



Michael DiPaolo,
Comtech EF Data's VP,
Cellular Backhaul Business
Development.



we have come out with a concept we call Virtual Transponders in which we use our new solution to allow our clients to combine, or harvest, any available capacity across a number modems (may be free space on same transponder, same satellite different band, or entirely separate satellite), while providing a single Ethernet interface to the end user. The system automatically adapts traffic to the different modems based on the modem link conditions to ensure the links are optimally full. For example, imagine a customer that needs 200 Mbps for a point-to-point link, however, there is insufficient contiguous capacity to provide it. Our new solution will allow them to aggregate capacity from multiple transponders or satellites (C-, Ku- or Ka-band) into a single bundle, providing the customer requested bandwidth. This is exciting as it opens up opportunities for satellite service providers to mix services from different bands or different technologies (GEO/HTS or MEO/LEO and even microwave and fiber) in providing a single bandwidth offering to a customer. It also opens the opportunities for satellite service providers to offer levels of bandwidth previously unimaginable over satellite. A project underway using this technology offers end users the ability to bind several transponders to provide up to 5 Gbps outbound. Additionally, this approach is inherently robust in that it eliminates single points of failure, creating a more fault tolerant environment which builds on the mission-critical ethos of Comtech EF Data. There are other solutions that we envision which will further drive the demand for more satellite and, essential to Comtech EF Data, more ground equipment."

Mr. DiPaolo believes a number of technologies will drive the space and satellite industry over the next year or so... "The company believes the correct technologies and development roadmaps are in place to address the firm's target markets. Specifically, those markets are driving demand for big bandwidth and high Quality of Experience (QoE) including mobility, government, premium enterprise, and MNO.

"The Mobile Network Operator market is primarily driven by demand for bandwidth and deployment of 3G, 4G and eventually 5G. We already have solutions capable of providing upwards of 1 Gbps of optimized LTE and 5G traffic across satellite. Many MNO customers have already selected Heights to support their 2G/3G/4G rollouts over satellite. Many of our Heights customers are benefiting from high efficiency outbound and inbound carriers operating a five order modulations (32ary) which, coupled with our integrated header and payload compression and integrated LTE optimization, are running at average efficiencies of 6 bits/Hz in both directions, far exceeding the efficiencies of traditional TDMA vendors. Our solutions are field-proven to provide MNOs with the highest performance and preservation of highest levels of Key Performance Indicators (KPIs) on the market. To the MNO, high KPI scores are essential to comply with regulatory requirements and offer service profitably and with highest level of customer satisfaction and in that respect, Comtech EF Data far outshines the competition.

"Another key market worth highlighting is high-end mobility where the leading cruise and oil & gas companies require ever-increasing levels of raw throughput to address the ever-growing demand for passengers and crew to access social media, remain connected with their loved ones and continue to work should that be necessary. After all, who isn't connected 24x7 today? Also,

the associated businesses demand connectivity to operate to the highest possible efficiencies particularly as they become more reliant on and take the opportunity of the business intelligence and remote operations techniques made possible through initiatives such as the Industrial Internet of Things (IIoT). Robust, high-performance mobility-enabled products are and will remain a key deliverable for Comtech EF Data today and into the future.

"We continue to see important innovation around pure trunking, be that for ISPs, fiber restoration and disaster recovery purposes, and now into the various LEO and MEO initiatives. Innovation doesn't stop with the technology. Business model innovations can also be realized via partnering approaches that best meet the continually evolving expectations of the community.

"It is exciting to be involved in the satellite communications industry. Innovation is at the heart, and Comtech EF Data is proud to an important contributor within the ecosystem.

www.comtechefdata.com

the project. The UCD team now moves to the next phase of the program and will begin to assemble and test an EIRSAT-1 prototype in newly installed clean rooms at the University.

Control, or WBC, tests a UCD-developed algorithm to control the movement of EIRSAT-1.

The EIRSAT-1 team includes students from the UCD Schools of Physics; Mechanical and Materials Engineering; Electrical and Electronic Engineering; and Mathematics and Statistics. The students, funded by the Irish Research Council, Science Foundation Ireland and ESA, are being supported by academic staff, postdoctoral researchers, technicians and industry mentors.

The EIRSAT-1 mission is supported by industry partners that include ENBIO, SensL (now part of ON Semiconductor) and Parameter Space.

Minister Halligan TD said that the EIRSAT-1 project provides the UCD student team with a great opportunity to develop skills in satellite development, a first in Irish space science education. The development of these skills will have an impact beyond those directly participating in the project, including in the expanding space industry sector in Ireland. Furthermore, UCD's participation in the Fly Your Satellite! program has significant potential to drive an interest in space among students at all levels of education at a time when Ireland's STEM capabilities are playing an increasingly important role in our international competitiveness."

Professor Lorraine Hanlon, UCD School of Physics and EIRSAT-1 Project Leader, added that cubesats, such as EIRSAT-1, are disrupting the traditional space sector globally, providing a fast and cost effective route to gaining spaceflight heritage. As an emerging space nation, Ireland's future space endeavors will benefit from the skills developed by the talented team of UCD students who are building EIRSAT-1.

Professor Orla Feely, UCD Vice-President for Research, Innovation and Impact, congratulated the EIRSAT-1 team of UCD students on successfully completing the first phase of ESA's Fly Your Satellite! program and wished them every success with the next phase of assembling and testing the satellite, adding that the Government's recent announcement of Ireland's membership of the European Southern Observatory provides significant benefits for advancing the skills agenda and research excellence in the space sector in Ireland. A key objective of the EIRSAT-1 mission is through its success to inspire the next generation of students to study STEM subjects. The skills base and the research and development agenda are closely aligned, and both need continuing investment by Government to ensure that Ireland can maximize its return from global opportunities in the space sector. The ongoing implementation of the Innovation 2020 strategy is key to building critical mass in key areas of importance in the space sector in Ireland to the benefit of individual enterprises and the economy.

www.ucd.ie

https://www.esa.int/Education/CubeSats_-_Fly_Your_Satellite



Photo of the University College Dublin, Ireland, EIRSAT-1 cubesat.

cubesats – fly your satellite!



John Halligan TD, Minister for Training, Skills, Innovation, Research and Development, has announced that Ireland's first satellite, EIRSAT-1, has successfully completed the first phase of the European Space Agency's (ESA's) Fly your Satellite! (FYS) Program, the Critical Design Review, and has now moved one step closer to launch into space.

Minister Halligan TD made the announcement during a visit to University College Dublin (UCD), where he met with the interdisciplinary team of 16 UCD postgraduate students who are building the satellite with the support of ESA's Education Office.

EIRSAT-1 (Educational Irish Research Satellite-1) is a smallsat and is comparable in size to that of an average shoebox. In May 2017, EIRSAT-1 was selected to be part of the second cycle of the FYS! Program. ESA has concluded that the objectives of the satellite's Critical Design Review have now been achieved, marking an important milestone for

Subject to passing further reviews and mission milestones, EIRSAT-1 is expected to be delivered to ESA in mid-2020 with three scientific experiments on board. After subsequent launch, it is anticipated to operate for a 6 to 12 month period. Once on orbit, the satellite will communicate data to Earth through a ground radio station, located at EIRSAT-1 mission control in the UCD School of Physics.

The three EIRSAT-1 experiments, designed and developed in UCD, will include technology from Irish industry partners that include ENBIO and SensL (now part of ON Semiconductor).

The main experiment on-board EIRSAT-1 will be a novel gamma-ray detector, called GMOD, which aims to detect gamma-ray bursts, the most energetic explosions in the universe, which occur when some stars die or collide. The second experiment, EMOD, is an in-flight demonstration of thermal control coatings developed by the Irish company ENBIO Ltd. The third experiment, called Wave-Based



ThinKom Solutions, Inc. and Telesat have signed a memorandum of understanding (MoU) to jointly develop a Ka-band enterprise user terminal for Telesat's planned LEO constellation of satellites.

As an initial step in the process, ThinKom's ThinAir® Ka2517 phased array antenna system, which is currently in production for commercial and government in-flight connectivity (IFC), will be used for over-the-air testing on Telesat's Phase 1 LEO satellite over the next few months.

Telesat's state-of-the-art LEO constellation will combine the company's global spectrum rights in Ka-band with Telesat's proprietary LEO architecture to transform global communications. The constellation will deliver an unsurpassed combination of capacity, speed, security, resiliency, latency and low cost.

Telesat's LEO constellation will accelerate 4G/5G expansion, bridge the digital divide by bringing fiber-like high-speed services into rural and remote communities, and set new levels of performance for commercial and government broadband on land, sea and in the air.

ThinKom and Telesat will collaborate in the development of a new Telesat LEO-compliant enterprise terminal for terrestrial applications. Building on ThinKom's disruptive antenna

technology and Telesat's commercial and technical expertise in satellite communications, the new terminal will be cost effective while delivering high-performance connectivity for applications including mobile backhaul, WiFi hotspots, isolated cable and DSL networks, and remote institutions.

Michel Forest, Director of Engineering at Telesat, said that ThinKom's new terminal, combined with the revolutionary value proposition of Telesat's LEO constellation, will unlock new satellite communications market opportunities with better value economics for service providers and their customers. Easy to deploy, cost effective and agile beam antenna technology are key requirements for the company's Telesat LEO constellation, which will be able to allocate bandwidth seamlessly and instantly where it's most needed. Live, over-the-air testing with Telesat's Phase 1 LEO satellite will validate that the ThinKom Ka-band aero antennas, which currently operate on geostationary satellites, meet all of the Telesat LEO system requirements.



Bill Milroy, Chairman and Chief Technical Officer of ThinKom Solutions, noted that ThinKom's patented phased-array architecture provides rapid switching speeds without the drawbacks typical of electronic scanning antennas in terms of limited instantaneous bandwidth, poor low look-angle performance, high power consumption and lower aperture efficiency. The company's proven antenna technology has the versatility to support an integrated LEO constellation solution offering gap-free pole-to-pole coverage with automatic beam switching, rapid outage recovery and network optimization for different geographical regions. This means ThinKom can offer a fast-track path to commercialization of a fully interoperable, multi-orbit solution in the near term.

For more on ThinKom's LEO/MEO/GEO interoperability, view the company's video at:
www.thinkom.com/future-proofed-satcom-antenna-technology/

www.telesat.com/

Boeing acquires satellite manufacturer



Millennium's Aquila satellite.

Boeing [NYSE: BA] has completed the acquisition of Millennium Space Systems, a provider of agile, flight-proven smallsat solutions.

Millennium Space Systems will operate under Boeing Phantom Works as a subsidiary called Millennium Space Systems, A Boeing Company.

The company will retain an independent operating model while benefiting from Boeing's resources, scale, manufacturing capability and technology

research as the leading provider of aerospace products and services. Boeing first announced the agreement with Millennium Space Systems on August 16, 2018, pending U.S. government approval. Terms of the approved deal were not disclosed and do not affect Boeing's financial guidance or the company's commitment to returning approximately 100 percent of free cash flow to shareholders.

Headquartered in El Segundo, Calif., Millennium Space Systems has approximately 260 employees and has developed high-performance satellites and space systems for exacting missions ranging from 50 KG to more than 6,000 kg.

www.boeing.com

www.millennium-space.com



Millennium's Altair smallsat.

InfoBeam

Ground station agreement

**Astrocast and Leaf Space
now have an agreement
for Astrocast's use of Leaf
Space ground stations**

— this agreement calls for as many as 12 antennas to be used by the Astrocast IoT network, a 64-unit smallsat constellation, which is scheduled to be launched in phases.

The antennas included in the agreement will be built and operated by Leaf Space and will be strategically located across six locations, providing dedicated service solely to Astrocast and its worldwide customers. This new ground segment solution, named Leaf Key, has been developed by Leaf Space to address high capacity and high efficiency missions, such as Astrocast's constellation.

The Astrocast IoT and Machine-to-Machine (M2M) communications network will provide cost effective services to customers spanning key global industries worldwide. Coverage will span the 90 percent of the globe not currently serviced by existing cellular systems. The constellation will consist of eight orbital planes, each encompassing eight operational spacecrafts along with two spare satellites.

The Leaf Space agreement provides Astrocast with the use of additional antennas each time the Swiss-based, IoT provider launches a new plane of satellites. Current Astrocast constellation deployment plans include

- *The Spaceflight-organized launch of two demonstration satellites onboard Falcon9 and PSLV in the 4th quarter of 2018*
- *An undisclosed launch of the constellation's first plane of Astrocast satellites during the third quarter of 2019*
- *The recently announced D-Orbit-led launch of a second plane of nanosatellites in late 2019 or early 2020.*

The roll-out of Leaf Space antennas will align with these satellite deployment phases. Offering remote IoT and M2M capabilities, Astrocast's constellation is designed to enable substantial operational efficiencies and cost advantages within key global sectors including maritime, oil and gas, mining, supply chain and logistics, transportation, utilities, agriculture, and many others.

Fabien Jordan, the co-founder and CEO of Astrocast, said the firm is pleased to engage Leaf Space for ground communication services. With the ability to develop and operate dedicated antennas, and to scale alongside our network, Leaf Space is the correct partner for our company. There are numerous businesses operating remotely which simply don't have access to key IoT capabilities because those services don't currently exist in those regions. The Astrocast network will be a game changer for these enterprises and Leaf Space's ground station capabilities will be a key component of this solution.

Giovanni Pandolfi Bortoletto, a co-founder and CTO of Leaf Space, added that the firm worked closely with the Astrocast team to develop a service able to reduce the ground segment to a predictable recurring cost, even for such a big constellation. Leaf Key is a flexible and scalable system that follows step by step the constellation deployment, providing the right performance at the right time.

Jonata Puglia, also a co-founder and the CEO of Leaf Space, noted that this is the first time a single ground segment provider has been awarded to support a full-deployment smallsat constellation. This is exciting, to see space startups such as Leaf Space, working closely together to achieve their goals. This is a clear sign that the smallsat market is consolidating and entering its mature stage.

**www.astrocast.com/
leaf.space/**



Iridium Communications Inc. (NASDAQ:IRDM) has been selected as the preferred provider of satellite communications services for The Ocean Cleanup, the non-profit organization deploying advanced technologies to rid the world's oceans of plastic.

The Ocean Cleanup is embarking on one of the largest environmental initiatives of this generation by cleaning up ocean plastic debris, starting with what's known as the Great Pacific Garbage Patch.

The Ocean Cleanup has selected Iridium L-band satellite broadband services to support this important mission. The service is being delivered in partnership with Iridium service provider The AST Group.

By creating a system of 600-meter-long floating plastic collectors (floating screens, or systems) that include a 3-meter-deep skirt, The Ocean Cleanup collects plastic pollution through a combination of the wind, waves, natural ocean currents and the floating screen's ability to prevent plastic escaping underneath it, or flowing over the top, while avoiding to ensnare sea life.

Each system is equipped with two Iridium broadband terminals, and upon full deployment of a fleet of 60 floating screens, there will be 120 Iridium broadband terminals operating as part of this project.

The Iridium terminals will be relaying critical systems data including compartment flood detection, position and location information, pictures, 360 degree video and system performance information.

The Iridium broadband terminals will receive data from a complex combination of sensors and data



gathering equipment hosted by each system. That information will then be relayed to The Ocean Cleanup's headquarters in Rotterdam in real-time. Iridium's constellation of 66 interconnected LEO satellites requires no local ground infrastructure and provides the robustness, reliability and redundancy needed to ensure this critical data is delivered as expected.

Iridium is nearing complete deployment of its next-generation satellite constellation, Iridium NEXT. The new constellation is completely replacing the previous network of 66 interconnected satellites. To date, there have been seven successful Iridium NEXT launches completed by SpaceX, deploying 65 new satellites.

One launch remains before completion of the company's historic constellation refresh. In total, 75 new satellites are being launched to LEO, of which 66 will be in the active constellation, with nine on orbit spares.

Iridium CEO Matt Desch said that the opportunity to play a role in such an important and historic endeavor was a no-brainer for Iridium. This is an honor for the company to be a part of The Ocean Cleanup's incredible mission to rid the oceans of plastics. A reliable, predictable and redundant communication network, that can work despite adverse weather conditions, is critically important to this system — that's when the Iridium network really shines.

Matt added that when the oceans aren't cooperating and several foot waves and powerful winds are causing havoc, the Iridium system will help make certain that The Ocean Cleanup understands the operational status of each floating screen in the fleet.



www.iridium.com

www.theoceancleanup.com

INNOVATION



FROST & SULLIVAN

Innovative ideas produce innovative results that further the causes of the industries and target market segments within the satellite and space environs. Frost & Sullivan helps their clients leverage technology convergence to create better solutions for their customers, with services such as technology vision road-maps, technology convergence workshops and technology commercialization strategies.

The company also assists their clients to evaluate and monetize their IP through a structured approach that integrates the firm's deep understanding of applications across multiple points in the value chain.

Mr. **Michael Blades**, the company's Research Director and Space Program Manager, was asked by *SatMagazine* why innovation is so important to the industry and, in particular, to his company?

Michael answered, "The industry is constantly changing by default and right now it is observing waves of disruptions by design cutting across business models, technologies and markets. The variability in the industry is becoming hard to predict. While businesses are evolving and changing the ways to meet new customer needs, the consequence is a avalanche of trends impacting the dynamics of the industry.

"The customer needs are changing and the requirements are getting increasingly specific and to meet this, the industry needs to standardize such that it meets the specific needs with customized value. This means innovation, in today's time is a unstoppable engine. Innovative standardization internally is required to deliver customized value outside so the businesses interact with diverse customer groups through diverse business models and technologies.

"Frost & Sullivan, being a consulting firm specializing in innovative research methodologies, keeps a close eye on the industry participants and continuously interacts with the industry participants to understand their travel and their target destinations. While technological advancement has been a part of Frost & Sullivan's overall innovation philosophy, our core strength is our research teams who conduct the market and technology investigations for our clients.

"Operationally we are work on collaborative efforts implementing the One Team philosophy where client value we deliver is a combination of contributions

from our experts across the globe. We use the new age technologies to enable this objective of ours. Summing up, innovation for Frost & Sullivan is bringing the core strengths much closer on multiple collaborative platforms aided with modern technology so we continue to support our clients achieve their objectives, challenging ourselves and improving along the way.

When discussing the innovative projects Frost & Sullivan has underway, Mr. Blades added, "Frost & Sullivan is embracing its own version of digital transformation and is aspiring to deliver new digital versions of its value added research services to its clients."

Turning to Mr. **Vivek Suresh Prasad**, Industry Principal—Space (he is also an ex-ISRO scientist), and Mr. **Arun Kumar Sampathkumar**, the Industry Manger—Space, both headquartered in India for the company, they were asked what Frost & Sullivan sees as the innovative technologies that will drive the space and satellite industry over the next year or so?

Their answers highlighted mega-constellations as a key disruptive trend that Frost & Sullivan is closely observing, as well as the technologies related to this are, which are crucial for the space industry, realizing what might be a new market segment that did not previously exist. The key technologies must involve smart manufacturing methods that will enable the satellite manufacturing community to establish serial production capabilities to meet the demand from mega-constellation operators.

The subject-matter experts then added that manufacturing the satellites is just the beginning of an involved process. They need to be placed in specific orbits at a specific time period, which means there needs to be dedicated launch services for these mega-constellations. The mega-constellations targeting the LEO segment are largely employing small satellites that currently are able to access space only as secondary payloads in the majority of cases — dedicated services are yet to be realized.

They said that Frost & Sullivan's research covers more than 30 of these developers who are working toward scheduled operations. Technologies covering range-independent launch systems to air-launched rocket systems are key in this segment right now. Simultaneously, governments are looking to enable spaceport based launch services for small satellites. The UK Space industry is much closer to realizing this business model which, when operational, will enable many new players and incumbents to deliver the other new segment of the space industry — dedicated launch services for small satellites.

They continued, "Once launched, the satellites need sufficient connectivity with ground stations to deliver near-real time observation as well as seamless connectivity services. The ground station operators are expanding their operations and, simultaneously, startups have enabled aggregate platforms for these players in order for them to integrate their excess capacities to support the evolving needs of satellite operators, while also generating additional revenue from excess capacities. Frost & Sullivan recognizes this trend as the 'Uberization of Ground Stations' and this is another area of tech innovation the space industry needs to invest in to enable sustainable space operations for the future.

Mr. Prasad and Mr. Sampathkumar closed by stating that, while they have their eyes on so many technologies within the space industry, for the next few years the ones they mentioned will be crucial to materialize into operational formats. When they do, the resultant impact will drive the space industry in new directions and will deliver new customers through the applications of new services and products.

ww2.frost.com



The Space & Satellite Professionals International (SSPI) have announced they will present their 2018

Promise Awards to Jillian

Gorsuch of SSL, a Maxar

Technologies company, Theodore McDonald of SpaceX and Mike Safyan of Planet.

The Promise Awards honor three space and satellite employees or entrepreneurs age 35 and under for outstanding achievement in the early stages of their career. The three recipients will be honored on October 9 in Silicon Valley at SSPI's 13th Annual Future Leaders Dinner. On that night, SSPI will also honor its 2018 Mentor of the Year, **Randy Segal of Hogan Lovells**, for the advice, support, and inspiration she has provided to young professionals throughout her career.

"The 36 previous Promise Award winners have gone on to assume leadership roles in technology, business development, government relations and management in companies, as well as starting companies of their own," said Executive Director Robert Bell. "Each year's winners are an inspiration to all of us to keep moving the industry forward."

The **2018 Future Leaders Dinner (www.satfuture.com)** takes place at The Computer History Museum in Mountain View on Tuesday, October 9, in conjunction with the **Satellite Innovation 2018 (satinnovation.com)** conference, produced by Satnews Publishers (**www.satnews.com**). The proceeds of the dinner go to fund SSPI's educational, professional development and industry growth initiatives.

The SSPI 2018 Promise Award Winners

Jillian Gorsuch

Additive Manufacturing Technology Manager, SSL (**www.sslmda.com**)

Jillian started her career at SSL through a Cooperative Education program in 2008 while working on her undergraduate degree in Mechanical Engineering at Cornell University. Upon graduating from Cornell with her Master's Degree in 2011, she joined SSL full-time as a Responsible Mechanical Engineer in the RF Payload engineering department, where she worked on product design and delivery of more than 30 assemblies. Three years later, Jillian participated in SSL's 18-month Rotation Program, during which she worked in the Mechanical Aerospace Ground Equipment department and the Solar Array department.



After demonstrating particular talent in the Solar Array department, she took on the role of Solar Array R&D Project Manager.

Jillian was selected for her current position as Additive Manufacturing Technology Manager in 2017 and developed a three year technology roadmap for SSL's additive manufacturing (3D printing) capabilities and products. She now leads SSL's Factory of the Future initiative for additive manufacturing, which includes planning investment areas and training other SSL employees in the use and benefits of additive manufacturing. Since taking her current position, Jillian has promoted the use of 3D printing in many design areas to reduce mass and improve assembly schedules, performance, and operational lifetime for future spacecraft. She is currently leading a company-wide initiative to educate SSL's employees on additive manufacturing to further increase these benefits. SSL is one year into Jillian's additive manufacturing technology roadmap, and the initiatives are well ahead of schedule.

Throughout her career, Jillian has brought her talents for teaching, learning and improving efficiency to a wide variety of teams. While working on a project impacted by electric orbit raising (EOR), she saw an opportunity to streamline sub-system EOR requirements and volunteered to author a completely new systems document in addition to her regular workload, which required her to spend months learning from experts in five different departments. Jillian also developed tools to automate and streamline the process of creating tooling documents in the Mechanical Aerospace Ground Equipment department. She created assembly models and documentation for transceiver assembly components as part of SSL and JPL's GRACE-FO mission, which launched in May 2018. The components required customized tooling not standard to SSL, so Jillian worked directly with the technicians building the assemblies to ensure accuracy.

Outside SSL, Jillian has helped her community, including joining her church's Community Response Team to provide meals for new parents and those recovering from surgery and co-leading a weekly women's Bible group.

Theodore McDonald

Manager, Raptor Test, SpaceX (**www.spacex.com**)

Theodore "Theo" McDonald began his career at SpaceX in 2008 after graduating from Worcester Polytechnic Institute with a degree in Mechanical Engineering. Theo is currently manager of the Raptor test program, which is based out of SpaceX's rocket development facility in McGregor, Texas. Raptor is a new methane engine being developed by SpaceX for use on its next generation vehicle, BFR, which will be the most powerful rocket in history. With a pressurized section larger than the main deck of an A380, BFR is capable of carrying payloads and large numbers of people as far as the Moon, Mars and beyond. Since 2014, Theo has led a hardworking team that has built the Raptor engine



testing program and associated test hardware from the ground up. Theo is known for his energy and positivity in motivating his team to continually push the boundaries of what is possible with Raptor development testing and qualification.

