

*Worldwide Satellite Magazine – September 2016*

# *SatMagazine*

*European Markets / SatBroadcasting™ / Geospatial Applications*

*Photo of Norheimsund, Norway, is courtesy of Morten N. Almeland, © Bridge Technologies 2016. Please see the corresponding article on Page 46.*









# SatMagazine

September 2016

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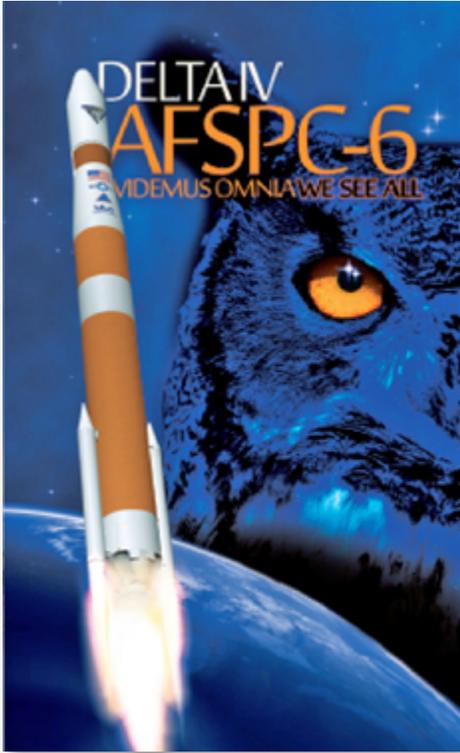


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## ULA's Delta IV Tears Through The Midnight Sky To Launch AFSPC-6

**On Friday, August 19, a ULA Delta IV was launched carrying the AFSPC-6 mission for the United States Air Force to orbit.**



The rocket took off from Space Launch Complex-37 at Cape Canaveral Air Force Station in Florida slightly after the opening of a 65-minute window, with T-0 at 00:52 local time (04:52 UTC) aboard a United Launch Alliance (ULA) Delta IV Medium+ (4,2).

Two Geosynchronous Space Situational Awareness Program (GSSAP) satellites were delivered to near-geosynchronous orbit. The twin GSSAP spacecraft will be a space-based capability operation within near-geosynchronous orbit to support US Strategic Command space surveillance operations.

As a dedicated Space Surveillance Network (SSN) sensor, GSSAP satellites will support Joint Functional Component Command for Space (JFCC SPACE) tasked to collect space situational awareness data allowing for more accurate tracking and characterization of man-made orbiting objects.

The second of the two pair of satellites are designed to patrol an orbit roughly 22,000 miles above the equator, on the lookout for potential threats to US spacecraft flying in that region.

The satellites will have a clear, unobstructed and distinct vantage point for viewing Resident Space Objects (RSOs) without the interruption of weather or the atmospheric distortion that can limit ground-based systems.

GSSAP satellites will have the capability to perform Rendezvous and Proximity Operations (RPO). RPO allows for the space vehicle to maneuver near a resident space object of interest, enabling characterization for anomaly resolution and enhanced awareness, while maintaining flight safety.

Data from GSSAP will uniquely contribute to timely and accurate orbital predictions, enhancing our knowledge of the geosynchronous orbit environment, and further enabling space flight safety to include satellite collision avoidance.

GSSAP satellites will communicate information through the worldwide Air Force Satellite Control Network (AFSCN) ground stations, then to Schriever Air Force Base, Colorado, where 50th Space Wing satellite operators of the 1st Space Operations Squadron (1 SOPS) will oversee day-to-day operations.

Orbital ATK designed, manufactured, integrated and tested the GSSAP satellites at their state-of-the-art manufacturing facility in Dulles, Virginia.

The company's facilities in Dulles, along with Goleta and San Diego, California, and Beltsville, Maryland, provided numerous subsystems, including the satellite's solar arrays, heat pipes, avionic boxes, flight computer, shunt regulator assembly, composite components and deployable structures.

The first two GSSAP satellites, both built by Orbital ATK, were launched July 28, 2014, on AFSPC-4, which included the Air Force Research Laboratory's Automated Navigation and Guidance Experiment for Local Space (ANGELS) satellite, deployed from the AFSPC-4, EELV Secondary Payload Adapter (ESPA).

Orbital ATK was the project's prime contractor responsible for overall system design and development.

This was the 110th mission for ULA since the company's founding in 2006 and will be the seventh launch of 2016. On July 28, 2014, two GSSAP satellites were also launched by the company, also by a Delta IV Medium+ (4,2).

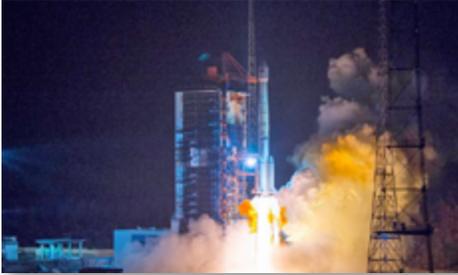
[www.ulalaunch.com](http://www.ulalaunch.com)





## Belintersat Project Breaks Through

With the first telecommunication satellite, **BELINTERSAT-1**, having launched and passing rigorous In Orbit Testing (IOT), the Belintersat Project is now ready.