Before managing the Raptor test program, Theo worked on the development, qualification and flight acceptance testing of the first Draco engines that power SpaceX's Dragon spacecraft as well as qualification testing of the first Dragon propulsion system test article. In 2010, Dragon became the first and only commercial spacecraft capable of reaching orbit and returning to Earth. Dragon spacecraft now make regular missions to and from the International Space Station carrying cargo for NASA. Following this, Theo went on to work as a senior engineer on the development and qualification team for the SuperDraco engine. SuperDraco engines power the integrated launch abort system of the crewed version of Dragon that will carry NASA astronauts to space in the near future as part of the Commercial Crew Program.

Outside of SpaceX, Theo is an active mentor for youth science and engineering initiatives, including Big Brothers Big Sisters and other community programs in the McGregor area.

Mike Safyan

Vice President, Launch, Planet (**www.planet.com**)

Mike began his career in the space industry at NASA Ames, where he worked on the PhoneSat project, developing low-cost cubesat platforms that use smartphone technology. In 2011, he joined the eight person founding team at Planet Labs as a systems engineer. As the company grew from the initial eight employees to a global organization of over 450 people, Mike moved through a wide range of roles, from export regulatory licensing and compliance, overseeing Planet's global ground station network to managing Planet's launch strategy, the position he holds today.

In his early career at Planet, Mike was responsible for obtaining the company's FCC Operational License, the first ever obtained for commercial CubeSats. Since then, he has been involved in the launch of over 300 satellites across twenty different launch attempts, helping Planet's fleet grow to the largest in the world. Mike has served as an advocate for the SmallSat community as well as for Planet throughout his career, speaking at multiple conferences and workshops and negotiating with satellite operators including ORBCOMM, DigitalGlobe, Spire, and NASA to establish fair and equitable spectrum and orbital sharing agreements.

In 2017, Mike oversaw Planet's record-breaking launch of 88 Dove satellites on India's PSLV. The launch allowed Planet to achieve its Mission One: imaging the entire Earth every day from space.

Described by his colleagues as passionate, generous and remarkably level-headed, Mike dedicates time to the smallsat industry outside of his work at Planet as well. In 2016, he helped



establish the Commercial Small Satellite Spectrum Management Association (CSSSMA), an industry organization that advocates for smallsat spectrum sharing. He also works with the Brooke Owens Fellowship selling Aerospace t-shirts (<https://www.etsy.com/shop/StarfishPrimeApparel>) to raise money, and volunteers with Meals on Wheels and Glide Church to help feed the needy in San Francisco.

The SSPI 2018 Mentor of the Year

Randy Segal

Partner,
Hogan Lovells US LLP
(www.hoganlovells.com/)

Randy Segal co-heads the Global Space Practice at Hogan Lovells, a position she has held for nine years. Her career in the space and satellite industry started in 1992, and includes many leadership roles, including serving as general counsel or director, for American Mobile Satellite Corporation, XM Satellite Radio, Hughes Network Systems, TerreStar Networks (now EchoStar), and Mobile Satellite Ventures/SkyTerra (now Ligado Networks).

At Hogan Lovells, Randy represents a wide range of clients, including some of the most active global satellite innovators and new space companies, startups, large Silicon Valley players, and even sovereign governments.

Throughout her career, Randy has served as a mentor, guide, and advisor for aspiring space professionals, particularly the growing number of young women entering the field. Her efforts include working with Satnews Publishers to profile more women at the company's SmallSat and Satellite Innovation Symposiums, as well as working actively with the Women in Space Initiative to advocate for mentorship and support for women in the satellite industry. For these achievements, the Women in Space recognized Randy as the first honoree for their Women in Space Excellence Award in March of 2017.

Randy has also served as a visiting faculty lecturer at the International Space University since 2012. Prior to that appointment, she served as an adjunct professor at George Mason Law School for over ten years, further demonstrating her commitment to educating and mentoring the next generation of industry professionals.

Randy is known to offer her experience and knowledge to everyone around the table, no matter what case or project she is working on. She has a deserved reputation as a trusted advisor for numerous industry people on a variety of issues, always making herself available to new industry entrants for quick chats, second opinions, and general advice.

According to Lisa Kuo, Head of Commercial Programs at The Aerospace Corporation, "Randy has been an advocate of helping newcomers navigate the complicated and sometimes confusing web of who's who. She has developed an insightful intuition about people, what makes them successful

at companies at various stages, and actively seeks out people who would benefit from her mentoring to bring their companies to the next stage."

Outside the space and satellite industry, Randy dedicates yet more of her time to helping and guiding others. She has served on the board of directors for multiple not-for-profits over the last twenty years, including Capital Caring, Network for Teaching Entrepreneurship, and 1000 Urban Scholars. She has also taught a "Street Law" program to 9th graders at the Thurgood Marshall Academy for the past eight years, aiming to enhance the professionalism and aspirations of her students.

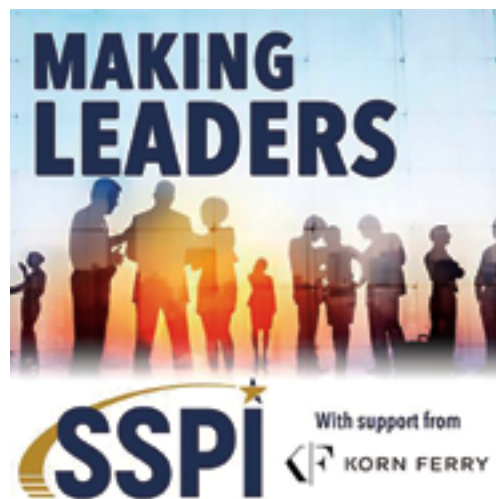
For her years of dedication to the industry, and her commitment to mentoring the next generation of space and satellite professionals, Randy Segal is a worthy winner of this award.

*Founded in
1983, Space
& Satellite
Professionals
International
(www.sspi.org)*

is on a mission to make the space and satellite industry one of the world's best at attracting and engaging the talent that powers innovation. With more than 3,700 members in 40 nations, SSPI is the largest space and satellite industry association in the world.

SSPI also offers their Making Leaders series of webinars and reports that offer guidance on managing people, from recruiting and engaging new hires to managing talent for results.

One of SSPI's recent Making Leaders seminar feature the Chairman and CEO of Viasat, Mark Dangberg — he was inducted into the Satellite Hall of Fame in 2015 for his many achievements.



SSPI will also be in attendance at these upcoming events:

NAB Show 2018, October 17 to 18

GWU CubeSat Presentation and Tour, October 18

InfoBeam

MT Mechatronics and five antennas

The Mainz-based company MT Mechatronics Germany, a subsidiary of MT Aerospace AG, has been awarded a contract for the production and delivery of five antennas by prime contractor SCISYS Deutschland GmbH for the ground segment of the "Heinrich Hertz" national satellite communications mission.

The five ground stations with antenna diameters between 7.3 to 13 meters will be performing various functions within the ground segment (in Germany). They will make it possible to control the satellite, execute and monitor the experiments and utilize the communication payloads on board of the satellite.

With the German "Heinrich Hertz" satellite communications mission, it will be possible to test new technologies under the extreme conditions of outer space and to carry out around 20 communications, antenna and satellite technology experiments on board the satellite.

In addition, the satellite will be fitted with an independent telecommunications payload, which will be used by the Federal Ministry of Defense for communication purposes.

Heinrich Hertz is being sponsored by DLR Space Management using funds provided by the Federal Ministry of Economics and Energy (BMWi) and with the participation of the Federal Ministry of Defense (BMVg).

Hans Steininger, CEO of MT Aerospace AG and thus the parent company of MT Mechatronics, said that the firm is pleased that SCISYS has selected us as the supplier for the antenna technology. This underscores MT Mechatronics' capabilities and skills in the field of satellite communications.

www.mt-mechatronics.com

www.scisys.co.uk/where-we-work/space.html



Yahsat, based in the United Arab Emirates (UAE) and wholly owned by Mubadala Investment Company, and Hughes Network Systems (HUGHES), a subsidiary of EchoStar Corporation (NASDAQ: SATS), have signed an agreement to enter into a joint venture to provide commercial Ka-band satellite broadband services across Africa, the Middle East and southwest Asia.

This new venture combines Hughes expertise as a global leader in broadband satellite networks and services with Yahsat's position and knowledge as the leader in satellite broadband solutions across these regions. Hughes will purchase a minority interest in the venture.

The new venture will continue to provide unserved and underserved communities with reliable, high-speed Internet services operating over Yahsat's Al Yah 2 (AY2) and Al Yah 3 (AY3) Ka-band satellites, and leveraging the capabilities of the Hughes JUPITER™ System, designed and optimized for large-scale High-Throughput Satellites (HTS). Hughes will also supply its proven Operating and Business Support System (OSS/BSS) solutions for comprehensive network operations and management.

Initially, the venture will focus on "direct-to-premise services" to homes and small- to medium-sized enterprises, and to community centers and



Artistic rendition of Yahsat's Al Yah satellites on orbit. schools that are served under local government programs across these regions.

In parallel, there will be an increased focus on "community hotspot" solutions to make satellite-enabled broadband more accessible to many more users across the AY2 and AY3 footprint, which currently covers more than 1 billion people.

In addition, the venture will also aim to capitalize on the accelerating transition towards Ka-band based backhaul and carrier solutions from mobile network operators.

Completion of the transaction is subject to customary regulatory approvals and closing conditions, and is expected to occur later this year.

Masood M. Sharif Mahmood, the CEO of Yahsat, said that the partnership with Hughes plays a significant role in Yahsat's growth story and serves as an important step in achieving the company's vision to providing global satellite broadband services to individuals, communities, governments and businesses in unserved and underserved communities.

He added that Yahsat's remarkable track record and experience in operating YahClick, combined with Hughes technology leadership and experience, are a winning proposition to unlock the mass market potential of satellite broadband services across the region. Mahmood is very pleased to see the firm's longstanding partnership with Hughes as a supplier over the years now advance to this strategic and very important joint venture for Yahsat.

Pradman Kaul, President of Hughes, added that Yahsat has been a valued customer for many years, incorporating the company's JUPITER System and operating expertise into their services. This next step in this beneficial relationship is a natural evolution that builds on the firms' shared commitment to connecting the unconnected and reflects the company's strategy to partner with leading providers around the world. The Hughes investment in this venture will expand the company's presence in Africa, the Middle East and southwest Asia markets, where broadband demand is expected to grow exponentially during the coming years.

www.yahsat.ae

www.hughes.com

A sense of WSBW



Dario Zamarian, the Group President of SSL, offers his thoughts regarding his experience at the recent Euroconsult World Satellite Business Week (WSBW) conference.

"This was an excellent opportunity to meet with the greater ecosystem of satellite operators, launch providers, manufacturers, service providers and suppliers for an update on the industry. In conference sessions, at lunch and in private meetings, we discussed how we as an industry are adapting to the changing market landscape and how disruptive innovation and promising new technologies are propelling the industry forward.

"There is agreement we must profoundly reconsider architectures in space and the general consensus is that will include standardized platforms with flexibility enabled by software-defined payloads.



Advanced robotics will also come into play, enabling assembly and satellite servicing on orbit and a reconfigurable space infrastructure with very different economies of scale.

"SSL and many of our colleagues project optical payloads, quantum encryption, and a new generation of flexibility beyond on-board processing, are all technologies that will make us more competitive and will position satellite to become a logical extension of 5G networks, enabling the goal of ubiquitous global coverage.

"Partnering and working together was a recurring theme at the event. Our consortium with Thales to develop the Telesat LEO constellation is just one example. Hughes announced it is forming a joint venture with Yahsat to extend broadband services in the Middle East, and Brazilian satellite operator Star One discussed how it partners with its sister company Claro to complement its mobile network in areas that lack terrestrial infrastructure. In other partnerships agreements, SKY Perfect JSAT and Hispasat have both invested in LeoSat, which underscores the interest in integrating LEO, GEO and MEO systems into the greater telecom infrastructure.

"Sentiment at the conclusion of the conference was mixed, as the satellite community acknowledges near-term challenges. However, this is an industry has a history of reinventing itself. One of my goals in meeting with customers was to deepen my understanding of where the business is going and I sensed renewed interest in working together to develop the right solutions to meet current and future demand.



Maxar Technologies sponsored the FinSpace reception at WSBW. Pictured are team members from Maxar, SSL and DigitalGlobe.

"In reflecting on the discussions at the conference, I want to reassure the industry that our culture and commitment to our customers has not changed. SSL continues to put the customer first and to focus on performance, reliability, schedule and cost, no matter what the future brings.

"The conference reminded me what a significant force SSL is in the satellite ecosystem and how much our industry colleagues are aligned with us in the goal of emerging from the current uncertainty as quickly as possible. It is this spirit of support and collaboration that bonds us as an industry and makes conferences like World Satellite Business Week both enjoyable and essential to moving our businesses forward.

www.sslmda.com

satellite-business.com

According to a recent research report by the market research and strategy consulting firm, Global Market Insights, Inc, the SAR in Space Sector Market will witness gains at 11.5 percent from 2018 to 2024.

Remote sensing solutions for developing high resolution imagery for applications of earth observation, weather monitoring, biomass measurement, space exploration, and ocean monitoring is expected to provide strong growth opportunity for SAR in space sector market. Moreover, capability of these systems to perform efficiently, even in absence of light and cloudy weather conditions will inadvertently propel the industry growth.

Europe accounted for the largest share in 2017, is expected to cross \$2 billion by 2024. This can be credited to the high number of projects in Russia, Germany, the UK, and Finland. Moreover, high emphasis of European Space Agency (ESA) on navigation, earth observation, scientific program, technology support, and situational awareness has significantly contributed to the industry growth.

According to the ESA budget for 2018, over 52 percent of the assigned budget capital was dedicated towards these activities, driving the SAR in space sector market growth.

Growing commercialization of imagery data obtained through these satellites are among the major trend gaining traction in the SAR in space sector market. Requirement to capitalize on these business opportunities has in turn led to intense competitive scenario among the industry participants.

For instance, in October 2015, U.S. Department of Commerce (DoC) provided the license to XpressSAR Inc. to operate commercial and private space based synthetic aperture radar sensing system. It was the first wholly U.S. owned company approved to operate constellation of four commercial X-Band radar satellites.

High development, deployment costs and complexity in proper utilization of the obtained image data are expected to remain the prominent growth inhibitor of the SAR in space sector market through the forecast period. Moreover, large space footprint and heavy weight architecture also contribute to the overall costing of these satellite missions impacting the industry growth negatively. Industry participants are expected to increasingly emphasize on the size and weight reduction of space borne radar systems and enhance the overall

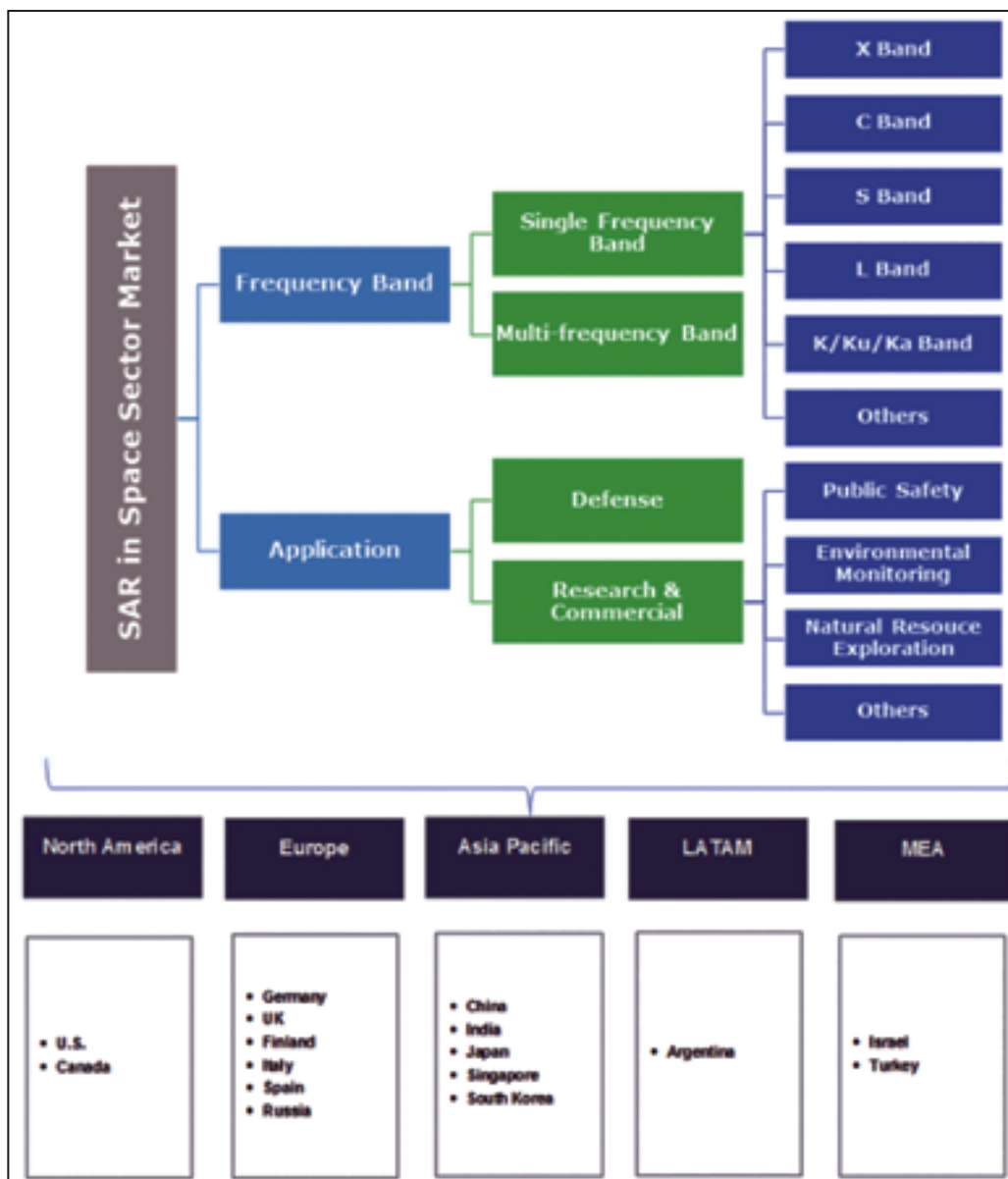
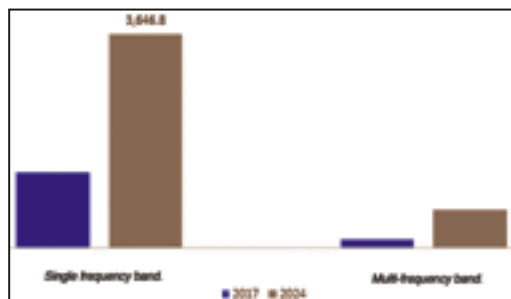


image resolution to gain competitive edge over their immediate competitors,

For instance, Iceye launched its first micro-satellite with synthetic aperture radar featured with the ability to generate two and three-dimensional imagery in January 2018. These technological advancements are expected to provide strong growth prospects to the SAR in space sector market over the forecast timeframe. Single frequency band contributed the largest industry share in 2017, owing to its conventional applications in the military operations. X-band was the largest frequency bandwidth in use in 2017 and is expected to continue its dominance over the forecast period. This can be attributed to its extensive applications in geographical mapping, military surveillance and reconnaissance.

Research and commercial applications are expected to witness inorganic growth over the forecast timeframe. Significant growth opportunity in the disaster management, weather updates, meteorology, navigation and natural resource exploration are among the dominant end use that will provide the strong growth prospects to the SAR in space sector market.

For instance, multiple constellation projects in Canada are expected to largely focus on the maritime navigation and ocean surveillance for tracking the trade and transport in the North Atlantic Ocean.

Global SAR in space sector market share is highly consolidated owing to the requirement of high initial cost, exceptionally skilled workforce, and multiple regulatory compliances.

Major industry participants include Airbus SE, BAE Systems, Capella, Harris Corporation, Iceye, Israel Aerospace Industries, Lockheed Martin Corporation, MDA Information Systems, Northrop Grumman Corporation, Raytheon Company, Thales Group and UrtheCast.

Industry participants are expected to focus on the development of multi-constellation projects for providing the global image information with updates ranging from hourly to daily basis.

For instance, Capella Space is expected to complete deployment of 31 constellations by 2020 to provide hourly updates on the earth observation imagery data by the space borne synthetic aperture radars.

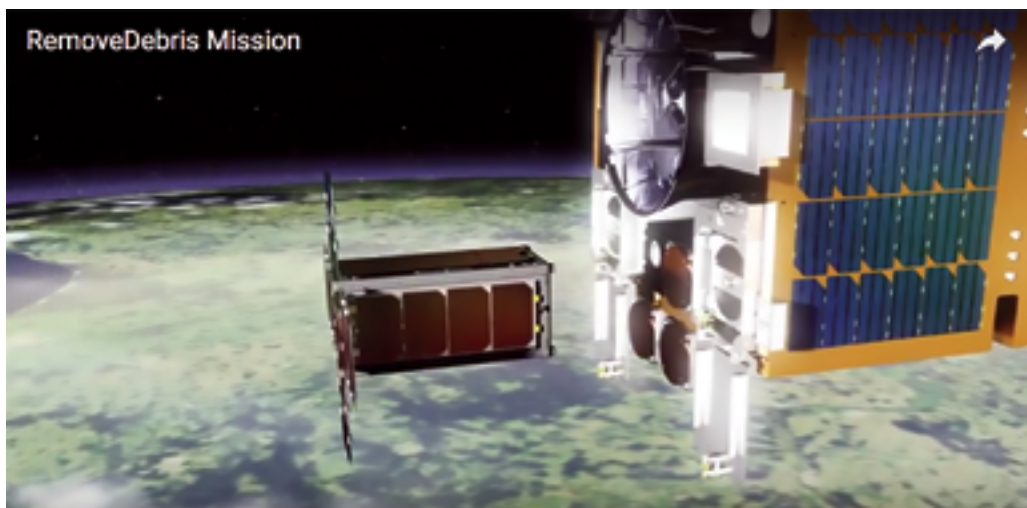
The RemoveDEBRIS satellite has successfully used its on board net technology in orbit — the first demonstration in human history of Active Debris Removal (ADR) technology.

The spacecraft began the experimental phase of its mission on Sunday, September 16, when it used a net to capture a deployed target simulating a piece of space debris.

RemoveDEBRIS was designed, built and manufactured by a consortium of leading space companies and research institutions led by the Surrey Space Centre at the University of Surrey. The spacecraft is operated on orbit by engineers at Surrey Satellite Technology Ltd. in Guildford, UK. The project is co-funded by the European Commission.

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

The U.S. Space Surveillance Network tracks 40,000 objects and the estimate is that there are more than 7,600 tons of 'space junk' in and around Earth's orbit, with some moving faster than a speeding bullet, approaching speeds of 30,000 miles per hour.



The research leading to these results has received funding from the European Union Seventh Framework Program [FP7/2007-2013] under grant agreement n°607099.

An excellent video of the RemoveDEBRIS mission is available for viewing at www.surrey.ac.uk/surrey-space-centre/missions/removedebris. The RemoveDEBRIS consortium consists of:

- Mission and consortium coordination – **Surrey Space Centre (UK)**
- Satellite system engineering – **Arianespace (France)**
- Platform, avionics and spacecraft operations – **SSTL (UK)**
- Harpoon – **Airbus (UK)**

- Net – **Airbus (Germany)**
- Vision based navigation – **CSEM (Switzerland)/ INRIA/ Airbus (France)**
- Cubesat dispensers – **Innovative Solutions in Space (Netherlands)**
- Target CubeSats – **Surrey Space Centre (UK)/ Stellenbosch University (South Africa)**
- Dragsail – **Surrey Space Centre (UK)**

Professor Guglielmo Aglietti, Director of the Surrey Space Centre, said that the organization is absolutely delighted with the outcome of the net technology. While it might sound like a simple idea, the complexity of using a net in space to capture a piece of debris took many years of planning, engineering and coordination between the Surrey Space Centre,

Airbus and partners; however, there is more work to be done. He added that these are very exciting times for all.

Ingo Retat, Airbus RemoveDEBRIS project head, added that to develop this net technology to capture space debris, the team spent six years testing in parabolic flights, in special drop towers and also thermal vacuum chambers. This small team of engineers and technicians have done an amazing job moving one step closer to clearing up LEO of debris.

www.surrey.ac.uk/surrey-space-centre

www.sstl.co.uk/

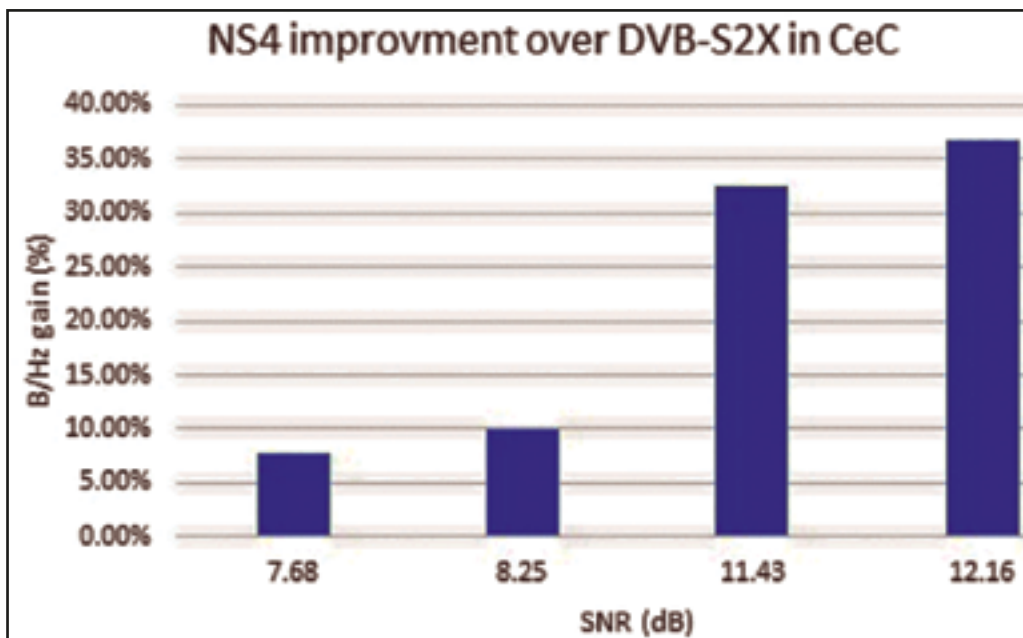


NovelSat NS4 just moved the satellite transmission efficiency bar even higher.

Recent independent testing, confirmed by NovelSat, a provider of satellite transmission technology, revealed that new enhancements to the NovelSat NS4 satellite transmission waveform have further increased its efficiency edge over the DVB-S2X standard.

Head-to-head comparison tests performed by a large teleport in the UK reveal that NovelSat NS4 performs up to 32 percent more efficiently compared with DVB-S2X. That translates into more data and video transfer per MHz of bandwidth for satellite communications providers, especially in saturated environments.

Live field tests were performed over a 36MHz transponder on both linear (non-saturated) and non-linear (saturated) links.



While NovelSat NS4 showed a 22 percent boost in efficiency, compared with DB-S2X over linear links, the

results over non-linear links far outstripped previous results, at up to 32 percent better than DVB-S2X.

The enhancements that NovelSat has made to their NovelSat NS4 waveform set the stage for the company to break the satellite transmission bandwidth efficiency record that it had set with the previous version of NovelSat NS4 (which performed up to 22 percent better than DVB-S2X).

The field tests also included linear bi-directional links supported by NovelSat DUET CeC (carrier-echo-cancellation) software-based Band Reuse Technology.

NovelSat DUET CeC doubles the effective data rate over the same transponder segment by enabling simultaneous full duplex video, data, and voice communication using the same bandwidth for both uplink and downlink.

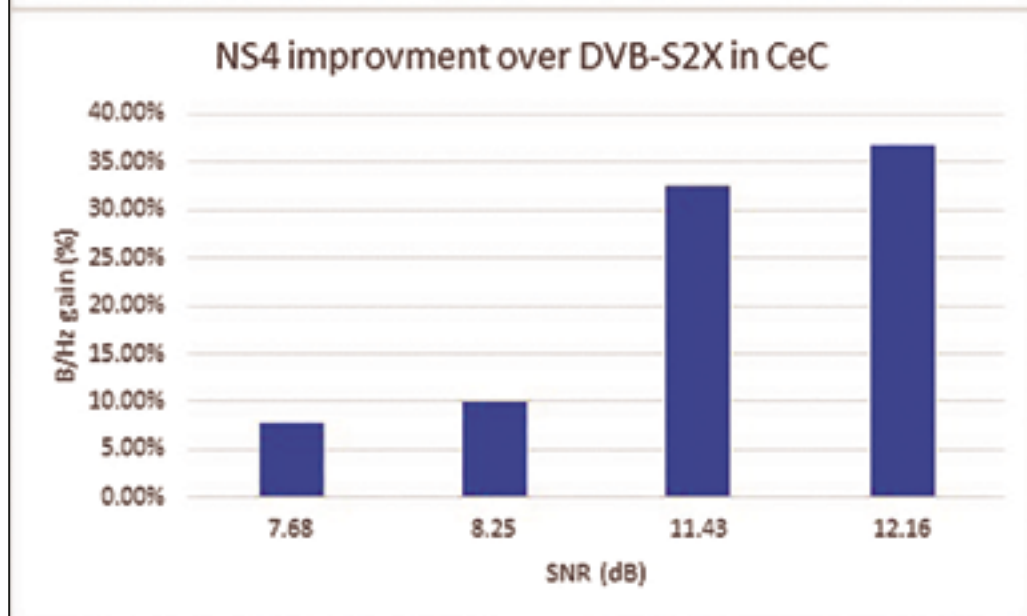
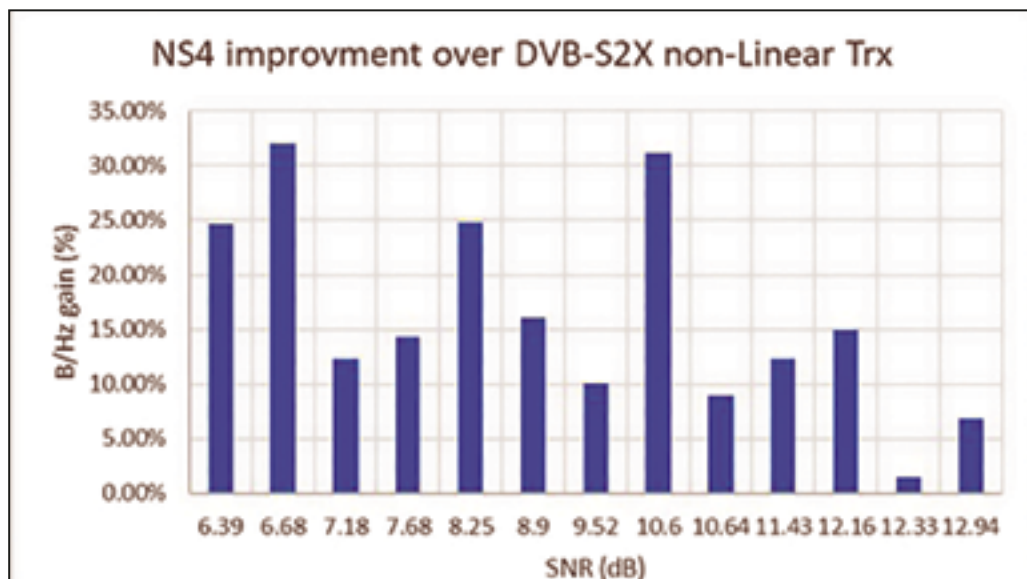
The results of these bi-directional tests rendered an impressive 37 percent advantage over DVB-S2X on the same links.

The NovelSat NS4 satellite transmission waveform can be implemented on any NovelSat satellite modem, modulator or demodulator — which also support DVB-S, DVB-S2, DVB-S2X and DVB-CID standards.

Existing NovelSat customers can benefit from the new NovelSat NS4 enhancements through easy OTA (Over-the-Air) software upgrades.

Itzik Wulkan, NovelSat CEO, said that their engineers are on a constant quest to break the satellite transmission efficiency records that they have consistently set over the last seven years. Their broadcast and data transmission customers are constantly increasing the load on their satellite links. With these new enhancements to NovelSat NS4, their clients will transmit even more data and video without increasing their budget of expensive satellite bandwidth.

novelsat.com/novelsat-ns4/



Sirius XM Holdings Inc. (NASDAQ: SIRI) and Pandora Media, Inc. (NYSE: P) have instituted a definitive agreement under which SiriusXM will acquire Pandora in an all-stock transaction valued at approximately \$3.5 billion.

The combination creates the world's largest audio entertainment company, with more than \$7 billion in expected pro-forma revenue in 2018 and strong, long-term growth opportunities.

This strategic transaction builds on SiriusXM's position as the leader in subscription radio and a critically-acclaimed curator of exclusive audio programming with the addition of the largest U.S. audio streaming platform.

Pandora's powerful music platform will enable SiriusXM to significantly expand its presence beyond vehicles into the home and other mobile areas. Following the completion of the transaction, there will be no immediate change in listener offerings.

According to the companies, this acquisition will drive long-term growth by:

- Capitalizing on cross-promotion opportunities between SiriusXM's base of more than 36 million subscribers across North America and 23 million-plus annual trial listeners and Pandora's more than 70 million monthly active users, which represents the largest digital audio audience in the U.S.
- Leveraging SiriusXM's exclusive content and programming with Pandora's ad-supported and subscription tiers to create unique audio packages, while also using SiriusXM's extensive automotive relationships to drive Pandora's in-car distribution music service.
- Continuing investments in content, technology, innovation, and expanded monetization opportunities through both ad supported and subscription services in and out of the vehicle.
- Supporting and strengthening Pandora's highly relevant brand.

- Creating a promotional platform for emerging and established artists, curated and personalized in ways to deliver the most compelling audio experience that connects artists to their fan bases, as well as new listeners.

www.siriusxm.com

www.pandora.com/about

THE FORRESTER REPORT PART II

A \$10 billion cash windfall for SES and Intelsat...

By Chris Forrester, Senior Contributor

A major 37-page report released on August 6 from equity analysts at investment bank Jefferies stated that the proposed restructuring of scarce satellite C-band frequencies over the U.S. in order to help drive adoption of 5G cellular telephony could result in a \$10 billion cash windfall — “at least” — for the two main proponents of the scheme, SES and Intelsat.

The report, authored by analyst *Giles Thorne*, said that the 5G industry has recognized that the C-band proposals are the optimal, “if not only,” way for the U.S. to guarantee any sort of global leadership. Indeed, the report says it is no longer an “if” or “when” proposal, but “how?”

The bank’s comprehensive report said, “Because Intelsat / SES’s negotiating leverage is so strong (because the FCC has no means of compelling them to act in a manner that they don’t want) and the stakes so high (win / lose the race to 5G), we expect an approximate of the Joint Proposal to appear in an FCC order in 1H19 with only the fettering of a two-stage auction process (similar to the broadcast incentive auction, where it was proven that the ‘bad politics’ of spectrum windfalls can be navigated with all reputations intact). We see reason for all MNOs to be interested (especially AT&T and Verizon). Precedent spectrum auctions can flatter to deceive on valuation, so we proceed very cautiously.”

Cautious the bank may be, but nevertheless, it values the benefit to SES and Intelsat as being worth some \$3.5 billion, net, to each operator. However, if the FCC and the SES/Intelsat consortium agree to reassign 200 MHz (currently only 100 MHz is on the table) and that a price of \$0.50 per MHz ‘pop’ (a standard industry measurement, where 1-Pop equates to one MHz of bandwidth passing one person in the coverage area in a spectrum license) is reached, then the rewards to SES and Intelsat could be far greater.

SatMagazine recently looked at a report from hedge fund operator *Kerrisdale Capital Management*, and Kerrisdale has updated its comments, saying that some key and important developments further “solidify” their confidence in Intelsat and SES. Kerrisdale said that the events have unfolded even more rapidly than they expected, stating, “What did come as a surprise, though, was how passionately key commissioners argued in favor of the Intelsat/SES proposal and against other possible outcomes. In particular, FCC Commissioner Michael O’Rielly, a Republican who for two years has spearheaded the search for a workable way to harness the C-band for 5G, who said: ‘The reality is that if everyone puts aside preconceived notions, a final proposal, in the very near future, can address everyone’s concerns and needs. Cooperation and avoiding unnecessary tangents will be paramount. ... There are, however, some things I would have done differently than what is contained in the item. As previously stated, it is of utmost importance that this proceeding is concluded and spectrum is released into the marketplace quickly. There can be no unnecessary delays or distractions.’”



Giles Thorne of
Jefferies Group

It is now known that the FCC decision will emerge by mid-2019. Kerrisdale now says, "One of the key points we made in our original report was that investors and analysts have been wrong to focus exclusively on just the initial 100MHz clearing target set forth by the satellite operators. In reality, almost the entire band will eventually be in play, as long as its economic value for 5G terrestrial networks sufficiently exceeds its economic value to incumbent users (primarily media companies). In our discussions with other market participants, some have expressed concerns that SES has taken a more cautious stance on the C-band opportunity than Intelsat has, giving rise to fears that it might (irrationally, in our view) refuse to consider clearing more than the first 100 MHz."



Steve Collar,
CEO, SES

also working on that range of spectrum, but firmly declined giving away any more detail.

Kerrisdale is correct, and SES CEO **Steve Collar**, speaking to analysts during the SES results announcement on July 27, as good as admitted that 100 MHz would not be the end of the story. Collar told analysts that SES wanted to be flexible.

Collar was, however blunt — "We couldn't live with anything short of what we propose," referring to the freeing up of 100 MHz of C-band spectrum. But it is quite likely that the FCC will be seeking 200 to 300MHz of spectrum, and Collar admitted that SES (and, presumably, Intelsat) were



Steve Spengler,
CEO, Intelsat.

Intelsat's CEO **Steve Spengler**, during its half-year results presentation, also confirmed that more than 100 MHz was a clear possibility and said: "[but] it's going to be a matter of cost and time, but it is something that we are very focused on. It's a more complex undertaking, so it's going to take a little bit of time to assess it technically and operationally."

Spengler explained the FCC process. "The July 12 open meeting of the Federal Communications Commission provided insight into progress on our breakthrough

market-based proposal to enable terrestrial mobile use of the C-band spectrum in the United States. We are pleased with the positioning of our proposal in the Notice of Proposed Rule Making (NPRM) which was distributed the following day.

"The comment and reply phase of the SEC rule making process will open shortly. During this phase we and our partners on the proposal will focus on four key areas as we continue to advocate for adoption of our proposal. First, we will streamline our implementation plan. We recognize that speed differentiates our proposal. Speed is key to minimizing disruptions to our business and to our customers operations. Speed is also essential to accelerate the \$500 billion in potential U.S. economic growth expected to be generated from 5G deployments. We are confident that our proposal offers the fastest path to cleared spectrum.

"Second, we'll refine the technical aspects of our proposal. Our proposal must balance the need to maximize the amount of spectrum we can clear and also ensures service continuity and continued reliability for our customers. It is the combination of these elements that optimize the public benefit of the spectrum.

"Third, we will work with our customers and the various associations to build additional definition around the role of the satellite operator consortium. Our goal is to ensure that these stakeholders are as confident as we are in the operational and cost reimbursement considerations of interference mitigation.

"Finally, we'll address the other concerns referenced by the FCC in the NPRM. Although we're pleased with the momentum behind our proposal, the FCC controls the process contents and timing of the ultimate order."

Spengler added that the consortium is already engaging with interested parties now. "We're engaged with all the stakeholders in this effort and so we understand the importance of the spectrum to various players and we are engaged with them to try to understand their specific needs and technical needs in terms of operating the spectrum. So those dialogs are going on right now."

He told analysts that the FCC seemed to be seeking speed in the overall process as well as protecting the core services for the consortium's C-band transmission clients. "We are engaged with the various parties now to make sure that we are able to move quickly as possible once we see all the criteria come together for execution."

Spengler also talked about the impact of C-band re-use around the world, especially in the Asian and Far Eastern markets. "[For] other regions, you will see the C-band utilized by many satellite operators, you're going to have multiple applications within that C-band in any individual market. It's possible that there may be an analogous situation overseas at some point in time that may come up, but right now we see this as being a US-focused initiative and opportunity."

While Kerrisdale might be considered more of a 'promoter' than a balanced and impartial observer, the equity analysts at Jefferies are a little more hard-nosed; however, their August 6 report is hugely optimistic. Jefferies gives Intelsat a share target price of an impressive \$32 (not bad, given that a more typical price as recently as March 2018 was less than \$4 a share). Jefferies gives SES a target price of 26 euros.

This, then, takes us back as to how much the telcos might pay for C-band spectrum. As Jefferies said, "Given the leverage in the capital structure, should events drift towards our 200 MHz / \$0.50 ('pop') price scenario then this is a c.\$65 equity."

That's a spectacular number and the timetable currently being proposed means that some of that bonus/windfall revenue stream could start flowing to Intelsat and SES (and, to a lesser extent, Eutelsat and probably Telesat of Canada) as early as 2020-2021, and certainly within 18 to 36 months of a favorable FCC decision.

Jefferies puts its view of the timetable and said, "Intelsat / SES anticipate the negotiation of SMAs to take three to eight months; the time from filing to FCC grant of coordinate mobile license two to seven months, and then the time for the Consortium to clear the anticipated block(s) a final 12 to 20 months — a total of 18 to 36 months. Finally, following clearing, final payments will be provided from the escrow to the Consortium."

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



UPLINK: INNOVATION — AVUL TECHNOLOGIES

Flat panel design is influenced by application

By Ian Timmins, Ph.D., Principal RF Engineer

Since the inception of satellite communications (SATCOM), the parabolic reflector antenna has been the “go-to” technology that has enabled reception (downlink) and transmission (uplink) of data using radio frequency (RF) signals from Earth-based SATCOM terminals.

While these ubiquitous “dishes” have provided a highly effective and efficient means for RF transmission from fixed points on the ground, the traditional parabolic antenna design does not lend itself as easily for...

- 1) *airborne*
- 2) *maritime*
- 3) *on-the-move ground vehicle*
- 4) *ultra-light “backpackable” communications due to the volume and space required for the dish shape, along with the need to mechanically steer the dish RF beam on a continuous basis toward the satellite.*

To address this issue, a growing number of companies are in the midst of developing flat panel satellite communication antennas, providing a low profile (flat) aperture with an electronically steerable beam that can be more easily adapted (affixed) to moving platforms. Additionally, flat panel antenna companies are pursuing a number of different technologies that can be categorized into two basic design approaches:

1) *waveguide-based structures*

2) *printed circuit board (PCB) technologies.*

Both technologies have distinct advantages and disadvantages for SATCOM.

Performance and Loss

Antennas designed with conventional waveguide-based structures are high-performing and are less lossy than PCB technologies.

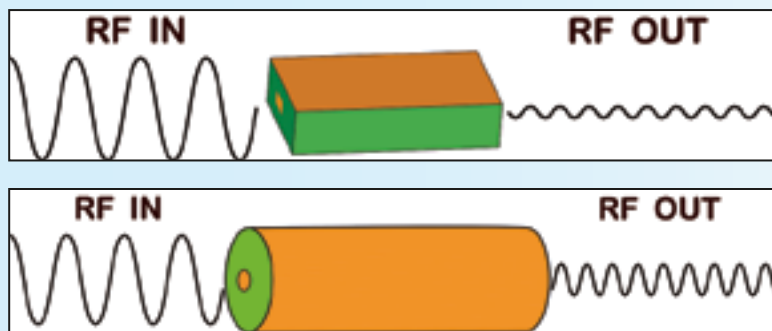
Waveguide is air-filled like a vacuum, so typically there’s no dielectric material for the signal to travel through or to create losses — waveguide is effectively lossless. Conventional waveguide antennas are considered familiar to many operators as these antennas use the same performance and loss calculations as reflector-based antennas.

PCB technologies are high performing and easily scalable, but they also operate with significantly more loss characteristics than waveguide structures — so much so that most operators don’t anticipate the signal degradation experienced with PCB-based antennas, particularly at high frequencies. The reason is that PCB is a filled material, so losses occur as a signal travels through the dielectric materials used for fabrication.

An analogy to losses using waveguide versus PCP materials would be signal loss in a coaxial cable. If a sine wave is introduced into a coaxial cable on one end, then at the other end the loss is observed as the sine wave is decreased on magnitude and also shifted in phase.

Losses generally are a problem when a strong, steady signal is a requirement, such as for SNG (*satellite news gathering*) or streaming video. For general data transmission, signal degradation will impact performance, but to a manageable extent. These losses are accounted for in the link budget, which is determined during the system design process.





Size and Weight

A clear disadvantage with conventional waveguide-based structures is that they tend to be large and heavy. In order to produce adequate gain for use in satellite communications, the resulting number of power dividers and antenna elements make for a structure that is heavy and often quite thick compared to typical user expectations.

The size of a waveguide-based structure will be determined by the application and performance requirements. A smaller waveguide-based terminal will work well with backpack comms-on-the-pause uses, but a much, much larger terminal will be required to maintain enough gain and bandwidth for a large aircraft with numerous simultaneous users.

That said, PCB structures are much more compact than waveguide based systems, and though the materials tend to be heavier than conventional FR-4 circuit board material, they typically are more in line with the expectations of the end user when it comes to flat panel technologies.

The downside to FR-4 is that it only works below 1000 MHz. SATCOM requires dramatically different circuit board materials, including ceramic-type materials, to operate at SATCOM frequencies.

For a backpack-based (manpack) solution, a PCB-based structure with a given performance expectation likely will weigh less and be more flexible in terms of scaling or using multiple subarrays. That said, a waveguide-based manpack antenna may be higher performing depending on the environment, but bulkier and heavier to carry.

Form Factor and Scalability

The dielectric constant in PCB structures can range between 3 and 10 for common high frequency materials and this will result in smaller PCB structures.

Therefore, as PCB structures operate at shorter wavelengths, PCB structures are inherently smaller. This makes PCB structures, particularly feed networks, significantly simpler to scale up for a larger terminal, or scale down for a smaller terminal when sub arrays are used.

PCB structures are rigid, but they're less rigid than waveguide-based structures. For a PCB structure to conform to a required shape, such as the top of the fuselage of an aircraft, flexible circuit material can be used such as a membrane, and that enables PCB structures to be shaped for conformal applications.

Air-filled waveguide structures have a dielectric constant of ~1 and there is no miniaturization of the waves. Therefore, adding subarrays to increase size is conceptually easy, but that, in combination with the required feed network, may prove to have weight and size characteristics that would inhibit this approach.

As waveguide structures are rigid, multiple waveguide-based subarrays would be needed for a conformal application and each subarray would share a common feed network. Shaping waveguide-based subarrays for a conformal application is challenging as well as heavy and bulky.

Manufacturability

Because of the significant number of power dividers and antenna elements needed to produce adequate gain, waveguide-based structures are typically complex to manufacture.

Each antenna element, such as a slot, has a bandwidth requirement that is difficult to achieve if the antenna is designed for structural simplicity or ease of manufacturability. Waveguide-based structures require significant engineering and expert manufacturing supervision, as well as well-trained manufacturing labor. While efficiencies of waveguide-based technologies tend to be more easily achieved than the PCB-based alternatives, the inherent designs tend to require shapes that typically require machined metal fabrication, making them much heavier.

PCB technologies have been used in commercial electronics for many years and, as such, offer lower costs per unit and are designed for high volume manufacturing. It's a natural progression to take circuit board technologies and apply them to the SATCOM industry, as PCBs have evolved to a somewhat more simple manufacturing process and are conducive to high volume manufacturing. PCB manufacturing also requires less hands-on labor; however, significant engineering and expert supervision is required to ensure precision manufacturing.

PCB material choices can create difficulties. Materials suitable for high frequency transmission, such as Ka-band satellite communications, are not low cost when compared to materials used for commercial electronics circuit boards, such as FR-4. Additionally, the materials suitable for high frequency applications are also difficult to manufacture into multi-layer circuit board structures.

Also, as commercial electronics have used PCBs extensively in product design, the availability and manufacturing tolerances are well understood. Difficulty for the antenna designer is often not in finding a PCB fab house, but rather in finding one with experience in working with the specialized materials required for satcom. This can include both the ability to manufacture and engage in the appropriate conduct testing.

Frequency Flexibility

A significant challenge in using array antennas for SATCOM applications is the frequency dependence of each array — this dependence means that flat panel antennas — regardless of waveguide or PCB structure — are not able to change bands to operate on vastly different networks. A Ku-band flat panel terminal only operates in Ku-, and a Ka-band terminal only operates in Ka-.

Arrays always have a limited bandwidth, hence the frequency dependence, and this creates the challenge of designing an array's bandwidth to be wide enough for SATCOM. In addition, the spacing of the elements affects the overall terminal pattern and a typical array terminal needs to have the elements spaced at half a wavelength to one wavelength apart.

For applications requiring frequency changes — such as an SNG truck that broadcasts through multiple networks — the operator would be better served with a parabolic antenna with quick-change RF kits, than with a fixed-band flat panel terminal. Many parabolic antennas are multi-band as long as the operator can change the RF equipment, and this enables significant flexibility when required.

www.avltech.com/

Ian Timmins, Ph.D., is the Principal RF Engineer at AvL Technologies. Prior to joining AvL, Ian was VP of Engineering for Optical Cable Corporation's Enterprise and Harsh Environment lines of business. He also previously held technical roles with Dell Computer Corporation, Cisco Systems and COM DEV Space Group. Ian holds a Ph.D. in Electrical Engineering and is an adjunct professor with Western Carolina University.



A CASE IN POINT GILAT SATELLITE NETWORKS

Bringing LTE connectivity to the Philippines

By Doreet Oren, Director of Product Marketing and Corporate Communications

This article spotlights Gilat Satellite Networks' fully managed satellite backhaul implementation for Globe Telecom.