The Belintersat 1 satellite launch via a Long March 3B launch vehicle. Photo is courtesy of Xinhua.

Having occupied the 51.5 East slot, this Belarusian satellite is becoming well known for ease of access and the extensive coverage available. All types of data transmissions and users' network requirements are also fully supported. Services available include...

- » VoIP
- » Video
- » Data
- » VPN
- » Broadcasting
- » And more...

Solutions provided by BELINTERSAT-1 include the ability to create WAN networks (Wide Area Networks), no matter the existing terrestrial infrastructure and localization in play. The company

provides round-the-clock management of the SATCOM system and can react immediately if an emergency arises.

### Africa Ku-band

Number of Transponders  
12x36 MHz

Uplink frequencies  
14000 - 14500 MHz

Downlink frequencies  
10950 - 11200 MHz

Uplink polarization  
Vertical & Horizontal

Downlink polarization  
Vertical & Horizontal

4x36 MHz cross-strapped (uplink in European beam, downlink in French speaking African Ku-band beam)

### East C-band

Number of Transponders  
12x36 MHz \*

Uplink frequencies  
5850 - 6450 MHz

Downlink frequencies  
3600 - 4200 MHz

Uplink polarization  
Circular polarization (left and right)

Downlink polarization  
Circular polarization (left and right)

\* Switch option for transponders between beams

### Europe Ku-band

Number of Transponders  
4x54 MHz, 2x36 MHz

Uplink frequencies  
12750 - 13125 MHz

Downlink frequencies  
10825 - 10950; 11200 - 11450 MHz

Uplink polarization  
Vertical & Horizontal

Downlink polarization  
Vertical & Horizontal



### African C-band

Number of Transponders  
16x36 MHz \*

Uplink frequencies  
5850 - 6450 MHz

Downlink frequencies  
3600 - 4200 MHz

Uplink polarization  
Circular polarization (left and right)

Downlink polarization  
Circular polarization (left and right)

\* Switch option for transponders between beams

### Outbound carrier

Carrier Data Rate

Up to 135 Mbps

VSAT Data Throughput

Up to 30 Mbps

Modulation

QPSK, 8PSK, 16APSK, 32ASPK

Coding

LDPC and BCH (DVB-S2)

FCC Rate (DVB-S2)

1/4, 1/3, 2/5, 1/2, 3/5, 2/3, 3/4, 4/5,  
5/6, 8/9, 9.10

### Inbound Carrier

VSAT Data Throughput

Up to 10 Mbps

Modulation

BPSK, QPSK, 8PSK

Coding

Turbo coding FEC 1/2, 2/3, 3/4,  
4/5, 6/7

Security

The Belintersat Project supplies integrated SATCOM solutions for companies and organizations that have departments and branches across the globe.

The latest technologies, such as those offered by iDirect and Gilat, are deployed and service is guaranteed 24x7x365.

Full system monitoring is guaranteed for all services.

[en.belintersat.by/](http://en.belintersat.by/)





## Major Maritime Moves By Satcom Global & Intellian

**An 'always on' high bandwidth VSAT service to maritime customers is a goal many firms involved in the global supply and distribution of maritime SATCOM equipment continually try to attain.**

To accomplish such a goal, Satcom Global has signed a strategic partnership agreement with Intellian, which will give the firm access to Intellian's full range of Ku-, Ka-band and FleetBroadband hardware and will support the delivery of their VSAT portfolio of VSAT and L-Band services to maritime customers across the globe.

Satcom Global will have access to Intellian's full range of maritime satellite antennas suitable for operation on SATCOM services including VSAT, Inmarsat Global Xpress, FleetBroadband and Television Receive Only antenna systems.

The company will also benefit from Intellian's three strategic service and logistics hubs located in South Korea for the Asia Pacific region; Rotterdam

for customers in Europe; and Irvine to provide logistics and service support in the Americas.

Dedicated stocks will be held in these three Intellian facilities, guaranteeing Satcom Global clients quick access to hardware as necessary and enabling the company to provide a fast and seamless global distribution service to meet deadlines and

installation requirements.

The Intellian v100 and v100GX antennas will enable Satcom Global to deliver an 'always on' high bandwidth VSAT service to customers.

Enabling a range of bandwidth hungry services, vessels will be able to operate as a true 'office at sea' while also keeping crews happy with sustained access to life online and onshore.



Guaranteed data speeds also allow the use of applications such as video conferencing, e-learning and training as well telemedicine.

According to Ian Robinson, the CEO at Satcom Global, Intellian is exactly the kind of committed partner his company wished to team with to help them penetrate deeper into the maritime market with a world class managed connectivity solution.