With a population numbering more than 100 million scattered across some 7,000 islands, connecting people is a fundamental part of the Philippines' nation-building strategy. While high-quality mobile connectivity is readily available on its larger islands, the same cannot be said for the country's smaller and more remote islands and regions.

Globe Telecom, the leading full-service telecommunications company in the Philippines, has risen to the challenge of delivering nationwide mobile broadband services. Using Gilat Satellite Networks' managed service offering, Globe implemented a satellite-based LTE backhaul solution that covers dozens of remote rural sites across the country and managed to do so in only three months.

Extending LTE Coverage to the Philippines' Outlying Regions

Extending 3G and LTE connectivity to outlying and hard-to-reach areas has always been a complex challenge for mobile network operators.

Given the Philippines' unique geography and extreme seasonal weather (e.g., typhoons and heavy rains), terrestrial-based solutions for cellular backhaul, such as fiber or microwave, are not a feasible option for extending coverage to many rural areas and remote islands.

Globe understood that the most practical and cost-effective solution for achieving a full nationwide LTE coverage was satellite-based cellular backhaul. Accordingly, Globe sought to upgrade its satellite backhaul capabilities — both in terms of performance and the ability to support new applications — for remote sites throughout the Philippines.

In addition to providing basic voice and SMS services, Globe wanted to offer high-speed LTE broadband services for consumers, fast broadband connectivity for enterprises, as well as infrastructure support for emergency communications.

While substantially improving quality of life for rural residents, Globe also stood to benefit commercially from this ambitious project. By being the first to bring LTE broadband access to underserved areas, Globe could increase their share of the Philippines' highly competitive communications market. Thus, fast time-to-market for the new backhaul solution also became a business-critical requirement.

Gilat's Managed Satellite Backhaul Solution

Globe selected Gilat's managed satellite backhaul solution after a rigorous proof-of-concept phase, during which the solution conclusively demonstrated the company's ability to meet Globe's key performance, environmental and implementation requirements.

In particular, this phase confirmed the high reliability and performance of Gilat's Ku-band VSATs in rainy conditions, which is a commonly perceived limitation of Ku-band in delivering broadband services.

Following project approval, the deployment of Gilat's complete managed service solution required only three months. This end-to-end solution includes all the elements required to support high-speed LTE data and voice services, extends nationwide coverage for consumers and enterprises, and supports emergency response teams during disasters using Gilat's quick-deploy technology.





Gilat's cellular backhaul solution consists of Capricorn-4 VSATs deployed in Mindanao and North and South Luzon regions. The VSATs are managed by Gilat's flexible and scalable X-Architecture hub platform, deployed in two different locations in the northern territories. To maximize operational efficiency and ensure compliance with an SLA guaranteeing 99.5 percent network availability, Gilat supports these sites with a 24x7x365 Network Operation Center (NOC) service for network monitoring.

With Gilat's VSAT technology, Globe has been able to cost-effectively deliver broadband data services to rural areas that previously did not have mobile services, as well as regions that only had basic voice and SMS services. In addition, as Globe continues to build out its 4G network, Gilat VSATs will also be used for transmission capacity augmentation for some of Globe's 4G sites until fiber capacity comes online.

Simplifying and Accelerating Backhaul Deployments

One of the salient benefits of Gilat's managed service is that it takes end-to-end responsibility for the entire project — from the network planning stages through ongoing operations and service management.



Gilat's scalable X-Architecture platform.

Globe defined the SLA and KPIs, while Gilat provides all the services and resources necessary to ensure smooth and cost-effective operations. Specifically, Gilat's managed service offering includes satellite network design, capacity setup and bandwidth management, network integration and onsite installation, NOC, call center, service level management and program management activities.

This business model allows Globe to focus on its core mobile network, while Gilat's experts handle the satellite backhaul and associated tasks as a fully outsourced service, *i.e.*, a "black box." Equally important, by reducing project complexity for Globe's network engineers, this managed services approach enabled Globe to

achieve faster time-to-market than competitors' solutions.

Unprecedented LTE Performance over Satellite

Gilat's satellite backhaul network was deployed on time and on budget, delivering unprecedented LTE performance to Globe subscribers.

Gilat's patented and field-proven acceleration technology, embedded in the hub and terminals, accelerates the high bandwidth application traffic inside the LTE GTP tunnel. As a result, Globe's rural subscribers now enjoy true LTE user experience on their handheld devices, without packet loss and regardless of weather conditions.

In addition, the scalability of Gilat's network allows for easy, cost-effective expansion to additional remote areas in the future to support a wide range of applications.

www.gilat.com

Doreet Oren (doreeto@gilat.com) is Director of Product Marketing and Corporate Communications for Gilat Satellite Networks. Doreet Oren has been in this role since 2012

and has been responsible for defining product positioning, messaging, go-to-market strategies, market research, and analyst relations.



Oren has more than 20 years of industry experience and has held management positions in R&D, product management and product marketing, for international high-tech companies. In this capacity, she contributed to next generation product definition and was responsible for delivering the company's vision to the media and analyst community.

Oren has published thought leadership articles in renowned international journals, and has spoken at numerous industry conferences worldwide. Oren received a BSc in Computer Science from George Washington University.

AEROSPACE CORPORATION ANALYSIS

Setting the standard for smallsats

By Dr. Danielle Piskorz, Member of the Technical Staff Visual/Infrared Sensor Systems Department, and Carrie O'Quinn, Sr. Project Engineer

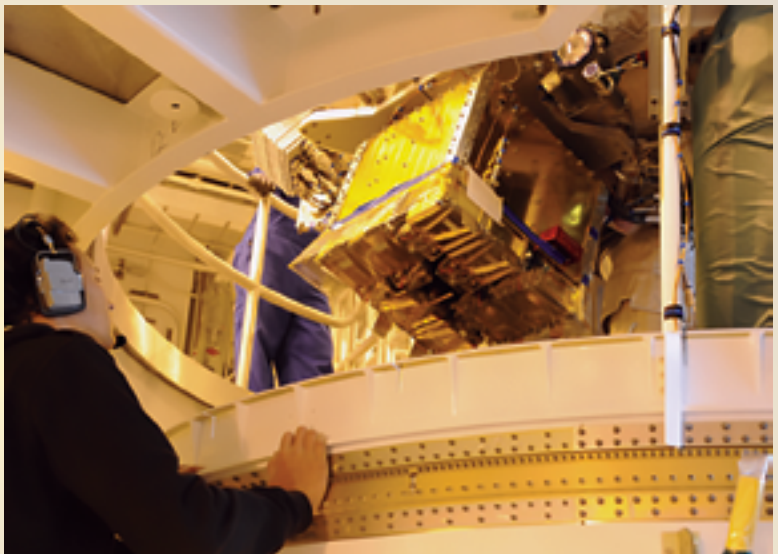
The push for capable, inexpensive spacecraft has led to a manufacturing explosion of satellites in the 25 to 200 kilogram range — smallsats.

These satellites lie roughly between a 12U cubesat and an ESPA-class satellite. Industry studies suggest that six times more satellites will be launched in the next ten years than were launched during the past ten years. There is a nearly endless variety of smallsats; however, their path to orbit is rife with obstacles and that suggests that a standard form factor for smallsats may be a significant part of the solution.

Over the past year, The Aerospace Corporation has led a consortium of satellite manufacturers, launch providers, rideshare aggregators, universities, and government agencies to define a standard form factor for smallsats called the Launch Unit (Launch-U). The consortium presented this recommended standard to the industry at the recent 32nd Annual Small Satellite Conference in Logan, Utah. Launch-U has the following attributes:

- **Volume:** $45 \times 45 \times 60$ cm
- **Mass:** 60 to 80 kg
- **Center of gravity:** 30 ± 5 cm along height and within 2 cm of centerline
- **First fundamental frequency:** above 50 Hz in both axial and lateral directions
- **Relevant mechanical and electrical interfaces**

In addition, the proposed Launch-U can be accommodated by most current and upcoming launch systems.



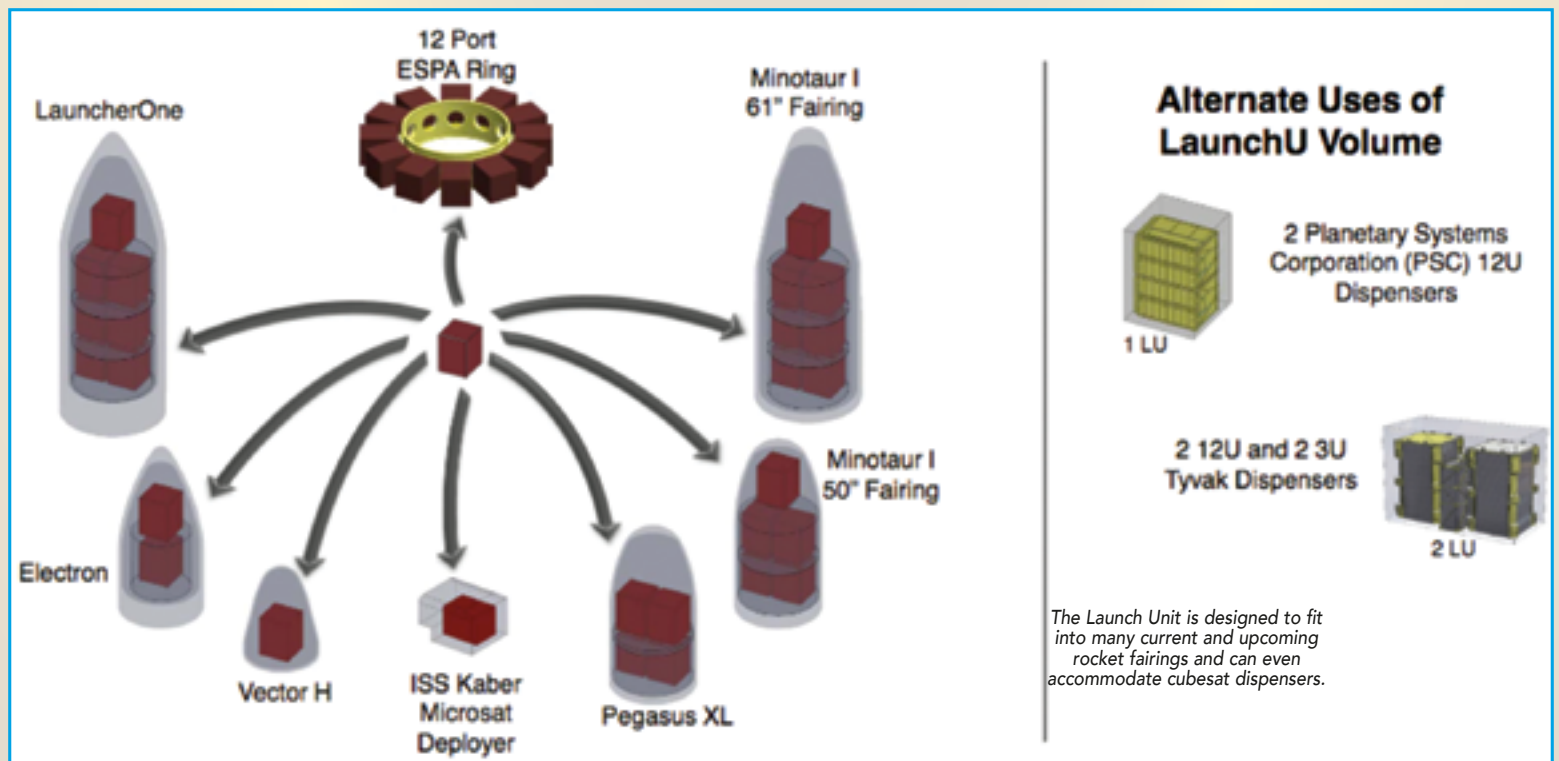
The Launch-U recommendation offers an opportunity to reduce integration costs, maximize launch fairing efficiency, and decrease time to launch.

The current rideshare (or multi-manifest) paradigm requires that a smallsat manufacturer identify its launch provider long before the launch date and perform time-intensive analyses unique to the launch vehicle.

However, in this setup, delays for the launch vehicle or primary satellite can have a serious impact on the small satellite's mission success. Given such delays, the smallsat mission would either have to wait for the original launch to be rescheduled or select a new launch provider and recalculate launch loads for the new launch vehicle.

In the Launch Unit era, launch providers would already know the launch loads to be expected for a satellite built to the Launch-U standard. Satellite developers can build their systems without a predetermined launch vehicle, and launch providers can design missions for smallsats without knowing which satellites will be launched.

It is even conceivable that, with widespread acceptance, smallsats built to the Launch-U standard can be swapped into and out of launchers close to their launch date, as has been done for cubesats. In doing so, the Launch-U enables flexible and assured access to space for the small satellite market.



LaunchU Rideshare

Define requirements for SmallSat developers to design and build their satellites



The Launch-U paradigm flow chart / path to launch.
Image is courtesy of Aerospace Corporation.

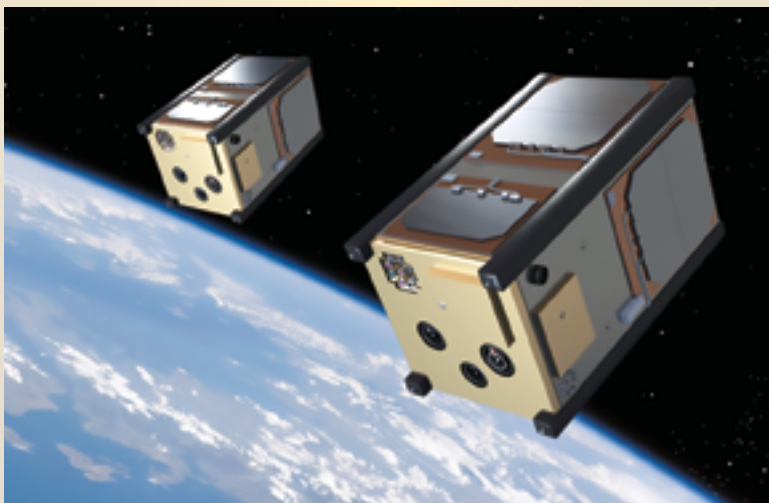
To make the Launch Unit era a reality, each stakeholder plays a key role in the implementation of the Launch-U. Launch vehicle providers, integrators, and aggregators can plan for how the Launch-U will affect their business models while spacecraft developers can build Launch Unit-compliant platforms.

Ultimately, launch swapping is affected by policies for licensing, export control, range safety, and propellants, as well as "do-no-harm" practices. Increasing the transparency of these regulatory measures will play a key role in the success of the Launch Unit paradigm.

Of course, the saga leading to the proposal of the Launch Unit has unfolded over the past 60 years as we have seen a wide diversity of objects launched to Earth orbit. From the game-changing Sputnik probe in 1957, to the record-breaking 88 Doves from Planet in 2017, satellite capabilities have improved by leaps and bounds, while the average size and mass of these satellites have fluctuated.

Small experimental satellites at the dawn of the space age gave way to large, expensive satellites with designs driven by capacity and capability. As satellites became commercialized, more emphasis was placed on cost and schedule constraints. This, alongside the miniaturization of satellite components, led to the development and adoption of the cubesat standard (10×10×10 cm and 1.33 kg.) for the smallest satellites during the late '90s.

The cubesat standard has played a critical role in lowering the barrier of entry to satellite design and development and encouraging low-cost access to space. Following the cubesat standard's footsteps, the Launch Unit standard will provide a similarly straightforward path-to-orbit that will benefit launchers, satellite manufacturers and end-users alike.



The Aerospace Aerocube-5 smallsat. Image is courtesy of the company.

The Launch Unit consortium is looking for feedback from the community on recommendations until the end of 2018. Please provide feedback at this URL: https://docs.google.com/forms/d/e/1FAIpQLSeHhaoQ7qbbwkuhZob-M_gGV0u-aqc9lHuCrMrFsfKpDD306A/viewform?c=0&w=1.

The Launch-U infosite: aerospace.org/Launch-u

Dr. Danielle Piskorz is a member of the technical staff in the Visible and Infrared Sensor Systems Department at The Aerospace Corporation. Since joining the company in 2017, she has evaluated various aspects of electro-optical system performance for space situational awareness (SSA) and overhead persistent infrared (OPIR) applications.



Prior to joining Aerospace, Piskorz worked in the space policy group of the Science and Technology Policy Institute (STPI) in and at the Space Studies Board (SSB) of the National Academy of Sciences. At STPI, she contributed to reports on the future of the space station and on-orbit manufacturing and assembly. At the SSB, she staffed reports on NASA's aeronautics division and the agency's strategic direction.

Carrie O'Quinn is a senior project engineer in the Research and Development Department at The Aerospace Corporation. She is responsible for providing direct technical support to the National Security Space Research and Development customer on a CubeSat experiment program which discovers, researches, builds, and flies new and emerging space technologies on a series of annually launched CubeSats. In this role, she also manages the Aerospace technical resources to assist in the development of advanced space technologies.



Prior to her current role, O'Quinn provided technical leadership to the National Reconnaissance Office (NRO) Office of Space Launch (OSL) in the areas of advanced development projects, rideshare and small satellite integration and launch processing activities, and systems engineering.

Before joining Aerospace, O'Quinn worked for Orbital ATK on the Taurus launch vehicle, Cygnus spacecraft, and a launch vehicle development program. Previously, she worked as a Six Sigma Black Belt Engineer for both Trane American Standard and Black and Decker.

Launch Unit Consortium Members



Off-satellite testing... transforming the world of SATCOM

By Geoff Burling, Chief Executive Officer — This article was originally published in Microwave Product Digest, June 2018, and is republished with permission.

Over the past half century, artificial satellites have transformed our lives, providing us with a host of information regarding our planet, its geology, its oceans, its weather and its people.

Satellites have also provided those people with an unrivaled form of communication and the ability to know their position on the planet down to a few inches. And yet some would argue that we are still only scratching the surface of the purposes to which satellites will be put. While, in general, as individuals, we might be aware of some of these current and potential opportunities, perhaps the greatest benefits seen in our daily lives and which we use on a daily basis are those of communication and navigation. The novelty of those early days of long distance television transmissions and telephone traffic may have worn off; however, the enthusiasm of industry to continue to exploit the vision of *Arthur C. Clarke* has not dwindled and, thanks to revolutions in electronics, software and signal processing, the use of satellite links is still enjoying the expansion from the initial explosion.

While the payloads on board our orbiting satellites have gone through several generations of performance standards systems on Earth have not stood still, either. No longer is equipment at the terrestrial end of the link comprised of just large fixed parabolic dishes and endless racks of equipment, new antenna technologies, solid state microwave techniques and digital electronics have all shaped the commercial and military use of SATCOMs to the point where even small hand-held devices make use of this incredibly versatile phenomenon.

The result is that we now see satellite communications kits appearing on boats, planes, trains and road vehicles. Miniature transmitters and receivers can be packed into suitcases and soldiers' backpacks. So many of the services we take for granted in our daily lives would be lost without it and therein lies another connection with modern day expectations — *reliability!*

In those early bird days of 50 years ago, it was accepted that the loss of a satellite signal was par for the course and worth, occasionally, putting up with. Today's world is less tolerant, and rightly so with severe logistical and financial down sides to breaks in transmission.

The need for reliable equipment and with it the essential and thorough testing both in manufacture and in service has never been greater.

While the reliability of radio frequency (RF) and digital technologies has increased manifold over the decades, so has the cost of equipment failure. One only has to consider the potential loss of advertising revenue, measured in millions of dollars per minute, for a commercial TV station if coverage of a major news or sporting event is interrupted.

Of course, there is no substitute for thorough testing of all forms of satellite communications equipment, in the factory and as it is built. Whole terminal installations will often go through an elaborate commissioning process, but SATCOM is a live activity and nothing should be left to chance in getting good clean RF signals to and from the satellite.

Failure or poor adjustment of a SATCOM transmitter has the ability to not only break continuity for its owners but also seriously upset transmission of other satellite users with consequent penalties, often financial.

There are other reasons also for wanting to test that vital RF link. Whether the equipment is designed to provide internet connectivity to airline passengers or to deliver key data to armed forces, both the manufacturer and other users will want to know just how well it does its job and how far its performance envelope can be pushed.

One way to carry out suitable RF testing, of course, is to switch on the SATCOM equipment for a live test on the satellite but to no surprise, this is no more popular with the satellite owners and other users than a 'dirty' transmission from a failing terminal. Enter the 'off-air' loopback test.

The transponder on board an LEO or MEO satellite, among other tasks, performs the function of a frequency converter, taking in the uplink frequency from earth and sending back the signal at an offset frequency. This is a function which can be very readily accomplished on Earth for test purposes and, with the use of microwave mixing suitable level adjustments and filtering, the loop test translator is born.

The Loop Test Translator, or LTT, is cabled into the ground station's array of transmitters and receivers such that, in test mode, a fraction of the uplink power normally destined to reach the satellite, is looped back to either the receiver or modem so that checks on spectral purity and modulation can be performed. This use of the LTT can be either occasional, for set up alignment, or continuous for quality monitoring.

UK-based AtlanTecRF has been delivering this kind of LTT for many years in a number of forms. In its most basic, the ALT Series (*pictured in Figure 1*) simulates the satellite link converting the transmit (Tx) signal to receive (Rx) frequencies. All adjustments are manual and local to the 19"x1U equipment.



Figure 1. AtlanTecRF ALT Series — Manual LTTs

Not all stations are constantly attended, however, and manual adjustments are not possible. Therefore, where control of a loopback test has to be undertaken with remote control, AtlanTecRF offers the ALR Series (*Figure 2*). In these units, the variation of turnaround, or local oscillator (LO) frequency and signal level attenuation is achieved via Ethernet and, with internet access, basically from anywhere on Earth.



Figure 2. AtlanTecRF ALR Series — Ethernet Control LTTs

Both the ALT and ALR Series have models for each of the commonly used SATCOM bands including S-, C-, X-, Ku-, DBS, Ka- and Q-bands. Each is also available in a choice of housing which includes the usual 19 inch rack mount as well as bench instruments, battery powered, ruggedized portable and weatherproof outdoor (*Figure 3*).



Figure 3. AtlanTecRF's SATCOM product range, showing the different housings available.

Cabled-in test solutions from AtlanTecRF continue with programmed control models where the main applications include testing of SATCOM systems in production as these come off the assembly line. For this purpose the previously mentioned housing options are joined by a 6U plug-in module (*Figure 4, next page*) for ATE set-ups.



Figure 4. AtlanTecRF Plug-in 6U module.

However cabling-in is not always possible and, in many of the current genre of SATCOM terminal, an LTT would be precluded because of its size. It is this type of application which has given rise to AtlanTecRF's range of Satellite Simulators. These operate with no physical attachment to the system under test (SUT), instead achieving the desired loopback via microwave antennas, just as in the live on-satellite operation.

The first such Simulator product out of the AtlanTecRF stable was its LSS Series (Figure 5) initially designed to operate in Ka-band with 30 GHz uplink and 20 GHz downlink.

To start with, these were aimed at the testing of antennas built into the fuselages of airliners for passenger internet provision (see Figure 6) — variants have also become available for putting most kinds of portable SATCOM systems through their paces. In the satellite news gathering (SNG) industry, a different problem arose because the SNG vans would have to travel out from their depots, gain a good 'view' of the satellite and then

carry out testing.

This was a costly and time consuming process but AtlanTecRF's SNG Series of Ku-band Satellite Simulators have enable broadcasters to run tests on the SNG van at the TV station's depot, saving time and money, while also improving reliability and



Figure 5. AtlanTecRF LSS Series — Ka-band Satellite Simulator. Front and back views.

revenue generation (see Figure 7).

These SNG models come in two parts: a weatherproof transponder unit, attached to a wall or mast, and a base control unit in which the test adjustments can be made either manually or remotely from a control room.

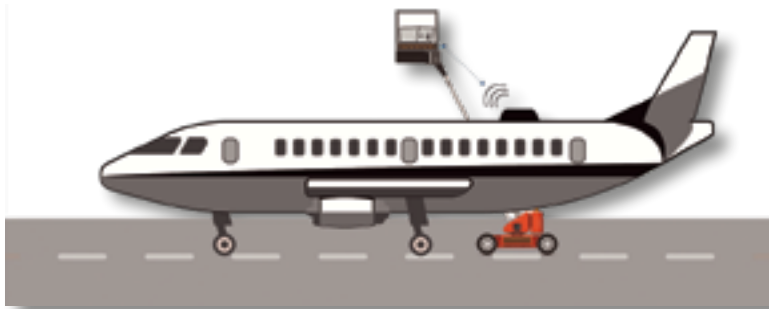


Figure 6. Airlines test antennas built into their fuselage using AtlanTecRF's LSS Satellite Simulator. The battery powered unit is mounted on a cherry picker.

Variants of such products, mostly in Ku- or Ka-bands, incorporate two transponders with the purpose of simultaneously testing two terminals and these

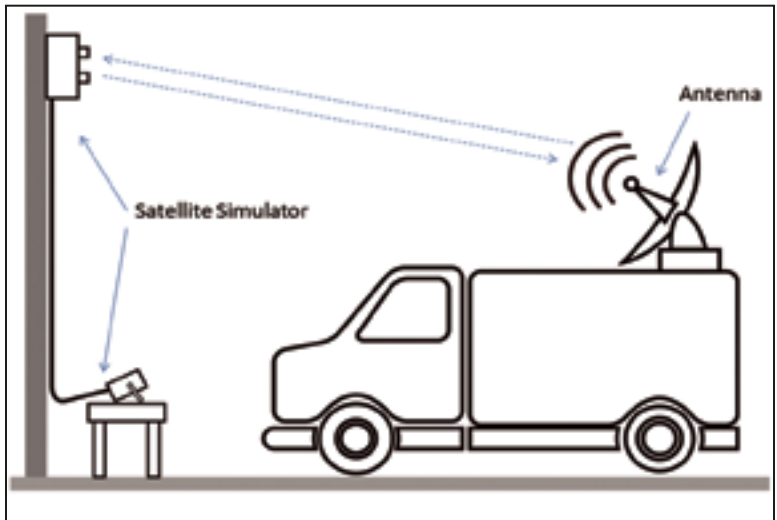


Figure 7 – Shows the set up for the depot based AtlanTecRF SNG Satellite Simulator.

Multi-Path Simulators are designated MSS Series by AtlanTecRF (Figure 8).

With the previously described Satellite Simulation Systems, there is the need to mount a transponder on a structure of some kind — wall, pole or mast — but such a provision is often not available where some mobile or fly-away terminals are to be operated.

AtlanTecRF had to propose another method of getting the transponder aloft. The choice was made to opt for the popular drone or UAV and a specially designed miniaturized and lightweight package was created (see Figure 9 on

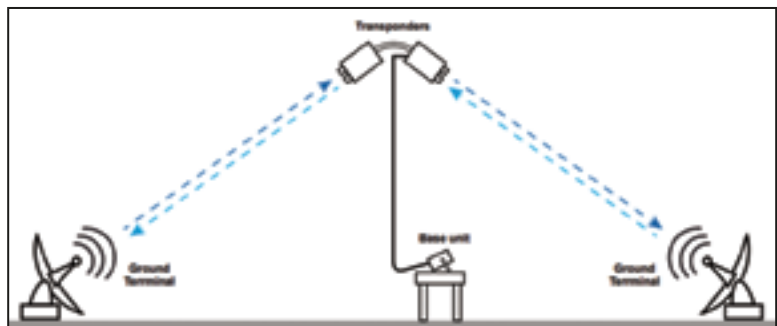


Figure 8 - The AtlanTecRF MSS Multi-Path Satellite Simulator simultaneously talks to two sets of ground equipment, enabling the user to run extensive and prolonged tests without the need to go "live" on a satellite.

the following page).

Once launched, it became clear that the Drone-Mounted Satellite Simulator possessed even greater versatility by virtue of its ability to move as opposed to the other transponders attached to a structure. In many satellite terminals which are on a moving platform, such as a ship, aircraft, train or vehicle, the antenna is required to change orientation to track the satellite position. Therefore, instead of maneuvering the mobile during a system test, the drone does the work, allowing the SUT to carry on in its normal operating mode (Figure 10, next page).

Having broken new ground in satellite simulation, these airborne test transponders are now attracting attention as primary communication platforms, where the 'satellite' communications system uses all the same ingredients as usual, except for the satellite!

Naturally, a transmission from a drone, high flying aircraft or high altitude balloon platform (HAPs) will not generate anything like the same foot print of coverage as a geostationary satellite. However, in some applications the abilities of the geostationary satellite are just not needed and, over a relatively small area, this new form of communication offers a more cost-effective alternative.

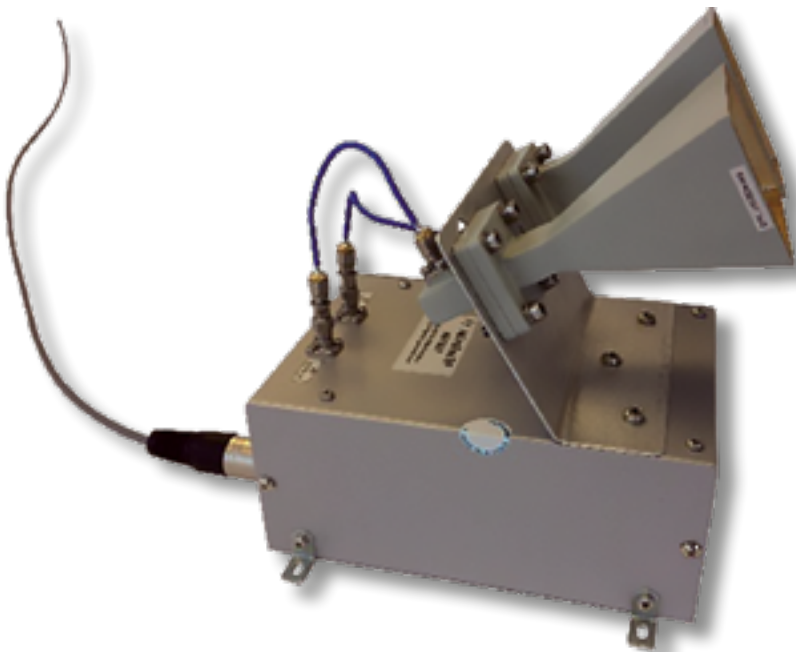


Figure 9. The new, lightweight, AtlantecRF Drone Satellite Simulator

Therefore, in some cases, the test product is replacing the system it was testing and, behold, a further generation of SATCOMs is born, sans satellite.

Military users have been among the first to seize the benefits of such alternative platforms and there are clear advantages to those where certainty of transmission is critical in a deployment zone.

What's more, whereas the equipment on a geostationary satellite is beyond reach of service or repair, it's no big deal to bring a drone or balloon back to Earth to replace malfunctioning equipment. Space-qualified systems are not needed with consequent and major reductions in acquisition and operating expenses.

However, there are further military advantages to be had. If a drone mounted transponder payload can 'pretend' to be a satellite for the purposes of system testing, it can also use this pretense ability to fool an enemy.

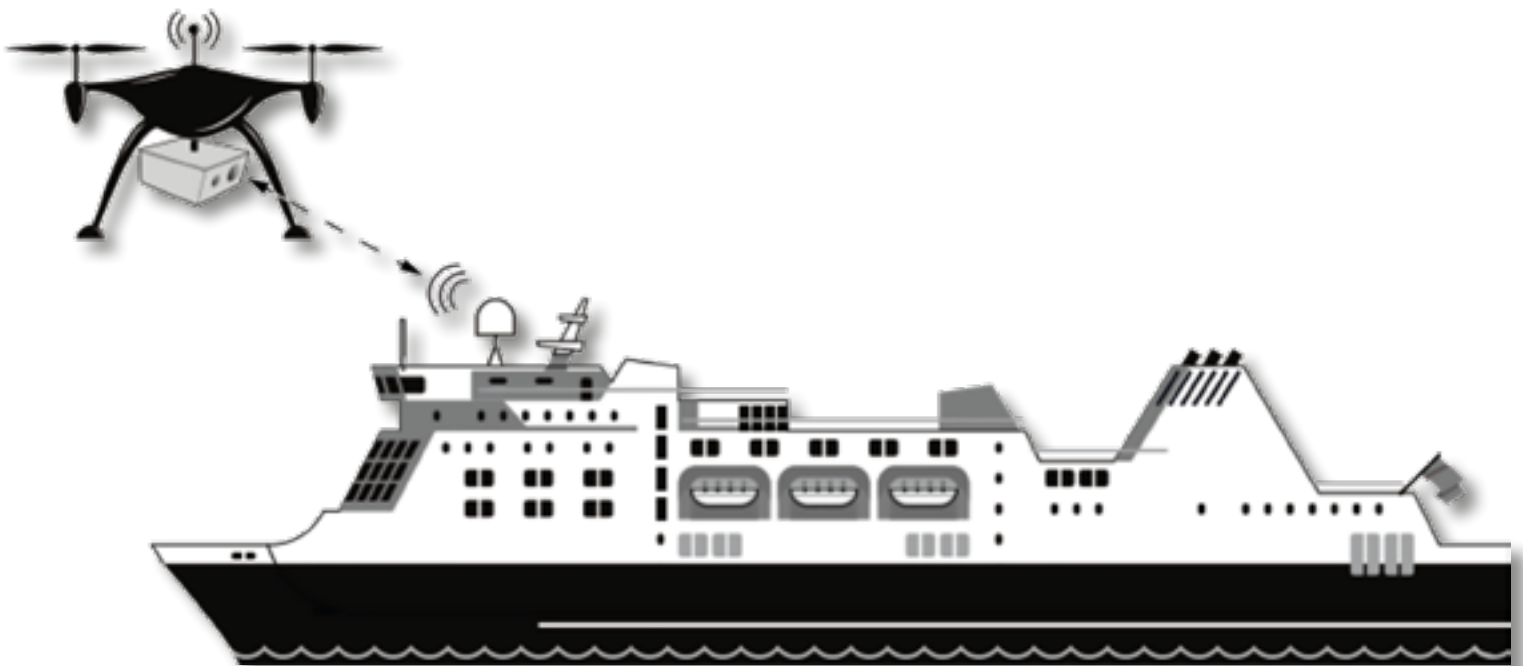


Figure 10 - the Drone Satellite Simulator is maneuvered so it aligns with the ship's antenna prior to testing. By then maneuvering the drone the operator can easily test the terminal's satellite tracking.

How can a team of combatants be certain that the signals they are sending up to their satellite are not being intercepted and how can they further be sure that the data they are receiving is actually from that satellite and not a spoof from elsewhere?

Satellite communications have opened up a whole new world of connectivity over the past 50 years or so with new applications appearing frequently; however, the need to test has now also had its own influence on communication growth and, in some ways which might not have been predicted.

The future is, therefore, bright for applications of microwaves, a phenomenon of physics which is difficult to replace.

AtlantecRF has been at the forefront of SATCOM RF testing for many years and now finds itself leading the way internationally, in satellite simulation with both standard and bespoke product offerings for every variant of the technology.

Atlantecrf.com/satellite_equipment.htm

www.mpdigest.com

AtlantecRF is a leading global manufacturer of RF and microwave equipment, components and interconnects and is based in Braintree in the U.K. The company specializes in providing SATCOM RF test equipment to Commercial, Military and Government organizations. The firm's comprehensive range of equipment includes Loop Test Translators, Frequency Converters, Signal Generators, Noise Injection Translators, Noise Generators, Line Amplifiers and Satellite Simulators. Equipment covers L-, S-, C-, X-, Ku-, DBS, Ka- and Q-bands.

Geoff Burling is AtlantecRF's CEO. His role, to drive growth across all aspects of the business by bringing to market a range of new and high quality RF and microwave components, interconnects and equipment. Geoff sets the company's long-term business strategy and takes the lead in building customer relationships and developing employees. A passionate engineer, who uses his in-depth knowledge and market expertise to ensure AtlantecRF delivers the highest quality products, technical expertise and customer service demanded by today's engineers.



EXECUTIVE SPOTLIGHT: RAMESH RAMASWAMY

**Senior Vice President and General Manager,
Hughes Network Systems**



Ramesh Ramaswamy is senior vice president and general manager of the International Division at Hughes Network Systems. In this capacity, he oversees the company's sales, marketing and operations in the global market. Mr. Ramaswamy began his career at Hughes in 1986 as a software engineer and was one of the original designers of the VSAT (very small aperture terminal) satellite product line. Prior to his current position, he was senior vice president of Sales and Marketing for the International Division.

Before that, he was assistant vice president and general manager of the Asia/Pacific region and for business development in the Middle East/Africa region.

Please tell us about Hughes international presence.

Ramesh Ramaswamy (RR)

Hughes is a global company — in addition to our North American business — where we design/develop core technologies/systems and operate services for consumers, enterprises, and governments — Hughes has subsidiaries in Europe, India, Brazil and Colombia, providing a wide range of satellite broadband and managed services. With the recent launch of the Hughes 63 West payload, we are expanding our Western hemisphere operating services into Peru, Ecuador and Chile. And most recently, we announced a joint venture with Yahsat to provide Ka-band broadband services in Africa, the Middle East and southwest Asia.

Our sales/support offices span countries on six continents, including Dubai, Indonesia, Italy, Mexico and Russia/CIS, where we supply systems and operating expertise to providers who, in turn, deliver services for their respective markets.

What is Hughes approach to the global market?

RR

Hughes is uniquely positioned in the industry to leverage the exploding opportunities of broadband technologies and connecting the digital world. In some markets, we operate our own services, and in others, we partner with leading providers. In both cases, our approach combines our systems technology and operations know-how to deliver the highest quality services to consumers, businesses, communities and governments, both directly and through service partners.

Some examples of our partnerships include the new joint venture with Yahsat, and our work with StarGroup to offer managed services in Mexico using our JUPITER™ System operating over EchoStar XIX satellite capacity.

In the international market, we also offer our systems technology directly to service operators by effectively “shrink wrapping” the platforms we develop for our Hughes services to enable these operators to offer similar services to their customers.

What are some recent areas of global expansion?

RR

It's been a busy few years for Hughes in the global market. In 2016, we expanded our successful enterprise business in Brazil to consumers with our HughesNet satellite Internet service using the Hughes 65 West hosted payload.

Late last year, we started offering HughesNet service in Colombia utilizing the powerful EchoStar XIX Ka-band HTS satellite. Now, our new Hughes 63 West payload expands our HughesNet offerings in both countries to the point that service will be available to more than 90 percent of the population in Brazil and more than 96 percent of the population in Colombia, besides bringing our service offerings, as I mentioned earlier, to Ecuador, Peru and Chile. With our Yahsat joint venture, we will further develop Ka-band satellite broadband services throughout Africa, the Middle East and southwest Asia.

In another area of expansion, Hughes brings our HughesONT™ Managed Network Services to new markets. We're a leading managed services provider globally, across enterprise markets like retail, restaurant, energy production and other types of franchises.

Artistic rendition of the EchoStar XIX satellite.



Hughes Europe has recently begun offering these solutions, which feature Software-Defined Wide Area Networks (SD-WAN) designed for multi-branch enterprises and with 99.99 percent network availability, 24/7 network monitoring and high security operations. Today, HughesON Managed SD-WAN deployments span 28,000 managed sites globally – and counting.

Hughes also enables cellular backhaul and community Wi-Fi solutions as a way of connecting the unconnected. For instance, we have provided solutions for more than 10,000 cellular backhaul sites across Africa, Asia and Latin America. Together with our partners, we have deployed more than 20,000 hotspots for community Wi-Fi in Mexico, Russia and Brazil.

How does the company decide where to expand their offerings?

RR

As we expand our service offerings into new regions, we look for a combination of factors including market demand, size of market and market access. The United Nations declared Internet access a basic human right, but approximately 4 billion people still lack connectivity. There is a disparity between developed regions, where access nears 100 percent and the billions living in rural or ex-urban areas with limited or no access to broadband. For instance, across Latin America, there are more than 20 million households unserved or underserved by terrestrial broadband solutions. Hughes is committed to connecting the unconnected by providing Internet access where and when it's needed the most.

What is the latest on your offerings in Latin America?

RR

Hughes now has the world's largest High-Throughput Satellite (HTS) coverage over the Americas through our EchoStar XIX HTS, Hughes 65 West payload and the newest Hughes 63 West payload. We are planning even more with the next generation JUPITER 3 ultra-high-density satellite, currently under construction and slated for launch in 2021.

Our HughesNet service in Brazil continues to grow very well, with high market demand — the additional capacity from the Hughes 63 West payload will further propel expansion. It is still in the early days for our HughesNet Colombia services, but we are optimistic about the growth potential there.

What kind of satellite opportunities are you seeing on the horizon?

RR

In developing parts of the world, often the most cost-effective and logical way to bring broadband services to lower income areas is through 2G, 3G or 4G services.

Mobile Network Operators (MNOs) around the world are recognizing that satellites, particularly HTS systems, are able to deliver the capacity at price points where it makes sense to implement satellite backhaul for remote base stations. We've seen a strong increase in the market demand for this sector in India, Africa and across Latin America.

Delivering broadband via WiFi hotspot services is another effective way to reach people in developing parts of the world. Deployment of WiFi hotspots enables people to access broadband at a very low cost, using their various personal devices and often with a pay-as-you-go model. Hotspots can be run by local merchants as a source of revenue or by local governments in community centers and libraries. We believe this will be an important go-to-market approach in every developing market around the world.

What does the future hold?

RR

We think this is an exciting time in the satellite industry, with new HTS capacity coming to market and new technologies like IoT, in which satellite will play a critical backhaul role. Hughes already uses M2M and software-defined technologies across the array of modems, gateways and terminals that we design and manufacture. We continue to innovate where it is needed to connect the unconnected and deliver the technologies and services that are needed to support today's on-demand, always-on economies and communities worldwide.

www.hughes.com

UPLINK: INNOVATION INTEGRASYS

A new dawn for satellite communications

By Alvaro Sanchez, General Manager

When the first communication satellite was launched, it was met with pure amazement from people across the globe. The height of innovation, satellite suddenly enabled communication services at a much greater scale than ever before thought possible and quickly became relied upon for a plethora of services.

Fast forward to today and the industry we know and love is challenged with competing technologies. Indeed, as new technology is emerging, many have predicted the waning need for satellite. However, the dawn of the next great wave of innovation for this industry is arriving and there are exciting times ahead to help rekindle that love of satellite by users.

The Phoenix from the Flames

Ok, so there haven't been any flames just yet and satellite remains important. However, over the past few years, the satellite industry has been challenged with rising competition from other communication networks.

Nowhere has this been more prevalent than the broadcast industry where IP video has enabled the consumer to access the content they want, when and where they want it and on any device. In many regions, the statistics show a decline in linear TV viewing, especially among younger viewers. Given that according to Northern Sky Research, video generates more than 60 percent of total satellite capacity revenues — that is a worrying trend — and not only that, but this trend is also echoed in other user groups.

Certainly not willing to take such news lying down, the satellite industry has been picking itself up by innovating and finding new ways to provide services for modern consumers. According to Northern Sky Research (NSR), the emerging space market has received an overall estimated investment of \$5 billion in the past 18 months alone, with more than 70 new companies entering the market.

This is an indication of a major industry push forward on innovation. Whether the innovation has been derived because of the challenges facing the industry, or in spite of such, the fact remains that satellite still has an important role to play and innovation is driving the industry forward.

At Integrasys, the company believes that satellite should look at targeting the broadcast industry and, in particular, carve out a role for satellite to power IP video delivery. According to NSR'S *Wireless Backhaul via Satellite, 12th Edition* report, IP Content Distribution could see well over 1.8 million sites serving various use cases deployed by 2027.

The Innovative World of Satellite

Currently, satellite is coming into its own. This is partly due to innovation.

First, there was High Throughput Satellites (HTS), which meant that even more of the world can be connected at a much lower cost and much more efficiently than ever before possible. By delivering access to much-needed services to more people, satellite has really found an important purpose, especially when addressing Comms-on-the-Move (COTM) and connecting remote communities.

The industry is also on the verge of the mega constellation era. There are already more than 1,000 LEO satellites in orbit and thousands more are due to launch during the next five years. These satellites will offer huge amounts of additional capacity and are likely to be key for delivering services.

This is particularly important because, over the next few years, an increased demand for global connectivity will be experienced. Consumers want more services than ever before and the connections simply don't yet exist to provide the connectivity needed for all of these new services, whether for video consumption, WiFi, Internet of Things (IoT), or a plethora of other uses.

How IoT Will Fuel Innovation

In particular, IoT will greatly drive both the need and innovation within this industry. According to a recent article from *Appinventiv*, the IoT market will rise

by nearly 20 percent in 2020 to \$8.9 trillion. The number of IoT devices will also grow to 31 billion across the globe by 2020, with the number to exceed 75.4 billion devices by 2025.

Clearly that is a massive increase and, in order to cope with an increase on that scale, growth must be matched with connectivity options. That is one important reason why satellite will play an important role in IoT. Many have commented that the increase in capacity afforded by the LEO satellites is far greater than current demand. But when you consider how IoT will increase over the coming years, it is apparent that LEO could have a huge part in handling that increase in demand.

This also means more than ever that we need to ensure perfect quality of service at all times, even in challenging circumstances. Decent monitoring across networks will increasingly play an important role to ensure that any errors are spotted early and signaled to the network operator before any degradation begins to affect services.

IoT on the Move

The other reason satellite will play a massive role is that some areas of IoT cannot be connected by any other communications method, such as the connected car.

Connected cars have long been predicted; however, so far, there hasn't been much movement in this space. That does look set to change, with *Research and Markets* predicting that the connected car market will exceed \$43,451 million by 2023.

Keeping cars connected will be a significant challenge and one that can only really be addressed using satellite technology. Consumers, used to have a connection, will not have patience for the connected car becoming just "car." That said, the satellite industry has for many years been providing COTM connections that must work with no intervention from satellite engineers. Most ships, for example, don't have engineers on board.

For that reason, there has already been a great wave of innovation, something Integrasys is proud to be a part of, enabling automated pointing for example. Being able to automatically point to the correct satellite and keep that connection will be absolutely crucial in the connected car environment. It will also be important that connected cars can troubleshoot themselves when problems arise and take steps to fix any errors automatically. At the same time, giving the network operators the means to properly monitor entire fleet of cars and troubleshoot from the NOC, further reduces any input needed from the consumer.

A New Dawn for Satellite

Innovation is delivering in a new dawn for satellite, both in innovation in the form of new and engaging services for consumers that need to be powered by satellite, and innovation within the satellite industry that is introducing new technology and automated tools.

All of this means that, rather than leaving the comms markets to other technologies, satellite still has an important role to play. However, in order to maintain that relevance, the industry will need to adapt to the new communication requirements that users have and will continue to demand in the near future — the industry taking advantage of the new innovations.

www.integrasys-space.com

Alvaro Sanchez is General Manager at Integrasys and is responsible for Integrasys' three offices (Madrid, Washington DC, and Seville) and guides the company strategy through daily tasks with the respective company teams. Before this role Alvaro was responsible for the Sales Department, providing the most innovative solutions for satellite operators and service providers, in the VSAT market for commissioning & maintaining the network automatically. Prior to joining Integrasys, Alvaro was a signal analysis expert at the largest collider worldwide, CERN European Organization for Nuclear Research, Switzerland, where he was working testing synchronization equipment for measuring if the accelerated neutrons could pass the speed of light.



Signal transmission from antenna to receiver

By Yannick Zeller, Systems Engineer

Whether in a cable headend, Earth station or teleport, reliable signal transmission and distribution is the backbone of a facility's successful operation. From signal reception at the satellite dish, to processing and distribution within a facility, and final distribution, signal quality availability must be properly engineered and managed. Redundancies play a key role in order to guarantee maximum reliability and uptime.

Satellite Reception

Satellite Earth Station antennas, often referred to as satellite "dishes," are used for receiving satellite signals from television programming networks at cable head ends and other facilities. Their size may vary from 1 to as large as 30 meters in diameter, depending on the frequency, satellite position, and service requirements.



Figure 1. Antenna field Earth Station in Raisting, Germany.
Photo source: Wikilimages / pixabay.com

The signals are transmitted from space to earth at different frequencies and polarizations between satellite and ground antennas. Television signals are usually sent in the Ku- (10-18 GHz) or C-band (3-6 GHz) or a combination, depending on local and regional environments.

A growing number of signals around the world are being broadcast at Ka-band (20/30 GHz). The direction of the electric field of the received electromagnetic wave is called polarization. The Vertical and Horizontal polarization are perpendicular to each other. The separation is performed by an antenna feed, which feeds the signals to a Low Noise Block Converter (LNB).

The LNB (Low Noise Block Down Converter) frequency converts the weak signals received from satellites and amplifies them for delivery via cables to indoor reception and decoding equipment typically racked with other electronic networking units.

The high-frequency input signals received (or downlinked) from the satellite in space are typically down converted by the LNB to the L-band (950-2150 MHz) or extended L-band (850-2450 MHz) frequency range and transmitted via cable, such as coaxial copper cables. Specially shaped antennas provide the ability to mount more than one LNB to receive several different satellite positions simultaneously.

Lightning protection devices directly installed on the antenna, or in the downstream signal path, can be used in order to protect equipment in the downlink chain from over-voltage damage.

Transfer to the Receiving Device (Inter-Facility Link / IFL)

The next step is the transmission of down converted signals from the LNB to the Integrated Receiver/Decoder (or IRD), which processes and decodes the signals to baseband.

This link is sometimes called the Inter-Facility Link or IFL. The electrical transmission over coaxial cable from the LNB often leads to attenuation losses, especially at longer transmission paths. Amplifiers are commonly used at the beginning of the route to compensate for losses. Otherwise, the signal level and Signal-to-Noise Ratio (SNR) can be too low to ensure proper signal quality.