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

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







## Advantech Modem To NATO Nation

Supporting SATCOM-On-The-Move (SOTM) mobility applications, Advantech Wireless has just earned a multi-million dollar order from a NATO member country for a specialized modem.



This advanced satellite modem is the AMT-83L and has added a number of advanced features to the unit's predecessor, the AMT-73L modem, which also happened to be the first worldwide satellite modem to be certified with MIL-STD-188-165A by DISA.

The AMT-83L possesses a much higher data rate, offers full-fledged IP traffic with a built-in router and also brings GSE encapsulation into play.

According to Cristi Damian, the Vice President of Business Development at Advantech Wireless, these modems have been designed to fulfill advanced, two-way, satellite gateway communication requirements in Defense Satellite Communications Systems and include Direct Sequence Spread Spectrum (DSSS) capability.

The AMT83L is based on the success of the AMT-73L line of DISA certified modems, with thousands of units deployed and field tested throughout the world.

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

## Moosburg Teleport Certified

Full certification from the World Teleport Association (WTA) is an event worthy of celebration—and, hopefully, Horizon Teleports GmbH will be doing just that as their Moosburg Teleport has achieved Tier 3 Certification under the organization's "Teleport Certification Program."

WTA's Teleport Certification Program aims to serve teleport operators and their customers by creating an objective, transparent, and internationally accepted method for teleport operators to document the quality of their operations for customers and strategic partners. It also aims to provide a means for customers to select teleport vendors delivering the price-performance level that is appropriate for their applications. Select this direct link for a list of certified teleports.

To achieve Full Certification under WTA's program, a teleport operator completes a +170-item questionnaire and submits it to WTA. The Association analyzes the data based on standards established by its Certification Committee and issues a Provisional Certification based on the self-reported information. An auditor is then dispatched to visit the teleport, provide independent validation of the data submitted in the questionnaire, and identify additional factors that may positively or negatively affect the score. Full Certification is issued at a Tier number from 1 through 4, of which 4 represents the highest degree of excellence, and remains in effect for 3 years.

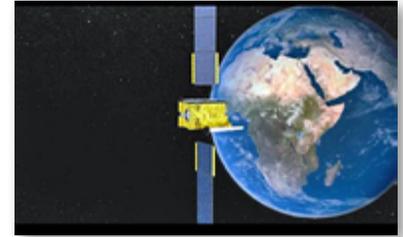
"We congratulate Horizon Teleport on achieving a Tier 3 Certification in WTA's Teleport Certification program," said WTA Executive Director Robert Bell, adding that this award is the conclusion of a grueling process of examination and evaluation and a mark of true distinction in our industry.

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

[www.worldteleport.org/?page=Certification](http://www.worldteleport.org/?page=Certification)

## SpeedCast's Government Work

Offering satellite communications to national governments requires military-grade SATCOM / MILSATCOM services that are totally reliable, viable and verifiable.



*Artistic rendition of the Skynet-5A satellite.*

SpeedCast has just signed a partnership agreement with Airbus Defence and Space to offer military-grade satellite communication services to the Australia and New Zealand governments. The company will be offering tactical secure communications services to government customers, delivering secure X-band network services that combine the affordability, operational utility and scalability required to meet the stringent requirements of government, military and humanitarian operations.

Airbus Defence and Space has also appointed SpeedCast to manage a new anchor station facility for the Skynet 5A military satellite, which is based at SpeedCast's existing teleport in Adelaide, Australia, inaugurated on May 18, 2016.

Pierre-Jean Beylier, the CEO of SpeedCast, informed all that his firm has more than 25 years of experience in serving the Australian government and providing military satellite communications services and that the firm is confident their deep rooted connection in the market and understanding of the needs can enable Skynet-based services to expand in the region.

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



# InfoBeam

## SES Takes Max Capacity Gold At Olympics

**This year's Olympics may not have been the most popular and was certainly beset with various "challenges" and malfunctions, yet SES' broadcast of Rio's Olympics came through with flying colors, providing viewers with more coverage than any previous Games.**

SES S.A. revealed a record uptake of the firm's satellite capacity for the Olympics as compared to previous Games with a total of 23,000 hours of capacity booked on four SES satellites.

The satellites NSS-806, SES-4, NSS-7 and SES-3, enabled transmission of the Games to broadcasters in The Americas, Europe, Asia and Africa.

SES served a total of 10 leading broadcasters based in the US, the UK, Switzerland, Italy, Brazil and Japan, which included Eurovision, CNN / Turner and Nippon Television Network.

Richard Lamb, General Manager of Occasional Use Services at SES, commented, "SES has provided capacity for the Olympics since 2000, and we are pleased that the capacity demand for Rio Olympics far exceeds the previous editions. For the first time ever, we are using more capacity on more satellites to broadcast more hours of sporting events and news coverage of the Games to a truly global audience.

*"This record demand illustrates how broadcasters continue to view satellite as an ideal and cost-effective way to broadcast excellent image quality of sporting events live to millions of viewers around the world."*



Also of note: SES S.A. also revealed that German pay-TV broadcaster Sky Deutschland will be launching two exclusive Ultra HD channels via SES's prime orbital position of 19.2 degrees East in the autumn.