For antennas and systems with transmission paths of less than 100 meters from LNB to IRD, transmission over coaxial cable introduces minimal losses and is typically acceptable for cost reasons. For larger cabling distances, or for systems with multiple antennas, where bigger line losses over coax would result, RF-over-Fiber transmission delivers major advantages and should be used. In addition, if a particularly high signal quality is required, coaxial IFL links may not be a prudent option.

In general, fiber optic transmission advantages include:

- Dramatically higher bandwidth capacity
- Virtually lossless over much longer distances and extremely low noise
- Unlike copper coaxial cable, fiber is very resistant to Electro Magnetic Interference (EMI) effects, such as can be caused by power systems, heating, ventilation, TV and radio station signals, radar, etc.
- Reduced fire hazard and lightning hazard: no sparks if cut; does not conduct electricity
- Security: fiber is much more difficult to tap than copper.

The conversion of an LNB output signal onto optical fiber usually takes place in dedicated devices that are housed outdoors in the rack shelters at an antenna site close to the antenna.

Compact units are typically used, such as RF equipment supplier DEV Systemtechnik's DEV 7152 outdoor chassis (See Figure 2). Devices mounted directly on the mast of the satellite dish are also in use. These devices can provide redundancy features for the link to the IRD (Receiver) in addition to performing electrical-optical conversion. They can also be used to set important parameters for onward transmission of the downlinked signal.



Figure 2:
Optribution® RF
over Fiber Outdoor
Chassis DEV 7152.
Image:
DEV Systemtechnik



Figure 3. Rack Shelter with devices for
electro-optical conversion.
Image: DEV Systemtechnik

Redundant Transmission and Antennas

In order to ensure continuous signal availability, even in the case of failure of a part of the transmission chain, routes are designed redundantly.

If a section of the route fails, a backup can take over the signal transmission of the failed part. Implementing one redundancy unit for each transmission part (a so-called 1+1 redundancy) would lead to an increase of costs. As backup equipment is only required in the rare case of a primary path failure, a more effective solution is to implement an N+1 redundancy. With N+1 redundancy, "N" number of primary units can share the same (1) redundancy unit, thanks to intelligent switching devices on both sides of the transmission line.

The concept of hedging against dropouts with redundancy is not only applied to transmission lines. Antenna fields can also be protected against failure. A motorized steerable backup antenna can be employed to restore failure of 1 to

N number of fixed (non-steerable) antennas in a facility. The backup antenna, controlled from an Antenna Control Unit (ACU), can be pointed to different satellite positions in order to restore one of several fixed position antennas. This antenna failure backup restoral can be accomplished using a Redundancy Switch typically installed in an antenna rack shelter. It is also possible to install the switch behind the optical fiber transmission link.

If the redundancy switch detects a malfunction of the signal from one of the fixed antennas, the ACU points the motorized steerable backup (redundancy) antenna to the faulty antenna's satellite position. Once peaked on the correct satellite, the backup antenna can receive and restore the signal in place of the faulty antenna. The signal outage is thus minimized.

For operators that do not have a management system that can perform the switching automatically, or do not wish to perform the integration, there is a special solution from DEV Systemtechnik: the DEV 1993 Antenna Redundancy Switch monitors and switches the signals of connected antennas, and it can completely take over the control of the ACU in the case of a dish failure. As a result, it creates a closed, automated system for achieving antenna redundancy without the need for an external management system.



Figure 4: Antenna Redundancy Switch DEV 1993.
Image: DEV Systemtechnik

Site Diversity

Failures are not only caused by technical defects. Severe weather events can affect entire antenna farms, due to attenuation of satellite signals caused by rain and atmospheric moisture, which more severely attenuates higher satellite frequencies (Ku-, Ka-band).

However, since outage-causing weather effects tend to be geographically localized, a concept called Site Diversity can be implemented to maximize uptime and minimize weather effects. With this Site Diversity approach, a redundant downlink antenna facility is built in another location, typically at least 50 to 150 kilometers away. RF-over-Fiber (RfOF) is used to link the two sites.

The redundant facility would typically be smaller, possibly unmanned, and may only include the primary satellite dishes, outdoor equipment and shelter. At the "Diversity Site," the downlinked electrical signals are converted for fiber transmission, multiplexed and sent to the main headend receive equipment via fiber optic links.

Since the purchase of fiber optic telecommunications service may be required for the fiber connection, and this can incur a costly recurring fee, methods such as CWDM (Coarse Wavelength Division Multiplexing) and DWDM (Dense Wavelength Division Multiplexing) are typically used to bandwidth-efficiently combine and transport the signals from the antenna Diversity Site to the main site. With CWDM or DWDM, using different wavelengths, up to 16 or 80 different signals can be transmitted over a single optical fiber. At the RF-over-Fiber receive location a demultiplexer divides the multiplex back to individual channels and paths. The switching between the antenna sources can also be managed by a 1+1 redundancy switch.

Distribution Inside the Facility

To distribute, demultiplex, transport, and switch RF-over-fiber signals within and between facilities, different approaches are viable, depending on the application and operator preferences.

The classic version is a hard-wired distribution: the incoming RF signals are fed to the electrical-optical converters on a splitter. Integrated amplifiers are mostly used here, since splitting reduces signal power. For instance, the signal level drops by about 3-4 dB with a 1:2 splitter. A distribution of 1:128 corresponds to an attenuation of approximately 26 dB. This very significant loss due to splitting must be addressed in addition to any line losses.

DEV Systemtechnik is a key supplier of equipment for RF signal distribution, switching and amplification functions, offering unique solutions in a single chassis. These products are available in different sizes and with different degrees of integration. Combining both the signal conversion and signal distribution in the same device delivers significant space and power consumption savings compared to conventional solutions.

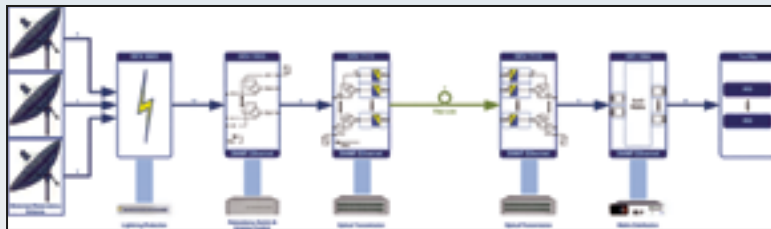


Figure 5. Overview of a complete signal path.
Image: DEV Systemtechnik

Matrix Switching: Operating Efficiency, Control & Redundancy

Another, much more flexible option than "hard wiring" a facility is to use a Matrix Switch. This makes it possible to switch an input source to any number of outputs, or vice versa.

With an RF Matrix Switch, it is no longer necessary to manually reconfigure the cabling or patch panels in order to change signal paths. Redundancies, optical-electrical conversion, and amplification can all be executed by a Matrix Switch. The device can be controlled remotely via a web browser or by an existing management system. The product portfolio of DEV Systemtechnik ranges from compact RF Matrix Switches with 8 inputs and outputs to a 64x64 matrix, which can be assembled in a cluster, and delivers up to 2048x2048 inputs and outputs.

RF signal routing requirements within a facility differ, depending on the application. For programming acquisition, incoming satellite and/or fiber RF signals are transmitted to IRDs (Integrated Receiver Decoders) to decode the video, and/or feed it to the cable or IPTV system multiplex. If an IRD fails or suffers faults, the Matrix Switch can be used to feed a backup IRD, or duplicate and route a problem signal to test equipment for testing and fault isolation.

On the outbound transmission side, matrix switches can also be used to route signals from IRD sources for forward distribution, for example to modulators for direct transmission onto an HFC (hybrid fiber/coax) cable network, or to IPTV encoding and multiplexing systems for downstream distribution to set tops.

www.dev-systemtechnik.com

Yannick Zeller is systems engineer at DEV Systemtechnik. He studied physics and mechatronics in Heidelberg and Aschaffenburg and is an expert in the application of RF signal transmission solutions. email the author at...: yzeller@dev-systemtechnik.com

SATBROADCASTING™: VIDEO OVER SATELLITE

Is there a future for this technology?

By Roger Franklin, Chief Executive Officer, Crystal

These days, there are two types of video: Video-On-Demand (VOD) or Subscription Video-On-Demand (SVOD) — that's the Netflixes of the world. Then there's Live and Linear TV — that's what is called TV Video.

Some are questioning whether TV video has a future. The short answer is yes, simply because there will always be TV as long as there are sports, news and other big events that people want to watch. This live (or near live) content is the main driver of TV as it needs to be distributed to multiple viewers simultaneously and with no latency. The best way to do accomplish this content distribution is through a broadcast channel, as opposed to multiple unicast channels to many individuals.

Satellite remains highly relevant as the technology is perfect for distributing TV channels on Direct-To-Home (DTH) platforms all over the world, and satellite broadcasting is also used by many TV channel providers to distribute channels to Over-The-Air (OTA) affiliates and cable headends, or from a super headend to regional headends. In fact, according to the **World Teleport Association's (WTA) Teleport Opportunity Survey**, 45 percent of teleports generate more than half of their business from the media and entertainment markets.

However, the internet has changed everything and is able to deliver a personalized, rich media experience to anyone who loads a web page or initiates a video stream. This could mean that TV video is at risk of falling behind.

Addressable Ads in Satellite TV

Advertisers have long been drooling over the opportunities presented by video over the internet, specifically the potential for addressable ads.

In actuality, however, digital advertising hasn't quite lived up to expectations. In 2017, Proctor & Gamble actually decreased its digital ad spend by a huge \$200 million, reallocating their ads to TV, audio and ecommerce ads. This shift resulted in a reach increase of 10 percent.

At the same time, it's still true that addressable (or targeted) ads in OTT (Over-The-Top) and VOD are much more effective than broadcast ads — so much so that targeted ad spots delivered to an

addressable audience command prices that are four to eight times higher than regular broadcast ad spots

Addressable ads are those that are served to specific viewers/audiences, according to specific viewer data. This data can range from anything, such as whether a viewer has pet insurance (which signifies whether they own a pet), or even generic data such as the location of a watching viewer.

Such collected data makes it possible for content providers to tailor which ads specific audiences are exposed to, thereby ensuring only the most relevant are inserted into a stream. This, therefore, increases the likelihood of the ad's success, and by extension, the value of the ad spot itself (as well as making the viewer experience more personalized).

Until recently, the common belief was that addressable ads can only be delivered in unicast streams to individual viewers: that is to say via VOD or SVOD. Nowadays, thanks to HbbTV and ATSC 3.0, there is a potential to deliver personalized TV with addressable ads to large audiences, especially when they are mobile.

The broadcasting company Sirius XM, for example, has already demonstrated how to combine satellite broadcasting with terrestrial repeaters to deliver reliable media to mobile receivers even when they lack line of sight to the satellite.

Addressable ads in satellite TV become even more of a reality when the rate of evolution in flat panel satellite antenna technology and the development of car roofs capable of receiving (and transmitting) satellite signals is considered.

Worth noting, however, is that satellite — like HbbTV (Hybrid Broadcast Broadband TV) and ATSC 3.0 (IP-based OTA TV broadcast



standard) — can struggle to provide a fully personalized and interactive TV experience in isolation. In order to do this, satTV needs ground repeaters and interactive back channels that are provided by terrestrial partners, such as mobile or fixed-location broadband service providers.

This could turn out to be a mutually beneficial relationship. After all, when there are tens of thousands of people streaming the same world cup match, there are tens of thousands of unicast streams gobbling up available capacity. As a result, mobile operators will need broadcast partners just as much as satellite companies will need terrestrial partners.

To truly make hybrid satellite broadcasting and terrestrial two-way unicast systems viable from the point of addressable ad delivery, the ability to switch to alternate video content at the correct point in time and the correct point in the distribution path is needed. The only way to provide that capability is to enable the switching device to know exactly which frames of video are being received now and exactly which video segments will be coming up in the near future for that same video stream.

Currently there are in-band signaling methods (SCTE 35) and video synchronization methods using fingerprints (like ATSC A/336) that do work well to this end and are industry adopted standards. However, there remains a problem in that no two TV network providers use in-band signaling the same way, or support synchronization methods... yet. These are big barriers to overcome before addressable ads in broadcast TV video can become a reality.

This is the area in which Crystal has been developing solutions, a number of which could prove to be revolutionary for businesses.

Clearly there are big challenges to enabling addressable ads in TV video, but they are certainly not insurmountable. It could even be the case that business

relationships prove to be the most difficult obstacle for the satellite industry, and not those of a technical nature.

In any case, successful addressable advertising in satellite TV would not just be a triumph for the broadcast industry — addressable advertising would also solidify the validity of **SatBroadcasting**.

crystalcc.com/

Roger Franklin's role as CEO of the company is to make certain the Crystal team has what they need so they can properly service the company's customers. Roger also focuses on methods and solutions that enable customers to increase the efficiency of resiliency of their video and data networks through customer observations and communications, as well as the Crystal sales and implementation teams, to understand where operational issues exist and then lead a collaborative group to design solutions.



Roger also stays involved with the development team to ensure that the solutions Crystal builds satisfy the needs of the customers. In addition to his day-to-day duties at Crystal, he also serves as a member of the board of directors for the World Teleport Association and participates in some of their sub-committees. Franklin is also involved with some video standards groups of the Society of Cable Telecommunications Engineers (SCTE) and the Interference Reduction Group (IRG).



UPLINK: INNOVATION — CRP TECHNOLOGY

Droning on and on with 3D printing technology

By Matteo Levoni Bemposti

CRP Technology, based in Italy, part of the CRP Group, has used their Windform composite materials and Laser Sintering technology to manufacture the 3D printed Tundra-M, the functional prototype of Hexadrone's first modular, easy-to-use, unmanned aerial system (UAS) drone.

The Tundra-M can turn into a formidably effective and pliable work tool, thanks to the unit's four quick connect arms as well as three accessory connections. This makes the Tundra-M suitable for a variety of flight scenarios.

The body, as well as the main parts of the UAS, have been implemented with the composite polyamide based material carbon filled **Windform® SP** and **Windform® XT 2.0**: the four arms supporting the body frame of the Tundra were 3D printed using Windform® XT 2.0 composite material. The remainder of the components and the body structure were developed with the Windform® SP composite material.

Understanding the limitations with traditional manufacturing technologies, the opportunity to develop a unique drone based on the use of Additive Manufacturing (AM) technologies was identified. AM technologies in UAS applications has presented opportunities and challenges to engineers in the field. The ability to produce parts and components using AM technologies holds promise in metals and plastics, whereas traditional Subtractive Manufacturing technologies can be restrictive in design development and material selection.

Windform® SP has waterproof properties and is resistant to absorption of liquids and moisture, making this technology suitable for dyno testing and on track testing and for applications requiring resistance to impact, vibration,

deformation, and high temperatures, such as UAVs, Aerospace and related industries, motorsports and automotive (for under the hood applications such as manifolds).

Hexadrone CEO Alexandre Labesse said that the company has engineered their drone by means of a cautious, multi-faceted and collaborative approach with the involvement of many broad-based stakeholders. Over the course of two years of consulting and R&D, the company has gathered all of the advice and customers' testimonials useful to the design process, which finally helped the firm in the process of devising an ideal UAV solution.

AM technology is often faster than designing and producing a tool for use with traditional manufacturing technologies. Furthermore, 3D printing has given engineers more flexibility in the timeline to engage in design improvements and enables them to think outside of the limitations caused by traditional tooling. The decision to use AM made it possible to substantially reduce the manufacturing costs and has been convenient in terms of timing, when compared to traditional production methods. The unique properties of Windform® XT 2.0 and Windform® SP composite materials have allowed system optimization that successfully withstands the necessary design requirements of space limitations and the extreme stress conditions that occur during flights.

"The Windform® selective laser sintering technology," Alexandre Labesse said, "and allowed us to easily prototype key components of our product, to out compete the plastic injection molding process in terms of deadlines, cost, and to test our prototype in real life conditions with almost the same mechanical characteristic."

"The project we have designed with these two materials, the Windform® SP and the Windform® XT 2.0 from CRP Technology, lies in the conception of different frame parts, junction parts, a quick release patented system as well as the components forming our patented carbon-made arm system. This 3D



printing time/cost saving technology helped us a lot and now allows us to calmly approach the mass production phase."

CRP Technology provided a fast response time to new requirements and enjoyed solid cooperation with Hexadrone and the CAD designer and obtained the best output quality using this unique and proprietary process.

Alexandre Labesse added, "Regarding the most innovative aspect of Laser Sintering technology with Windform® materials, lies in the possibility to prototype with all the pros of the plastic injection process without the cons this method entails in terms of cost and deadlines. Furthermore, Windform® provides us with a close enough material in terms of properties (e.g., density, color, tensile strength, modulus, elongation at break, etc.)"

The most interesting parts that have been made using the Windform® SP and the Windform® XT 2.0 are the body frame, which is composed of the main frame, plus a removable top lid. This component contains the brain of the Tundra-M (the main circuit boards as well as the cooling system).

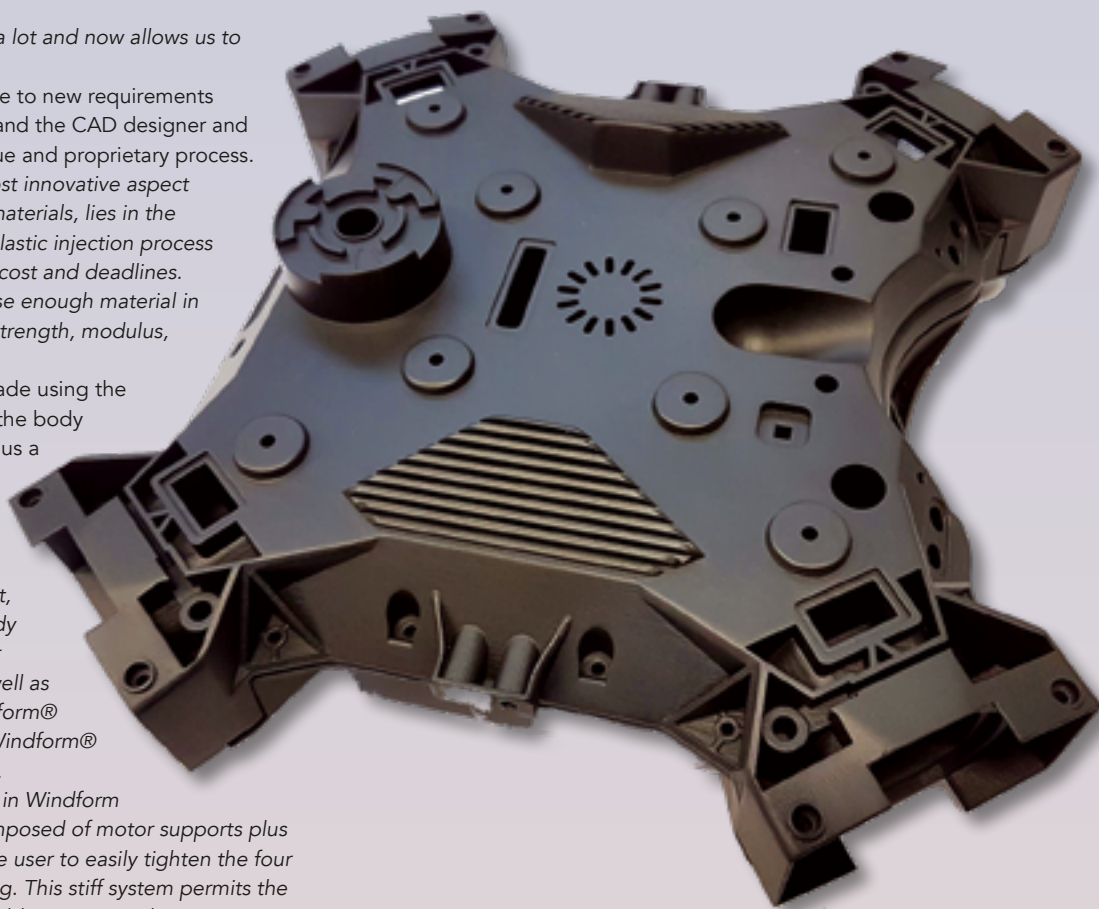
Labesse continued, "To devise this component, we were in need of a water-resistant, durable and sturdy material. Moreover, this sturdy frame comes with an emergency parachute, four removable and scalable arms, two batteries as well as three easily interfaceable accessories. The Windform® composite material used for the body frame is Windform® SP due to its mechanical and thermal properties.

"Other interesting applications manufactured in Windform composite materials are the arms, which are composed of motor supports plus the removable arms. An interlock base allows the user to easily tighten the four arms with the support of a patented "tension ring. This stiff system permits the user to connect and disconnect the interchangeable arms on a discretionary basis. Our patented technology offers a reliable and sturdy connection while being a waterproof solution in case of inclemency. This interlocking connection is also able to handle the stress of leverage forces, which are primarily generated through the components at the end applying a constant force through masses."

The Windform® composite material used for the arms is Windform® XT 2.0

The tests Hexadrone carried out included...

- The assembly / disassembly tests of the different parts to road test their structure as well as the fatigue resistance of these new materials
- Landing tests, folding and unfolding the landing foot structure of the Tundra-M drone, whose different structures were made in Windform® SP and which support the full weight of the Tundra-M. On top of the weight of the device, those small parts also have to handle the stresses due to the folding/unfolding of the landing system
- Flight tests, to determine whether the mounted parts can handle the different strains encountered throughout the many different flight scenarios.



The Tundra body frame.

The Windform® Composite Materials

Windform® XT 2.0 and Windform® SP are the LS polyamide-based, carbon fiber reinforced, Windform® materials within the Windform® family of high-performance composite materials.

Windform® XT 2.0 is the ground breaking carbon fiber reinforced composite 3D printing material well-regarded for its mechanical properties and is particularly suitable in demanding applications.

Windform® XT 2.0 is an innovative material that replaces the previous formula of Windform® XT in the Windform® family of materials. Windform® XT 2.0 features improvements in mechanical properties, including +8 percent increase in tensile strength, +22 percent in tensile modulus and a +46 percent increase in elongation at break. The material allows for the creation of accurate, reliable, and durable prototypes and is perfect for functional applications.

Windform® SP has excellent mechanical properties similar to Windform® XT 2.0, with the addition of increased resistance to shock, vibrations and deformation. The material also shows increases in impact strength and elongation at break, as well as excellent thermal properties and resistance to high temperatures.

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UPLINK: INNOVATION — ETL SYSTEMS

What is DWDM? Why is it important?

By Steve Fendley, International Sales Manager

Dense Wavelength Division Multiplexing (DWDM), with routes in the IP domain, has suddenly become a hot topic for the satellite industry. In many cases, there is now far further distances between the satellite dish and operating center. When sending signals over these longer distances, DWDM is the only reliable way to do achieve this without affecting signal quality.

RF over Fiber

When RF signals are sent from a satellite dish over fiber to the control center, how this is accomplished depends on a number of factors, such as the distance the signals need to travel, the number of fibers available and whether that fiber is owned or rented as well as how many channels are accessible.

By far the simplest way to accomplish this is to have a separate fiber for each feed. In 90 percent of cases, just a few feeds coming off the antenna and going across a short unimpeded distance of around 500 meters is the focus. In these cases, simple works well.

However, what is being seeing now are SATCOMs operators wanting to carry signals from dishes over longer distances. The rising use of High Throughput Satellite (HTS) and Ka-band is one of the biggest drivers for DWDM technology. That is because operators are often deploying diverse sites to combat potential rain fade, which can cause severe loss of signal in extreme weather conditions.

The distance of diverse sites away from the main site depends on the location. In some places, weather is so localized that 40 kilometers may be enough. In most scenarios, more likely the distance being talked about is between 70 to 100 kilometers to be in a different weather pattern. The signals need to get to both the main and backup antennas in the same condition — DWDM is currently the only way to ensure that such occurs.

What is the Difference between DWDM and CWDM?

There is often a fair bit of confusion between Coarse Wavelength Division Multiplexing (CWDM) and DWDM — both technologies are about being able to send multiple optical signals over single fibers.

CWDM combines as many as eight optical signals on a single fiber by using different wavelengths (at 20 nanometers apart) for each signal. Wavelengths are combined in a CWDM multiplexer and separated at the other end in a CWDM demultiplexer.

DWDM combines multiple optical signals on a single fiber by using different wavelengths. These are combined and separated using DWDM multiplexers and demultiplexers in the same way as CWDM. However, DWDM transmitters use a different laser technology, each creating a far more narrow spectrum of light, allowing for a far higher number of wavelengths to be combined into a narrow optical bandwidth. This means that they can be combined at spacings of less than 1 nanometer.

The problem arises when a longer distance is required. This naturally causes more optical loss in the fiber and means the need for an optical amplifier to boost that signal. This is most commonly done using an Erbium-Doped Fiber Amplifier (EDFA).

The distance at which this becomes necessary depends on certain other factors, such as the quality of the equipment and the fiber itself. Typically, if the distance exceeds 70 kilometers, an EDFA is likely going to be needed; however, depending on the application, that may also be required at a shorter distance, as well.





*StingRay200 DWDM
AGC L-band receive fiber
converter with mon port.*

As soon as an EDFA is used, CWDM becomes unfeasible. That is because EDFAs are inherently narrow band — in order to amplify multiple wavelengths, a much finer optical signal can only be achieved with DWDM.

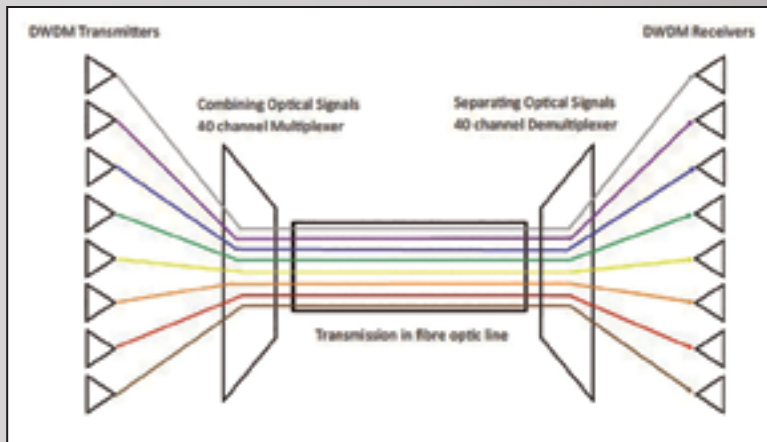
The Challenges

DWDM is an exciting technology and one that is becoming increasingly important in the satellite industry. However, DWDM is not without challenges, the biggest of which is that of dark fiber; fiber that is rented, usually from a telecoms operator.

Most long fiber transmission paths use dark fiber. That, of course, makes a lot of sense, even though the cost of rental is extremely high and the cost and effort of laying owned fiber is even higher and, generally, totally impractical. The cost of rental is another reason why DWDM is needed, as no company wants to rent more fibers than is absolutely necessary. Being able to send multiple signals on a single fiber is, therefore, quite attractive.

While the financial savings are appealing, the satellite industry also recognizes the associated challenges with dark fiber, the first issue being the condition of the fiber is not identified and, secondly, many telecom operators do not understand the requirements for RF signal transmission.

This can be very difficult, especially in certain areas of the world, to make it clear that RF signals need to use a certain type of fiber, as well as needing to be sent on a dedicated fiber and not shared with other data communications. If that necessity is not adhered to, it can be detrimental to the signal, the very element to be protected.



What is needed is to educate companies about the importance of adhering to these requirements for RF signals; however, that will require a concerted industry-wide effort and time.

The Opportunity of DWDM

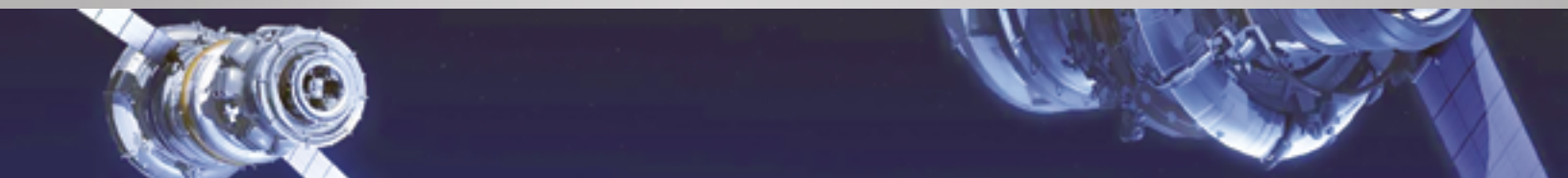
In spite of that challenge, DWDM is an excellent opportunity for those long-distance signals.

Dark fiber can have a variety of challenges; however, in many areas, a problem isn't caused, and many telecom operators are perfectly able to adhere to stringent RF requirements. Ultimately, DWDM means that RF signals can be sent over long distances without massive signal losses, thereby maintaining that all important feed quality.

Of course, if the antenna and control center are just across a small field and there are only a couple of feeds, a normal RF over fiber link should be used. If distances are being crossed between 2 and 50 km., use CWDM. However, if you signals need to be carried over 50 km., DWDM is an extremely viable, even vital, technology.

www.etlsystems.com

Steve Fendley is an International Sales Manager at ETL Systems. Steve has over 25 years' experience in sales, as well as technical expertise in RF and microwave components and systems and fiber optic system design. ETL Systems designs and manufactures RF satellite signal handling equipment and is one of the largest of its kind in the UK.



CSIR™: The efficient, interference solution

By Philip Chu, Senior Technical Project Manager

Radio frequency interference in satellite communications is a growing concern for military and commercial users alike. With increasing spectral density and frequency overlap, interference incidents have become commonplace — reported interference cases (a small subset of overall interference cases) reached 20,000 reported incidents per year in 2016. With Low Earth Orbit (LEO) satellite constellations and 5G terrestrial players entering the SATCOM landscape, this number will experience tremendous growth.

This growing incidence of interference highlights the need for improved interference mitigation capabilities. Existing interference mitigation techniques burden satellite operators and network owners with expensive, inflexible architectural design and/or significant bandwidth constraints.

For example, orthogonal interference mitigation techniques, such as MIMO and CDMA, require architectural expenditures and system complexity. Other techniques, such as frequency hop (FH) and adaptive coding and modulation (ACM) trade off throughput for interference resilience and again burden system design with additional complexity.

Glowlink's Interference Removal Algorithm

Glowlink's Communication Signal Interference Removal (CSIR™) simplifies the interference resilience solution — interference resilience with no tradeoffs or additional burden.

CSIR can be inserted into any receive chain and mitigate unknown interference in a variety of interference scenarios with zero added complexity for everyone from the system architect to the terminal operator. The primary design focus of CSIR leverages existing knowledge of the operator's signal of interest (SOI), namely SOI symbol rate and center frequency, to deliver interference resilience.

CSIR does not require any information about the interfering signal. As a mature, DSP-based solution, CSIR is offered in a wide range of configurations: from an in-line unit that can fit into existing satellite receive paths all the way down to an IP core on a field programmable array (FPGA) integrated directly into a modem.

Interference Pattern	CSIR™ Headroom
Single CW Tone	40dB+
Multiple CW Tones	35dB+
Modulated Signal	20dB+
Modulated Signal + CW Tone	20dB+
Non-Stationary CW Tone	20dB+

CSIR takes an approach that requires no additional operator knowledge to set up and no satellite operator intervention when an interference event occurs. The satellite operator already has all the necessary CSIR setup knowledge — SOI symbol rate and center frequency — since the receive modem must be configured with the same information. There is no need to tell the algorithm that an interference is present; the algorithm will simply begin working once interference appears.



This is a key point in understanding the value-add of CSIR. Once CSIR is set up, the operator could be taking a nap in a hammock when an interference arises, and CSIR would still deliver full interference resilience.

Both in the development laboratory and in the field, CSIR has shown significant performance against a wide variety of interference patterns. Users for CSIR have ranged from PhD-level scientists to novice satellite communication operators. Thanks to CSIR's operator-centric design focus, the entire range of users has been able to install the technology and protect their communication link from interference.

CSIR Performance Metrics and Examples

As a novel interference removal approach, CSIR requires the definition of a new performance metric in order to fully articulate the algorithm's power. Glowlink has defined 'headroom' as its interference removal metric. Headroom is defined as the increase in maximum interference power that a receive link can tolerate with CSIR in-line.

Specifically, the bit error rate (BER) of a modem will remain quasi-error free (QEF) down to some minimum $C/(N+I)$, where C is SOI power, N is noise level, and I is interference power. By mitigating interference, CSIR allows the receive modem to operate QEF at a higher I , or correspondingly lower $C/(N+I)$, than an unprotected modem. Practically, when taking a headroom measurement in the lab, we operate two receive modems side by side. One has CSIR protection; the other serves as an unprotected reference. We set C , I , and N to a level where the unprotected reference is still QEF.

We raise I to I_{ref} where our reference modem BER is no longer QEF. We then further raise I to I_{CSIR} where our protected modem is no longer QEF. Headroom is $I_{CSIR} - I_{ref}$.

Headroom is a function of many elements — from SOI characteristics to interference patterns to noise levels to desired FPGA resource utilization. As a result, the number of headroom measurements is infinitely long. To give a rough order-of-magnitude understanding of CSIR's capabilities, the following table has been developed for headroom measurements achieved with a QPSK LDPC-2/3 SOI.

This performance sample represents a drop in the proverbial results bucket. For more information and further details, please contact Glowlink directly.

CSIR is able to provide ample interference rejection performance with minimal burden on the operator. With interference resilience that requires no operator intervention, minimal additional equipment, and no additional operator information, CSIR is an impactful, efficient solution to the growing interference problem.

Complimenting Existing Interference-Resilience Approaches

CSIR can be an additive measure to systems that already have interference mitigation designs.

From MIMO to FH, CSIR can provide additional interference resilience to a protected communication link. For schemes that require increased architectural complexity, CSIR can be a tool to help minimize the cost and burden of that architectural complexity. For schemes that trade communication data throughput for interference resilience, CSIR can help maximize the achievable data throughput. With its flexible implementation, CSIR is harmonious with existing interference resilience techniques, ready to be delivered in the appropriate form factor.

GS380X — CSIR Implementation

The GS380X is a powerful inline interference removal system utilizing Glowlink's CSIR algorithm to provide the user with continuous, real-time interference excision and link protection. The GS380X is placed into the signal receive path directly before the modem and, with the CSIR algorithm, protects the communication link from interference ranging from multiple CW tones to strong modulated interferer (see Figure 1 below).



The GS380X prioritizes existing operators and legacy satellite communication systems by introducing zero additional constraints on the system-wide architecture to achieve significant interference resilience. As with all CSIR-based products, the GS380X does not require operator intervention to deliver protection during interference events.

By minimizing cost and maximizing simplicity, the GS380X offers efficient interference resilience as an additive capability that does not require system redesign. Even for systems that already have existing interference-resilience capabilities, the GS380X can be used to deliver additional resilience against interference.

The newest generation of this product has improved bandwidth capabilities over the original GS380X.

RCM — Wideband Implementation

The RCM is a high-performance version of the GS380X intended for use by the United States government and allies. For those requiring a high-bandwidth, high-performance system, the RCM can deliver similar to enhanced interference excision capabilities in a compact form factor. For further details, please directly contact Glowlink.

GS380S — Interference-Preserving Implementation

The GS380S is a variant of the GS380X that also preserves the interference signal. In addition to protecting the SOI from the interference, it also produces a cleaned-up version of the interference itself as a secondary output. For those interested in knowing more about their interference signal, the GS380S provides an interference observation capability.

GS380L — Geolocation Implementation

The GS380L is a variant of the GS380X that is designed as a companion to the Glowlink Model 8000 Geolocation device. The GS380L removes competing signals on both the primary and adjacent satellites to provide a cleaner, more accurate geolocation result. Paired with the Glowlink Model 8000, the GS380L has successfully resolved geolocation cases that were previously not possible with any geolocation system.

IP CORE — Integrated CSIR

For those interested in direct integration onto an FPGA, CSIR is available as a licensable IP-block. The IP Core works at clock speeds specified to the top of the satellite communications bandwidth range. In addition, the already modest resource consumption of the IP Core can be further optimized for available FPGA space. Depending on the urgency of the customer, this IP Core can be available immediately.

For further information, contact the Glowlink team at sales@glowlink.com— visit the company's website at www.glowlink.com, or call the firm at (650) 237-0220.

Author Philip Chu is the Senior Technical Projects Manager for Glowlink Communications Technology

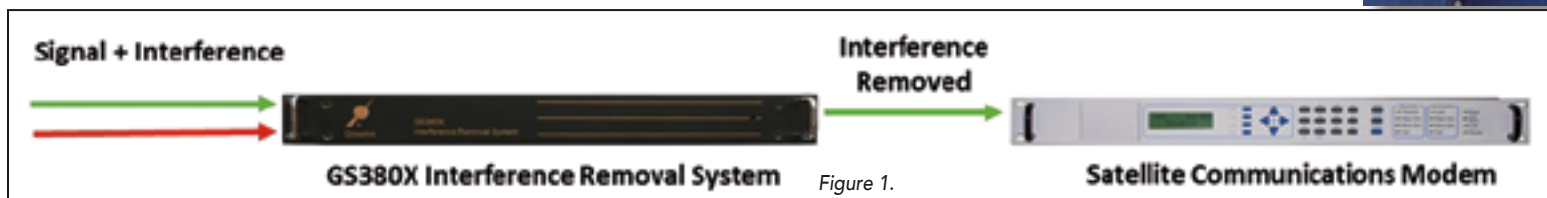


Figure 1.

Driving NewSpace...

By Roman Buff, Market Manager, Aerospace

The NewSpace industry is growing rapidly — with new technologies and innovations changing the space-scape as we know it. Previously an industry almost completely headed up by government and space exploration entities, with the aim to discover and monitor the unknown, the next space age — NewSpace — builds on the knowledge and key findings from the Old Space era, and seeks to capitalize, economize and privatize the sector.

Activities being undertaken in the new space era are not limited to the space tourism which is often presented in the media today. Private entities and government groups are constantly investing, developing and deploying new projects into the atmosphere including asteroid mining, satellites for internet and high-class orbital imaging, as well as commercial space stations and further innovations in colonization and research. And, there is no sign of this slowing down, with the space sector set to be worth \$2.7 trillion over the next 30 years¹.

The UK alone produces around 44 percent of the world's small satellites, as well as maintains the facilities to operate and manage the satellites once deployed². The United Kingdom Space Agency (UKSA) also recently partnered up with a number of U.S. organizations to set in motion the first launching of commercial rockets from the island. Virgin Orbit, the latest space endeavor from Richard Branson and successor to Virgin Galactic, has also secured permission from the UKSA to launch rockets from Newquay Airport in Cornwall from 2021³.

There is much competition in the commercial spaceflight industry, with the major players of Virgin, SpaceX and Blue Origin all head-to-head in the race to space. Elon Musk's venture, SpaceX, recently announced the company will be ready to send a crewed mission to the International Space Station in April of 2019⁴.

Also on the agenda is the introduction of reusable flight vehicles that are intended to withstand the harsh atmosphere of space for multiple journeys through the atmosphere. Still in the concept phase, Stratolaunch's Space Plane is completely reusable, initially developed to ferry cargo, but with the potential to accommodate space tourism in the future⁵. However, behind the headlines, big names and bright lights, there is technology that is making all of these innovations possible.

Challenges to Overcome

Due to the demanding nature of the space environment, the technology in the background must offer the greatest level in flexibility and ruggedization, as well as meet the many criteria and standards in place set by industry bodies — RF microwave technology can rise to these challenges and more.

There are increasing trends in the RF manufacturing world to develop flexible, reconfigurable systems that operate seamlessly from launch to orbit. Greater capacity and bandwidth are only a few of the networking demands that NewSpace applications encounters which further the need for a robust, reliable connection.

Just as the latest onboard satellite systems require the latest innovative engineering processes, so, too, do the connectivity solutions that bear the brunt of the harsh environments of space and space flight. Adding to the demands of the installation, a number of deployments also have limited space to reserve for these connectivity solutions, so solutions must be able to fit in seamlessly or run the risk of damage and deterioration.

The Trusted Technology

Choosing a provider of cables and connectors can be difficult, especially with the critical nature of the atmosphere in space. Organizations must ensure solutions are tried and tested in the intended environment, or as close to as possible.

In space applications, as you can imagine, low-weight and maximizing space technologies are ideal. Ensuring that the selected manufacturer is using the latest technologies in ultra-light materials can save the operator a weight reduction of as much as 50 percent as compared with other standard cable

assemblies on the market today, adding benefits without sacrificing electrical and mechanical performance. Companies no longer need to decide between space saving or high-performance— there are now technologies that offer both elements.

In addition to low-weight features, also essential are flexible components. Companies such as HUBER+SUHNER are manufacturing technologies specifically for space applications. Developing state-of-the-art microwave components for more than 20 years, the company is renowned for their extensive Space Flight qualification heritage and providing industry-leading solutions which are not only dependable, scalable and reliable in theory but also in practice.

With the introduction of bend-to-the-end style technology, the patented, solderless assembly processes from HUBER+SUHNER allows operators to achieve an unparalleled bend radius right at the end of the cable entry, which eliminates the need for right-angled connectors and the risk of breaking solder joints.

R&D

Currently, providers of RF technology are investing heavily in research, development and testing which is crucial for the solutions they provide to operators.

By simulating the conditions found in outer space, it ensures all components are able to withstand the extreme requirements of their deployment. Testing in thermal vacuum chambers gives manufacturers the best indication of component operation as compared to real-life deployment. This process of test and measurement is so alike to the conditions found in space that even entire satellites and space components have been tested in this manner.

Operators should also ensure they are using the best connectors and cables for optimum performance of the connectivity solutions. In particular, TVAC type connectors are vented in such a way to ensure a continued flow of air in and out of the cable assembly, as well as fitted with additional defence properties armors to protect performance.

RF connectivity solutions, such as MIL qualified connectors, are ideal for applications where space is critical, as they are proven and reliable. MIL interface based high-density connector solutions can operate at up to 65 GHz and are available as board-to-board, board-to-panel, and cabled solutions which uses critical space and weight saving.

Continued Innovation and Seamless Operations

Innovation is the cornerstone of the NewSpace. Unsurprisingly, technology has played a huge part in space and space exploration, and with no sign of things slowing down, the industry is heading for a major boom. As the major players in the industry inch closer and closer to launch day, it is important that operators not lose sight of what is at stake at liftoff.

It is essential that operators undertake in-depth research and testing before implementing connectivity solutions into their space flight projects. To ensure a reliable, seamless operation from the testing phase to launch, these organizations must ensure they choose tried and tested microwave and RF connectivity solutions to bolster not only their current exploration and communications equipment and projects but for the future of space tourism.

www.hubersuhner.com/

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A CASE IN POINT: COG + FLEET SPACE TECHNOLOGIES

Embracing modularity for the satellite-connected device

By Carl Nerup, CMO, Cog, and Andrew Barton, CTO, Fleet Space Technologies

A dramatic growth of up to 30 billion IoT devices by 2020 is estimated to occur. This is a big number; however, one element in common for all IoT devices is the 'I' for internet, which, by direct implication, means that the internet needs to be connected through some form of medium.

The potential for the proliferation of satellite-connected IoT devices is a dramatic area of growth in this industry to bring smart, connected devices to the entire world.

Without question, the security of these devices is the ultimate assurity of the value of the data coming from these satellite-connected IoT devices, especially when they act as gateways for an extended series of even more IoT devices, as people will use that data to make decisions that may have widespread consequences.

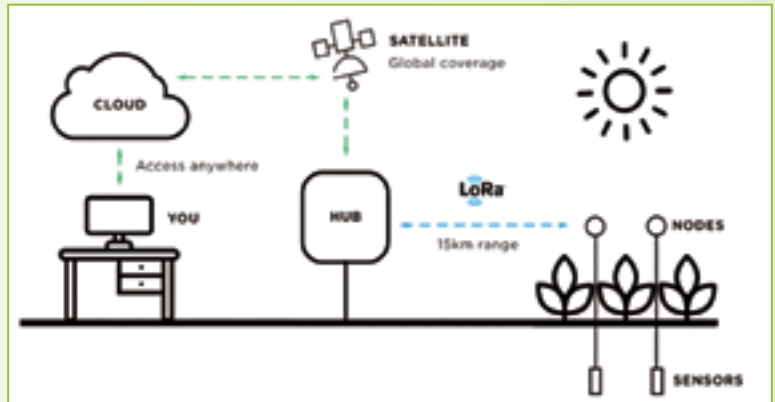
Case in Point

Fleet Space Technologies is an Australian start-up selling satellite connectivity solutions to the IoT market. Funded with a series A round in 2017, Fleet's focus is on satellite-enabled, massive, IoT deployments, which connects hundreds and potentially thousands of industrial devices in areas with no cellular or public low-power wide-area network (LPWAN) coverage.

Fleet provides ground-based user equipment called the Portal, which is an IoT gateway, proprietary edge network server and a satellite modem all combined into a single unit. Fleet is already selling Portals that connect to existing satellite networks to customers around the world and, in the future, Fleet will also launch its own satellites.

The Portal's edge server includes software that selects key data, encrypts and then transmits that data securely back to the cloud over the satellite network. With this approach, the Portal enables global, low cost, low power, IoT backhaul, becoming a critical component in any remote IoT solution.

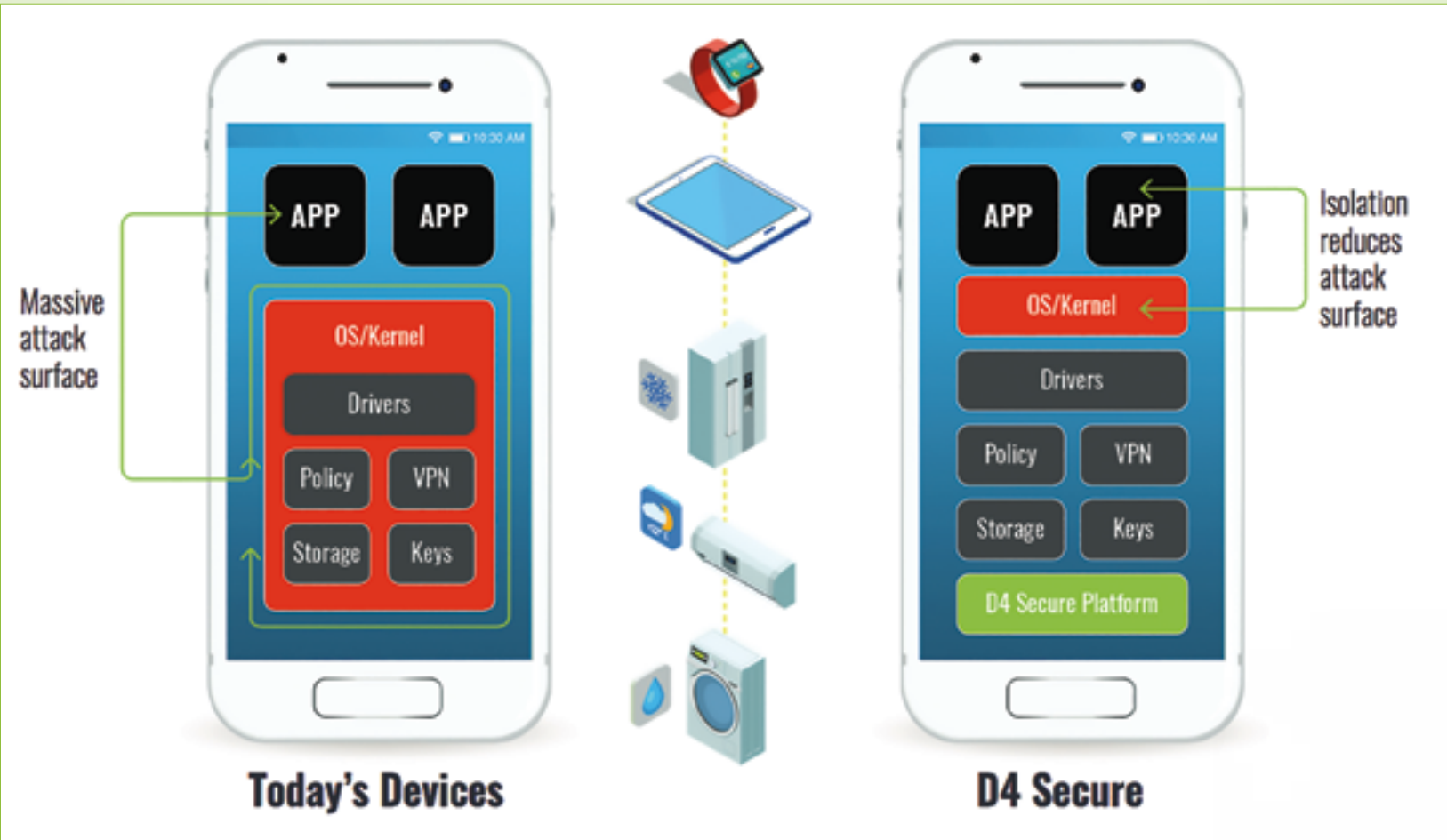
This criticality is what brought Fleet and Cog together to create a highly secure solution, allowing Fleet to be able to create a broad based sensor network in very remote locations. This solution is especially effective for remote industrial agriculture, maritime logistics, mining and environmental applications.



The Challenge

As Fleet approached device security, they were faced with the fact that most satellite connected IoT devices are built with a monolithic design, meaning the device is basically one, big, software stack, which leads to the following issues:

- The monolithic design creates a cumbersome approach to building scalable products with a quicker time to market
- The bigger the code base, the larger the attack surface, creating numerous opportunities for hackers to exploit
- This design makes it difficult to ensure backhaul radios are utilized for valid traffic only
- It's hard to be sure that data integrity remains intact, and data is the asset by which the value of the device is measured.