Sky Deutschland will show one game per each Bundesliga match day on Sky Sport Bundesliga UHD and selected games from the UEFA Champions League on Sky Sport UHD – all in video resolution that is four times higher than HD.

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



## An Epic Launch Upcoming Up For Arianespace



Artistic renditions of:  
Top: Intelsat 33e  
Bottom: Intelsat 36

**Ready, set, go... well, almost—the Arianespace Ariane 5 launch vehicle has been integrated with the payloads of the upcoming VA232 launch of the Intelsat 33e and Intelsat 36 satellites that is scheduled for Wednesday, August 24th from French Guiana.**

Designated Flight VA232, the mission will be Arianespace's sixth launch in 2016, and the fourth using a heavy-lift Ariane 5 this year.

The two payloads will be the 57th and 58th satellites launched by Arianespace for Intelsat which continues a relationship that began in 1983 as the US-based operator developed a network to deliver high-quality, cost-effective video and broadband services worldwide.

During preparation activity for Flight VA232 in the Spaceport's Final Assembly Building, Intelsat 36 was installed atop the Ariane 5's core stages on Friday, positioning the 3,250-kg.-class spacecraft as the mission's lower passenger.

This was followed by the lowering of the launcher's "composite" that consisted of Intelsat 33e along with the Ariane 5's SYLDA dual-payload deployment system

and the protective payload fairing into position over Intelsat 36.

Deployed first during the mission to geostationary transfer orbit, Intelsat 33e, which has an estimated liftoff mass of 6,600 kg, is the second satellite in Intelsat's nexgen HTS Intelsat Epic NG series and joins Intelsat 29e, which was launched by Arianespace aboard another Ariane 5 last January.

Built by Boeing using a 702MP spacecraft platform and operating from an orbital slot of 60 degrees East, Intelsat 33e's Ku- and C-band coverage will meet broadband demand for carrier-grade telecom services, enterprise networks, aeronautical connectivity and certain media services.

The satellite's Ku-band spot beams are to provide broadband services for Europe, Africa, the Middle East and Asia, while a Ku-band wide beam provides broadcast coverage of Europe, the Middle East and Asia.

The satellite's C-band spot beams will cover high traffic telecommunications centers in Europe, Central Africa, the Middle East, Asia and Australia; while a C-band wide beam is to deliver coverage over sub-Saharan Africa for data and media services.

The Intelsat 36 satellite, built for Intelsat S.A., is designed to provide media and content distribution services in Africa and South Asia.

Set to complete Arianespace's Flight VA232 at 41 minutes after liftoff will be the separation of Intelsat 36, which is designed to enhance Intelsat's media neighborhoods serving the South African and Indian Ocean region.

Manufactured by SSL (Space Systems Loral) on their 1300 platform, its Ku-band payload was built to support the MultiChoice direct-to-home (DTH) service in South Africa.

Intelsat 36's C-band relay capacity provides in-orbit resilience for the company's video content distribution neighborhood at the orbital slot of 68.5 degrees East where the satellite will be co-located with Intelsat 20, which was launched by Arianespace in August 2012.

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

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

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



## Four From ISRO To Head To Moon & The Sun



**The Indian Space Research Organization has ambitious goals as they plan to launch four key satellites as well as trips to the moon and the sun.**

The Indian Space Research Organization (ISRO) has planned to launch four more key satellites in the next three months this year, according to Mylswamy Annadurai, director, ISRO satellite center.

Speaking to the media on the sidelines of a private college function, Mr. Annadurai said that India had launched 10 satellites between August 2015 and August 2016, adding, four more launches—INSAT-3DR and SCATSAT-1—are scheduled for departure in September this year, with GSAT-18 in October and ResourceSat-2A in November 2016.



These have all been planned by the space body that is currently working on a tight schedule of 70 satellite launches over the next three years, Deccan Chronicle reported.

Further stating that India has decided to go solo in the Chandrayan-II project, without taking help from Russian space agency as has been agreed earlier,

Annadurai said that the country's lunar exploration program, Chandrayan II, the lander and rover, was expected to be launched by the end of 2017 or in the first quarter of 2018.

As per the Deccan Chronicle, the mission objective of Chandrayan-II is to soft-land at a suitable site on moon's surface and carry out chemical analysis.

According to Annadurai, ISRO also has a plan to launch 'Aditya-L1', the first Indian mission to study the sun by the year 2020, said Deccan Chronicle reports.

[www.isro.gov.in/](http://www.isro.gov.in/)

# InfoBeam

## Innovative Tracking Going On



**Marlink and IDG Europe are two companies who are now collaborating and they have opted to conduct trials of the Smalltrack portable tracking system.**

The companies have completed trials of the new Smalltrack portable tracking system on a fixed wing aircraft operated by Scandinavian Air Ambulance and a helicopter operated by Scandinavian MediCopter in Sweden.

Marlink's nexgen location-based Iridium tracking device features a new, compact and lightweight design, Smalltrack is a mobile device with user-friendly operation and installation.

Operating on the Iridium satellite network, the system can be used in any location without providing accurate tracking to support flight safety and logistics, in addition to manual and automatic emergency alerting.

The fixed wing aircraft Smalltrack testing took place on a Beech Super King Air 200 over a period of five days. Smalltrack was placed on the glare shield of the aircraft and position reports closely monitored.

The successful trial proves that placement on the glare shield does not affect the ability to transmit or receive data. During the trial, tracking data was made available through the Smalltrack online interface.

The helicopter testing was aboard an AS 365 Dauphin N2, with daily flights for three weeks. Throughout the testing all data reports were transmitted.

As with the fixed wing testing, Smalltrack was set to start-up using the built in accelerometer so it does not have to be included in the pre-flight check list, which saves the pilot time before taking off.

[marlink.com/overview/smalltrack/](http://marlink.com/overview/smalltrack/)

## GomSpace & Swedish Space Going Small

**This is a start and, if all goes well, GS Sweden AB), parent company of GomSpace ApS, and the Swedish company "Svenska rymdaktiebolaget" (the Swedish Space Corporation) will potentially acquire 100 percent of the shares in the Swedish company NanoSpace AB.**

The Letter Of Intent (LOI) contains broad terms of a potential transaction with the right for GomSpace to conduct a due diligence investigation—the acquisition is conditional upon both parties entering into a definite agreement containing specific signing and closing terms and conditions yet to be negotiated.

MEMS-based micropropulsion system NanoSpace's miniaturized propulsion system provides extremely small and precise thrust for a variety of satellite missions. Formation flying and precise attitude control are examples where thrust levels in the micro- to milli-Newton range are required.

Should the acquisition be completed, the parties have agreed that the purchase price is to be paid with 600,000 newly issued shares in GS Sweden AB and with a cash payment of 3,000,000 SEK (US\$356,265).

NanoSpace is a company that develops and provides propulsion technology and products for nano satellites, and participates in space technology projects funded by the European Space Agency ("ESA") and Swedish national funding programs. NanoSpace's propulsion technology and products are based on the company's leading expertise in applying MEMS (Micro Electro Mechanical Systems) technology to space propulsion—providing unique advantages in miniaturization and precise thrust control.

GomSpace's wish to acquire NanoSpace AB is to build up more Swedish activities and to have satellite propulsion products in their portfolio alongside the activities already in Gomspace

ApS. Future operational nanosatellite missions will depend on constellations of satellites and therefore require the ability to fly these satellite in an accurate formation—as can be achieved using ability provided by the propulsion technology and products developed by NanoSpace.

GomSpace and NanoSpace already collaborate closely in multiple customer projects on integrating NanoSpace propulsion technology into GomSpace satellite platforms. Should the acquisition be completed, Swedish Space Corporation has accepted to make an executive director available for the board of directors in GomSpace.

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

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

# InfoBeam

## New Guidance For Russia's Aist-2D Satellite



**Last April, Russia launched their Aist-2D satellite from the Vostochny space center.**

The satellite is a remote sensing spacecraft that was designed by the nation's Progress research center and Samara State Aerospace University to engage in spatial investigations.

Sputnik News has reported that Russian scientists have started a number of adjustments to the guidance, navigation and control (GNC) system on the Aist-2D satellite.

The on-board motion control system installed on the Aist-2D satellite is supplemented by an innovative GNC system that's based on micro-acceleration compensation hardware designed by the Institute of Electronics and Instrument Engineering at Samara.

The new GNC system aims to control vehicle orientation and to compensate on-board rotating micro-accelerations in the low frequency spectrum—the system allows for the determination of the precise location of the satellite, based on the GPS data and the satellite's orientation to the Sun as well as the geomagnetic field.

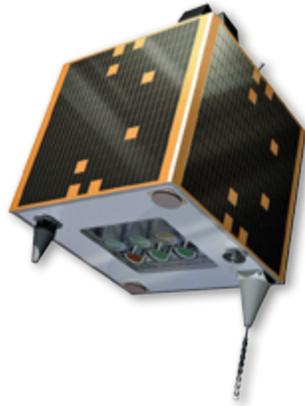
## Celebrating Seven Years Of Disaster Monitoring

### **UK-DMC 2 is one of two enhanced DMC (Disaster Monitoring Constellation) Earth observation satellites, UK DMC-2 and Deimos 1.**

These satellites are capable of imaging several thousand km along the target track and delivering double the data density of the first generation DMC satellites, increasing the ground sample distance from 32 meters to 22 meters, while maintaining the very wide swath of 660 km.

Seven years ago, another satellite was launched and added to the Disaster Monitoring Constellation (DMC) otherwise called the Earth observation satellite, UK-DMC2.

The DMC delivers valuable geospatial information for agriculture, forestry, land cover mapping, disaster monitoring and environmental sciences, coordinated and specialized in rapidly programmed campaigns.