This design comes with an enormous risk of bottom line implications. Imagine a hack where a botnet orders the device to start pinging a satellite. With every ping, the company is charged for bandwidth. Simultaneously, those communications drain the battery, drastically shortening the life of the device. The amount of operational and financial damage an attack such as this would mean for a company cannot be overstated.

The Answer: Modularity

Modularity means the isolation and protection of critical functionality — essentially by creating separate modules or containers for each function on the device. This approach proactively secures devices by reducing the attack surface. It also increases reliability by eliminating single points of failure.

This can then be overlaid by modules that provide double encryption, non-bypassable VPNs, and nested VPNs, as needed to build resilient systems with defense in depth. The system can scale linearly and infinitely, thus reducing bottlenecks and preserving performance. Perhaps more importantly, modularity on secure foundations now enables device makers to extend and enhance the device with new capabilities.

Fleet and Cog will install Cog's D4 Secure platform on Fleet Portals to provide proactive kernel protection, radio isolation for satellite communications, and a VPN tunnel to ensure secure data transport for Fleet devices. As a final step, Cog will isolate other sensors so they only draw battery power when a specific event is executed.

What are the advantages of this modular approach?

Reduced attack surface: *Inherently, a single block of software is more susceptible to nefarious attacks. By carving up the large block of software into independent virtual machines, we decrease the attack surface which allows for the selective hardening of key drivers and software on the device. This is a key approach used by most OEMs — traditionally by isolating with added chipsets versus through software.*

Proactive protection: *One of the unique advantages of the D4 Secure Platform is the Cog enables 'kernel hardening' at the hypervisor layer, the purpose being to stop known malware from attacking the device. This should not be considered a 100 percent solution any more than a flu shot would be — but just like a flu shot, it is a proactive activity toward prevention.*

A non-bypassable VPN: *When the potential risks to an IoT device are considered, aside from merely encrypting the data traffic to "man-in-the-middle" attacks, the ability to hijack the modem and broadcast data (good or bad) from the device clearly becomes a weak spot. By forcing all data from the device to run through a non-bypassable VPN, Fleet can ensure egress from the VPN at a determined connection. This enables Fleet to analyze and manage all the data coming off the device, including shutting down any possible corrupted data from a compromised component in the extended network of devices on the Fleet gateway device.*

An IoT Market Turning Point

The solution that Fleet is bringing to the market delivers the uniqueness of an IoT gateway that serves the traditionally non-connected parts of the world through satellite communications. This solution will improve the efficiency, productivity as well as reduce costs for business across the world.

The recognition by Fleet that security is one of the key requirements for creating a quality device for their marketplace is forward leading and something that Cog is proud to support with its D4 Secure Platform.

cog.systems/

www.fleet.space/

Carl Nerup's experience is a powerful mix of proven, marketing and sales leadership and strategic execution. Carl is a frequent speaker at industry forums and conferences. He also provides advisory services to numerous companies in the emerging high technology and telecommunications industries as well as select non-profit organizations and graduate schools.



Previously, Carl was Vice President in Samsung's Global Enterprise Business, where he had sole accountability for all direct and indirect sales for the industry leading Samsung Knox Secure Mobility platform. Prior to that, he was a member of the Executive Team at General Dynamics Broadband, where he was the Vice President in charge of global business development for their new line of business in the secure mobility industry – GD Protect.

He also served as an Executive in Residence at Carnegie Mellon University, where he worked with the Quality of Life Technology Foundry; a National Science Foundation Engineering Resource Center.

He was a Vice President in AT&T's Strategic Business Development organization, where he had responsibility for identifying new business opportunities across all AT&T business units. He also evaluated all venture opportunities and managed the full Minority Investment Portfolio for AT&T.

Prior to AT&T, Carl was a Managing Director at Digital Island, a Cable & Wireless Company, a start-up provider of global hosting and content delivery services. Previous to that, Carl was on the launch team for Aerial Communications, a start-up provider of GSM services in seven markets across the U.S., where he was the Head of Sales Operations and Distribution Strategy.

Carl continues in his role as a Partner at Skyline Partners, a private equity firm based in Denver that specializes in select investments and specialized management consulting. Carl is an avid backpacker and lover of the outdoors.

Dr. Andrew Barton is Chief Technology Officer for Fleet Space Technologies. In that role, he coordinates the company's technology planning, oversees the technical staff and manages strategic partnership engagements with supplier and technical partners.



Andrew previously worked at the XPRIZE Foundation as Director of Technical Operations for the Google Lunar XPRIZE where he was responsible for the implementation of all technical aspects of the prize including development of the format and award criteria of the \$5.25 million Milestone Prizes, selecting and managing the panel of independent judges and communicating technical aspects of the prize to the space industry and the general public.

Prior to his role at XPRIZE, Andrew was involved in the private space industry in Europe as a technology developer, project manager and entrepreneur. Among other roles, he also worked for four years as a specialist at the European Space Agency in the Netherlands where he supported the development of scientific satellites, future planetary landing missions and the VEGA launch vehicle.

Andrew holds a Ph.D. and a bachelors degree in aerospace engineering from the University of Sydney and a Masters degree in Space Studies from the International Space University.

SATCOM CHALLENGES: INTERFERENCE

Are we heading in the correct direction?

By Martin Coleman, Executive Director, Satellite Interference Reduction Group

Satellite interference is a problem that just won't go away — it has no boundaries. Yet all around the world, applications and services rely on reliable satellite communications for essential connectivity, from the military to broadcasters.

The Satellite Interference Reduction Group (IRG) has been working hard to make a truly palpable change to the way operators, users and manufacturers approach, solve and prevent interference — the organization does seem to be on the verge of successfully managing the situation.

However, the industry remains affected by interference on a daily basis.

On a positive note, IRG has seen a number of new technologies and solutions implemented over the last few years that are proving to be quite successful in the

field right. This innovation does continue to grow; however, where does the industry currently stand in regard to interference? What future innovations does the industry need to explore to ensure that satellite remains valid?

Carrier ID — Has It Reached Its Potential?

IRG was heavily involved in the development of Carrier ID (CID), an embedded signal found in the data transmission path which enables operators to identify the source of an interfering carrier.

IRG successfully lobbied manufacturers to install Carrier ID (CID) within all new equipment as standard and that was great progress. Sadly, equipment is still shipped with CID switched off, with many users oblivious to the need to switch it on.

Of course, these are still the early days when it comes to investing in CID. Naturally, it's not viable to simply ditch expensive equipment which works well that may not have CID, particularly for those who operate in a sector which experiences relatively little interference. CID will become more commonplace over the coming years, as meeting the challenges of IoT, HTS and LEO, for example, requires that aging equipment be replaced.

Looking Ahead

It has been a long road to get where we are now. There seems to be balance in that interference is manageable, with operators saying that downtime caused by interference is reduced, but not totally resolved, on the whole.

At the time same, the industry is changing, along with the sectors which rely on satellite services. IP and the use of Very Small Aperture Terminals (VSATs) in broadcasting, for example, has massively changed the landscape for keeping spectrum clean.

If the future of the space environment is considered, it looks worrying. LEO constellations, smallsats, 5G, the demand for constant connectivity — all of this has the potential and, no doubt, will cause more interference, but also significantly changes the way the satellite industry operates. LEO and smallsats also represent opportunities to boost the relevancy of satellite, but we can't ignore the fact that more satellites in space means more congestion and, therefore, the increased likelihood of disruption.

In the military sector, any disruption in a service can mean the difference between life and death, success or failure, of critical missions. In the broadcast space, competition from terrestrial infrastructure means that a high quality and reliable broadcast signal is absolutely essential if satellite for broadcast is to remain valid. In short, many of the services that rely on satellite are pretty much essential to the everyday lives of humans across the world.

Even if interference only causes issues for a handful of users, this is still too many — it's not acceptable to throw our hands up and mark the job as finished. Instead, what should be done is to consider what the industry can do to reduce errors and increase satellite efficiencies. In this manner, the industry will be able to:

1. Increase stability and reliability for users, and;
2. Make satellite more profitable for businesses.

The questions that needs to be asked is how can innovation will be able to succeed in a congested future, and how should companies work together to bring about new processes to safeguard the space environment for all. The new initiative of Space Traffic Management (STM) currently supported by the U.S. and Europe will hopefully have a huge impact here.

An AI-Future?

IRG and Intel-Sec's conducted a joint event in Asia, where I moderated a session on the potential for Artificial Intelligence (AI) and machine learning to assist in managing, automating, reducing errors and improving efficiencies within satellite operations.

Currently, AI technology is relatively unexplored in our sector, which seems strange given the innovative nature of satellite. When we consider what the technology has enabled in other industries, it is likely that AI could help us achieve our goals in several ways.

First, it's a sad fact that many experienced satellite engineers are simply getting older and retiring. Add to that over the years, not enough young people have been to our industry.

There is change afoot. A slow start, but young people are starting to be seen entering the SATCOM workforce. They naturally bring innovation, those new ways of thinking to the table. AI is a major key for the industry to use to connect and appeal to these younger professionals, managed through the industry's own innovativeness and by working more closely with universities and schools.

Consider this — right now, AI could help the industry plug the gap that will be left behind by those knowledgeable satellite professionals who are leaving and help the transition to a new era of STM.

Secondly, AI has the potential to act as a framework for developing better methods of preventing interference in the first place. AI can automate tasks, analyze data for patterns to predict incidences as well as monitor and fix minor issues. This can be done on a continuous basis, before such problems become noticeable to an operator or result in service degradation. The best thing about the AI-machine learning process is that it learns from the data it is given and the more it is 'fed,' the processes are further empowered.

The Crossroads

The industry appears to be at somewhat of a crossroads currently.

Interference and the changes in the use of space that are upon us means that interference management is an absolutely necessity and the satellite industry must innovate rapidly to stay relevant.

They key to these aims is to collaborate on ways of maximizing the efficiency of satellite, and therefore increase demand for satellite services, all the while continuing to build solutions to help the industry prevent interference as more and more satellite constellations are launched.

satirg.org/

Martin Coleman is the Executive Director of the Satellite Interference Reduction Group (IRG). He is responsible for spearheading a number of significant initiatives and is committed to introducing new technology and processes to mitigate all types of satellite interference: VSAT TDMA Systems, BIG Data; a reference guide to Interference; sorting out those Difficult Cases including new standards and processes within the Geolocation industry; assisting the ITU in dealing with Harmful Interference; and implementing Carrier ID (CID). Martin regularly addresses the industry on the subject of satellite interference, at global industry events, on an individual basis, and at IRG-led conferences and webinars.



A GLOBALSTAR FOCUS: SPOT ON...

How SATCOM is keeping forest workers safe...

By Gavan Murphy, Director of Marketing, EMEA

As forestry organizations look to safeguard employees, including firefighters and other first responders, they are increasingly turning to satellite solutions.

Globalstar's **Gavan Murphy** looks at how satellite communications (SATCOM) is taking off in the forests of the UK, France and Sweden.

While cartoon woodcutters tend to get walloped by the tree they are felling, in reality, the risks for today's forest-based workers come from many different quarters. What is certain is that spending long hours carrying out many laborious tasks in remote locations can involve major accidents related to vehicles, heavy machinery, extreme weather and fire. In the forestry sector any rescue and recovery challenges are compounded by the fact that many times workers are on their own.

With mobile and radio communications patchy and unreliable in most isolated woodland areas, a number of European organizations involved in forestry — as well as firefighters who battle forest and wildfires — are turning to (SATCOM) to provide new levels of worker safety.

Adopters of satellite communications include the **UK Forestry Commission**, France's **Société Forestière** and **Orsa Besparingskog**, a private company in Sweden's Orsa region. These organizations have all deployed Globalstar's SPOT Gen3 messengers, providing a lifeline to remote workers.

In an emergency situation, workers can press the SOS button on the handheld SPOT device to alert emergency services that they need to be rescued. Many forestry sector users, such as **Société Forestière**, additionally use the rescue service provided by the **GEOS International Emergency Response Coordination Centre (IERCC)**, which contacts local first responders to ensure help is rapidly dispatched to the precise location where and when needed. More than 6,000 rescues worldwide have been initiated by SPOT devices, many of those rescues were life-saving.

The SPOT Gen3 relies on Globalstar's constellation of satellites to transmit its GPS location every 2.5, 5, 10, 30 or 60 minutes. This tracking feature can be used to locate forestry staff even if they are unable to press the emergency button. Operations staff can track user locations on a SPOT app for real-time updates.

The UK Forestry Commission decided to deploy the satellite-enabled SPOT device because of the unit's small size and ease-of-use, as well as providing a long battery life and affordability. The device has been used for several years in England and Scotland, with more than 700 SPOT Gen3 devices.

The Commission said, "In an emergency situation, particularly if a person is in danger of going into shock, having a device that is quick and easy to use is paramount. We wanted something small enough to fit in a pocket, yet able to provide a lifeline in critical situations. Many members of our team work in the most remote parts of the UK that are unreachable by radio and mobile phones. With the SPOT Gen3, they have a satellite-based device that brings peace of mind."



*Spanish firefighter pictured with his SPOT device.
Photo is courtesy of Globalstar.*

Across the Channel, French legislation obliges commercial and non-commercial organizations to provide the best possible security to safeguard lone and remote workers. France's **Société Forestière** saw the hugely positive results from the UK Forestry Commission's deployment and opted for SPOT as well.

Before finalizing their decision, **Société Forestière** conducted trials of GSM-based alternatives, including iPhone apps, but these were not up to the job due to inadequate reach in remote areas and poor battery life. Other solutions proposed by France's mobile network companies failed to function in locations where signal was weak.

"We knew we needed a solution that was independent of GSM mobile networks and other terrestrial alternatives," said **Alain Guillon**, Information Systems and IT Security Officer at **Société Forestière**. "After testing SPOT, we were confident to recommend the SPOT system to the Health and Safety Committee as the best way to protect workers, and to uphold our staff welfare obligations."

By the start of 2018, **Société Forestière** had deployed 100 SPOT Gen3 devices, supporting operations in six regions: Auxerre, Bordeaux, Bourges, Dijon, Le Mans and Reims.

Meanwhile in Sweden, **Orsa Besparingskog**, a company that manages a range of forestry, commercial and recreational activities in the vast woodlands of Orsa, opted to use SPOT Gen3 to improve safety for forest-based workers and hydro-electricity personnel.

Orsa Besparingskog is responsible for managing approximately 75,000 hectares that are owned by a consortium of local owner-partners. This includes overseeing 60,000 hectares of woodland, harvesting and selling timber as well as maintaining Orsa's extensive road network. Also, an important part of the business is **Tallheds Plantskola**, a large nursery where trees and plants are grown to ensure the long-term sustainability and welfare of Orsa's forests.



Forest photo is courtesy of Orsa Besparingskog.



The SPOT Gen3 helps forest workers in the UK, France and Sweden to stay safe. Photo of the unit in use is courtesy of Globalstar.

The company also owns eight small hydroelectric power plants located in neighboring Gävleborgs County, delivering approximately 28 GWh to the Swedish electricity grid.

Fredrik Eriksson, Senior Ranger with Orsa Besparingskog, said, "We were eager to provide a means of communication and safety for our staff who spend long periods of time in remote areas with no reliable GSM signal."

Orsa Besparingskog considered using alternative solutions and technologies, but SPOT Gen3 was selected for the product's superior, reliable reach. Additionally, SPOT's help button and SMS message capability were deemed as unique and compelling, and were persuasive factors in the procurement decision.

"The help function is especially useful in cases where there has been a vehicle breakdown or puncture in the forest," added Eriksson. "Now, with our SPOT devices, our teams feel safer and connected."

Help During Forest Fires

Firefighters in Spain have gone a step further and are using satellite communications to help them manage wildfire and forest fires, as well as to safeguard crews.

Castilla La Mancha is a vast region in central Spain. With the area's dry and often hot climate, forest blazes and wildfires are a fact of life for the people and businesses in the region. **Junta de Castilla La Mancha**, the administrative authority whose responsibilities include forest and wildfire management, employs some 2,000 response personnel who are always on standby to help keep forests and wildfires at bay.

Junta officials started talking to wildfire solutions specialist **Technosylva**, a provider of fire behavior analysis and management software, to learn about what options were available.



Joaquin Ramirez Cisneros, Principal Consultant at Technosylva, explained why Globalstar's SPOT Gen3 was selected to meet the Junta's requirements as an integral part of his company's Wildfire Management System, **fiResponse**.

"To keep firefighters safe, it is critical to know where exactly they are at all times," Cisneros explained.

"The positions of the crew members need to be known in relation to the engine and equipment resources being used, and it is particularly important to know how far away they are from the heart of the fire. Providing these professional teams with the communications and support they need in the extremely dangerous situation of wildfire is an absolute must."

Additionally, with SPOT satellite tracking devices attached to pumps, helicopters and aerial fire apparatus, operations coordinators can know precisely where their resources are, where they need to be and how much time will be required for them to arrive on location.

Juan Bautista Garcia, Wild Fire Coordinator at **GEACAM** (Public Agency of Castilla La Mancha)

commented on why this satellite solution was deployed. "Tracking our teams with the reliability that SPOT provides fundamentally changes the way we can face operations. Not only is safety dramatically improved, providing situational awareness in real time to all of the organisation, it also helps to improve our response and tactics, enabling us to provide a better service."

All these organizations are taking advantage of the latest developments in satellite technology to ensure staff can be found and rescued in an emergency. However, these flexible solutions are also helping them to more effectively manage resources to better support their operations.

www.findmespot.eu/SPOTLoneWorker

Based in Globalstar's European HQ in Dublin, **Gavan Murphy** is responsible for the development and implementation of Globalstar's marketing strategy across the European, Middle Eastern and African regions. He spearheads the marketing of Globalstar's consumer products, including the SPOT tracking solutions portfolio, as well as the B2B marketing of voice and data solutions for a range of vertical sectors including maritime, energy, safety and security, commercial fishing and shipping, construction and heavy industry as well as the burgeoning M2M sector. Prior to joining Globalstar in 2008, Gavan worked with leading global mobile provider Vodafone as Channel Development and Category Manager.



UPLINK: INNOVATION — SMARTER SHOWS

The future of propellants and propulsion systems

By Nicole Heins, Conference Producer

Propulsion systems were a main topic of discussion at Space Tech Expo USA 2018 — not only on the Launch Systems day, but also on the Satellite Systems and Future Programs day.

On the Satellite Systems day, one of the Innovators panels, led by moderator **Dave Barnhart**, focused on advanced propulsion systems for satellites, with speakers from **Enpulsion**, **Additive Rocket Corporation** and **Neumann Space**.

During the session, delegates were able to send in their questions via the **SLi.do** app and three of the questions so submitted have been summarized below, as the panelists definitely had some interesting answers



What is the future of propellants?

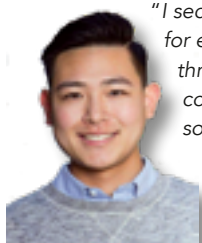
Dr. Alexander Reissner, CEO at Enpulsion



"At the end of the day there won't be a one-size-fits-all type of propulsion, even though we [at Enpulsion] are advertising modular building blocks and putting them together to create a custom solution. This still has its limits. It's absolutely true that you wouldn't want to use this technology to go to an asteroid and then bring it [its resources] back. You want to use a propellant that is available there. If you need to use a high thrust for a quick maneuver somewhere, electric propulsion will not be your choice. You would need to have some sort of chemical propulsion and a super-cool engine. I don't think that there will be a one-size-fits-all solution or technology. Within electric propulsion we can see a market leader, but electric propulsion will not replace all chemical propulsion systems. It totally depends on the application."



Andy Kieatiwong, CEO at Additive Rocket Corporation



"I second that. Chemical propulsion is used for, for example, higher Delta V applications moving through the soup of the atmosphere or for collision avoidance in space. It's going to have some sort of tradeoff given each different fuel type. Like Alex said, it's going to be based on emission and this will be very specific for each type of application. Chemical propulsion is going to get better over time as our hardware evolves. Think of things such as start-stop capabilities, deep thrust capabilities. In the end you are going to have to choose some sort of hybrid system or propellant mix depending on where you want to go and how you want to get there."



Patrick 'Paddy' Neumann, Director and Chief Scientist at Neumann Space



"I concur and I am going to give a concrete example as to why. In the last presentation before lunch, Jim Armor from Space Logistics talked about their ideas of their on orbit servicing vehicle, which uses Hall effect thrusters for its long-haul missions as it has to be able to go out from its transfer orbit to geosynchronous orbit, as well as transfer around in geosynchronous orbit."



Neumann continued, "However, for the short outburst of thrust it needs to do, its actual rendezvous, it uses monopropellant hydrazine. These different technologies have their place. Everything has its niche. What you choose for one application will not be the best for all applications."

Given that mega-constellation developers are making decisions on satellite propulsion, are you too late to have an impact on the market?

Reissner

"From my point of view I would say no! But also for everyone in the audience I would say no. Why? Because a mega constellation, let's take OneWeb's as an example, is a market in itself. What does that mean? It means that yes, these mega-constellation operators are choosing their technology to demonstrate one thruster on their demo missions. But if you are a constellation operator you don't want to have a single-source supplier for 600 satellites. What people are doing — and that's personal experience because we are in these programs and engaging very much with our customers — is they want to have three propulsion suppliers for one constellation, which are interchangeable and use the same interfaces and requirements."

"Even looking at one constellation of 800 satellites, for me, the most likely scenario is that there will be two or three propulsion systems suppliers for that constellation and then the next constellation and the next constellation. From a propulsion perspective, I would not look at mega constellations as a one-off, 100 percent or nothing project. As a propulsion company, I am expecting not to supply 100 percent of a constellation, but 50 or 70 percent of that constellation."

"There is some granularity there. That means that at the end of the day, if you have a product and show that your performance is better than the existing product and it can fulfill the same requirements with a lower price, then there will be a point in time where a prime operator is willing to switch the technology. However, replacing an existing technology on a satellite with another one is an effort. It's a big effort for a satellite manufacturer, so you really need to have a value proposition to justify the effort. Not just the same performance and 10% cheaper, that doesn't work anymore. If you introduce really a game-changing value proposition, then there is room for everyone, I think."

Kieatiwong

"I agree with Alex's points. Our mission is to be able to democratize propulsion for these small satellites, so any player from university level to a small company level and above, if they want to be able to put some sort of propulsion capability on their satellite we want to be able to offer that to them. So being able to bring down the cost of all these in-space propulsion systems to something that is feasible, even to the budgets of a small team, that's very much worth it for us and that's part of our mission at ARC."

Do you see, from your vantage point as a provider, that this a burgeoning industry where there are going to be hundreds of propellant suppliers, or is it really going to be vertically integrated? Are you guys going to be bought up and sucked in?

Neumann

"This is an interesting question because it is about the future and no one can look in a crystal ball and look five to ten years down the track. What I have been seeing around through publicly available documentation and news articles is that there are rather a lot of new propulsion companies coming along with bright new ideas looking at new systems, bringing those to market and doing a lot of demonstrations. This especially happens in the cubesat and smallsat side of the market. How many of those will survive, how many of those will be viable businesses or how many of those will remain independent propulsion subcontractors?"



Smartershows™

Neumann continued, "There have been several companies who specialized in various subsystems that were absorbed into prime integrator families over the years. What would that look like in five to ten years from now, after everyone has had the chance to test and succeed, test and fail, or just have their business run out of runway?"

Reissner

"I totally second what Paddy said. There are a lot of new startups with new ideas about propulsion, which is great. There was a lot of venture capitalist funding going into these companies in the last four, five years. What we do see now is that this funding is kind of drying out because people want to see results, revenues, demonstrations. If you look around, this is true for the smallsat industry but in the propulsion industry it's more so the case. If the founders don't have a lot of background, which still happens, then it becomes harder and harder to raise money for propulsion companies.

"What we are already starting to see in the propulsion sector is higher and higher volatility in mergers and acquisitions, smaller companies buying each other, merging and things like that. Of course, I don't have a crystal ball either. I think that there are going to be two scenarios: one where you have a horizontal integration where a sufficient number of propulsion companies merge to become a strong enough supplier for different applications to survive as an independent supplier. On the other hand, you see vertical integration with companies vanishing into, for example, Airbus, Boeing or whoever.

"A personal note is that I think that when you look at other industries, having an independent supplier of different propulsion technologies for different primes could be an advantage. They would have a breadth of choice that suits their different applications. If I am integrated in SSL, and PhaseFour is integrated in Boeing, then you will have a barrier all the time.

Author Nicole Heins is the Conference Producer for Space Tech Expo and is based in Brighton in the United Kingdom.



For additional information regarding Smarter Shows, please visit their infosite at www.smartershows.com.

Now in its eighth year, **Space Tech Expo** will be returning to Pasadena, California, for 2019. America's meeting place for space technology and engineering grows bigger and better year on year, bringing together industry leaders, decision-makers and buyers to meet the engineering and manufacturing supply chain for commercial, civil and military space.

Space Tech Expo 2019 will be located at the Pasadena Convention Center in Pasadena, California, from May 21-22 2019, with 250+ exhibiting companies and 4,000 expected attendees joining the show.

www.spacetecheexpo.com