*Artistic rendition: UK DMC-2 satellite.*

The ground sample distance was increased from 32 meters to a 22 meter resolution multispectral satellite imagery, and the option for very wide area monitoring, adjustable up to 620km swath.

In addition, because of the daily revisit capacity coupled with rapid data delivery, the DMC is able to deliver up-to-date imagery and rapid whole country

coverage. This is a helpful tool for all applications requiring timely image collection.

As an example, in North Africa, prone to yearly plagues of locust, UK-DMC2 data is used by the Algerian Space Agency to assess vegetation conditions. When combined with weather data, locust forecasts can be created and used to focus the application of pesticides, which in turn can help prevent the spread of locust swarms.

Land cover mapping also takes benefit from DMC imagery. Because of their rapid revisit and wide swath imaging capabilities, annual and seasonal maps are easily available, providing a dataset for change detection analysis. Such land cover evolution maps are critical for applications including climate change, ecology and conservation, urban and landscape planning, along with health and hazard assessments.

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

## MicroWave Imager Comes Complete With Super Powers

**CGS SpA Compagnia Generale per lo Spazio, a subsidiary of OHB SE, and Airbus Defence and Space GmbH, are planning on delivering better weather forecasts as they have just contracted for new equipment.**

The contract includes the MicroWave Imager preliminary design activity, the selection of all subcontractors necessary to install the device on MetOp Second Generation (SG) weather satellites and the price conversion to firm fixed for the realization phase—the value of the contract is 166 million euros.

The MicroWave Imager is a sophisticated instrument that will be installed on board the Satellite B series.

The instrument will provide Europe's National Meteorological Services and by extension, the international users and Science Community, with improved and invaluable data for meteorological and climate monitoring.

CGS is responsible for the design and the development of the MWI instrument, from Phase B2 to the final in-orbit verification of three flight models, to be supplied to Airbus DS GmbH, the prime contractor of the MetOp-SG Satellite B.

Roberto Aceti, Managing Director of CGS said, *"With the responsibility for this important instrument of these satellites, CGS confirms its role as expert for sophisticated space-systems, we are delighted to contribute to the success of the MetOp-Second Generation project.*

*"The scientific information that will be provided by the MicroWave Imager with extremely high radiometric accuracy will lead to an outstanding improvement of weather forecasts and a better understanding of climate changes."*

The MetOp-SG satellites will constitute the space segment of the EUMETSAT Polar System Second Generation (EPS-SG) program that consists of two series of satellites, "Satellite A" and "Satellite B" fleet, with a nominal baseline of three units each. MetOp-SG satellites are developed as a cooperative undertaking between the European Space

Agency (ESA) and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT).

[www.cgspace.it](http://www.cgspace.it)

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

## Kudos To Kubos & Innovative Solutions In Space

**ISIS—Innovative Solutions In Space B.V.— is located in Delft, The Netherlands, and Kubos Corporation, located in Denton, Texas, are joining forces to provide Linux to satellite developers.**

These companies have signed a Memorandum of Understanding (MoU) related to the port of KubOS Linux to the iOBC, ISIS' on-board computer.

ISIS has helped democratize space over the firm's ten years of existence with both their launch services and their CubeSat Shop.

ISIS is now taking their approach to the next level by supporting the development of open source software on their platform.

To assist users in using KubOS Linux for their mission, Kubos has built an open source community, called OpenKosmos.org, where users will find source code, documentation, and a public Slack channel to communicate with other developers.



Kubos also provides a downloadable SDK and a suite of tools. Kubos offers Service Level Agreements to provide support and solutions for missions running KubOS RT and KubOS Linux.

The iOBC with the newly developed operating system will be available by the end of the year from both companies' websites as well as on CubeSatShop.com.

Jeroen Rotteveel, the CEO of ISIS, believes that Kubos will enable new creative projects from people within the open source community but who have a limited experience of space systems—this move will help to lower the barrier to entry to the smallsat market even further.

[www.kubos.co](http://www.kubos.co)

[www.isispace.nl](http://www.isispace.nl)

# InfoBeam

## KOMPSAT-6 To Enjoy An Angara Flight



*Artistic rendition of KARI's KOMPSAT-6 satellite.*

**Now confirmed by the Korea Aerospace Research Institute (KARI) is that the launch of the KOMPSAT-6 (AKA: Arirang 6) satellite will be handled by a Russian Angara 1.2 carrier rocket sometime in 2020.**

The launch will be conducted from the Plesetsk Cosmodrome that's located in northwestern Russia.



*Russia's Angara launch vehicle. Photo is courtesy of Roscosmos.*

The main focus of the satellite's mission will be disaster detection, although the satellite is also defined as a multipurpose spacecraft, this according to a report from Korea's Yonhap news agency.

Seoul's aerospace research institute confirmed that the Russian Angara-1.2 carrier rocket will put the South Korean KOMPSAT-6 satellite, also known as the Arirang 6, into orbit in 2020.

The Angara family of space-launch vehicles is designed to provide lifting capabilities of between two and 40.5 metric tons into LEO and has been in development since 1995.

Angara was the first orbit-capable rocket developed by Russia to replace the older Proton-M rockets.

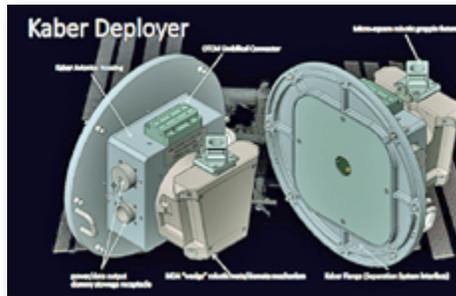
[www.kari.re.kr/](http://www.kari.re.kr/)

## New Contract Finds SST-US Engaged In NanoRacks'ing

Seeking to expand the satellite launching capabilities of the International Space Station, Colorado-based Surrey Satellite Technology US LLC (SST-US) has signed a contract with NanoRacks LLC for future flights of a 100-kilogram-class satellite platform specifically developed by SST-US for deployment from the International Space Station (ISS) using the NanoRacks Kaber deployment system.

The satellite platform can weigh as much as 100 kilograms, accommodating payloads of up to 45 kilograms in mass in multiple configurations. Each spacecraft will be able to provide an average power of 50 watts and can also be upgraded for missions with higher mission requirements.

The ISS- optimized spacecraft will be shipped to the ISS inside a cargo resupply vessel and deployed from the station using a system called the "Kaber" that was developed by NanoRacks.



The Kaber deployer is on orbit and currently being prepped for operations on the ISS in the Japanese Experiment Module (JEM). The satellite platform is designed to go from contract signing to launch readiness in just 12 months, with manufacturing, integration, and testing performed at the SST-US facilities in Englewood, Colorado.

NanoRacks is able to provide this space station opportunity via its Space Act Agreement with NASA's US National Labs.

According to Dr. John Paffett, the Chief Executive Officer of SST-US, the use of the ISS for launch of small satellite platforms has increased in recent years, with a number of cubesat platforms being deployed.

SST-US' agreement with NanoRacks and the development of their one-hundred-kilogram-class, ISS-optimized satellite platform will significantly expand the capability, enabling larger, higher performance missions and payloads to be deployed from the station.

[www.sst-us.com/](http://www.sst-us.com/)

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

## Peru's First EO Satellite Finds Itself Integrated

### **Airbus Defence and Space has completed integration of PerúSAT-1, Peru's first Earth observation satellite, built in less than 24 months.**

PerúSAT-1 was ordered by the Peruvian government for their national space agency, CONIDA, in 2014. PerúSAT-1, based on the highly flexible, compact AstroBus-S platform, will observe Earth via a revolutionary silicon carbide optical instrument system at 70 cm resolution.

PerúSAT-1 is scheduled for take off aboard an Arianespace Vega launcher on September 16 (03:45 CEST). The 400 kg satellite will deliver images from its orbit at 694 km to be used in the areas of land management, border control, and drug trafficking enforcement.

PerúSAT-1 will observe Earth through the latest generation of a silicon carbide optical instrument, with a 70 cm resolution and may also be used to support management of humanitarian aid and evaluation of natural disasters (floods, forest fires, landslides, erosion).

PerúSAT-1 proves that a powerful and sophisticated Earth observation satellite can be built in less than two years. AIT (Assembly Integration and Test) of the instrument was completed in about eight months, with the platform construction phase, satellite construction, and technical and operational system validation taking only five months each, respectively.

This success was made possible by the creation of the "Projects Factory©", a new and more integrated working organization in the Space System business unit.

This new way of working brings down development and construction lead times for satellites up to 500 kg and optimizes their costs and schedule delivery, without impacting quality.

The program also includes the construction of the Centro Nacional de Operaciones de Imágenes Satelitales del Perú (CNOIS) hosting the ground control segment for image reception and processing developed by Airbus Defence and Space, as well as a complete technology transfer program for the Peruvian engineers and technicians (from advanced

instruction in space technologies to satellite operation and the development of appropriate imaging applications) and the supply of images from the Airbus Defence and Space fleet of optical and radar satellites.

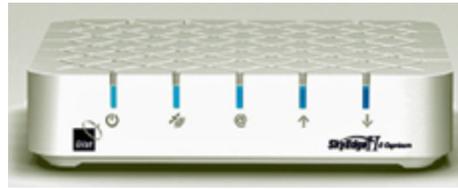
## Backing Backhaul In The UK

**Gilat Satellite Networks Ltd. (NASDAQ, TASE: GILT) has reported that Avanti Communications Group plc ("Avanti") has selected their one-platform/multiple-application X-Architecture and MEC-enabled Capricorn VSAT to support Avanti's contract to supply EE Limited with satellite capacity for 4G cellular backhaul across the UK.**

Gilat's MEC-enabled SkyEdge II-c Capricorn enables Mobile Network Operators (MNOs) to deliver true LTE-over-satellite performance.

With this network, EE Limited will be able to provide dedicated voice, data and video services at high speeds using satellite backhaul.

Gilat VSATs will be deployed at fixed and portable sites throughout the UK later this year.



*Gilat's SkyEdge II-c Capricorn.*

According to Hagay Katz, the Head of the VSAT Line of Business at Gilat, the MEC-enabled Capricorn provides the highest data and encryption rates on the market and maintains IPsec data security at unprecedented speeds without packet loss under fade conditions, bringing to play a flexible solution that will allow the company to quickly deploy a wide range of applications in the future.

Mansoor Hanif, Director of Radio Access Networks at EE Limited, added that this cellular backhaul over satellite solution will play a key part in enhancing their 4G network resilience and help the company to extend the network even further into rural areas as they continue their efforts to cover 95 percent of the UK landmass with their services.

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

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







# SatBroadcasting™: News-On-The-Move... Fast, First Rate SATCOM

By Volker Jarsch, Director, SATCOM Solutions, ND SatCom

**M**edia companies and broadcasters invest millions in contribution networks to provide real-time news to the public—ND SatCom's News-On-The-Move system enables news teams to instantly transmit live streams of moving scenes from any location via VSAT networks.



ND SatCom's News-On-The-Move system is an ideal choice when time-to-air requirements mean transmitting the first report on the go, such as live coverage of a cycle race to reporting from an extended or remote geographic area.



Leading satellite operators have confirmed that the use of an adopted (non-proprietary) satellite antenna with the SKYWAN terminal suspends transmission when the line of sight to the satellite is interrupted by buildings or trees—that transmission then continues immediately when the sight line is open once again.

ND SatCom offers a more seamless transmission solution. The special COTM (Communications-On-The-Move) feature of the SKYWAN system maintains connectivity, even when passing groups of trees or buildings, providing higher transmission availability than other solutions. The built-in Doppler-Shift feature compensates for accelerations and curves and is tested up to 2,000 km/h. This is a true News-On-The-Move advantage.

ND SatCom offers flexibility and turnkey integrations. The remote site can be a compact backpack terminal, a standard vehicle with a mobile News-On-The-Move system with roof-mountable antenna (that requires no vehicle mod) or a special vehicle with an integrated antenna. Based on a customer's needs, any integrated camera, encoding and recording equipment may be used. ND SatCom has a successful track record when tailored media solutions are required.

With ND SatCom's SKYWAN technology, infrastructure can be expanded without ever substituting any investment, starting with the minimal CAPEX and OPEX cost for two terminals (one as a remote site and the other as the home site receiving the news stream).

A promotional graphic for ND SatCom. The background is a dramatic scene of a volcanic eruption with a large plume of orange and red lava and ash. In the foreground, a dark-colored SUV is driving on a dark, rocky path. The text is overlaid on the image in white and orange. The ND SatCom logo is in the top right, and the event information is in the bottom right. The company name "ND SATCOM" is at the very bottom right.

**News-On-The-Move**  
Fast, First-rate Satellite  
Communications Everywhere

**We are at the IBC 2016!**  
Amsterdam  
September 09–13  
Booth 5.A60

**ND SATCOM**



This starter configuration connects the IP camera to the LAN port at the remote terminal and delivers the news stream at the LAN port of the home terminal. Customers can select to connect additional IP equipment at both sides of the feed and use connectivity for the smartphone or tablet.

As needs grow, further remotes can be added to the system (various types are possible). They all share the same satellite capacity, which is assigned in real-time by the home terminal.

This requires no hardware change. In addition, transponder and transmission planning, live bookings and accounting of network resource usage is managed by the MFM application.

If an organization requires more than one central site to receive and process news or other content, additional central sites may be equipped that are similar to the first one.

The SKYWAN network commits the throughput and the service quality for the transmissions that are prioritized.

The private network is fully under customer control and does not depend on any public network resources and unsecured routes.

With News-On-The-Move, a remote staff can communicate directly with other locations even when there is no cellular network available.

Simply use the "mesh" option and get connected. No matter where one travels, no matter the mode of transportation, customers may rest assured that all of their valuable news and content are immediately and reliably transmitted for that "first to air" moment satisfaction.

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

*Volker Jarsch works as the Director of Satcom Solutions for ND SatCom. His duties include the development of concepts for synergies between customer applications and their systems and the features of ND SatCom's portfolio of SKYWAN and integrated terminals. His experience builds on numerous customer projects in the field of governmental applications and enterprise communications which were realized by ND SatCom in the past years.*



# Catching The Wave With HTS A Newtec Perspective

By Jo De Loor, Market Director for Multi-Service, HTS and Enterprise, Newtec



**A**lthough High Throughput Satellites (HTS) using spot beam technology began to emerge in commercial satellite communications more than a decade ago, only over the last five years has the market for HTS exploded, with new market entrants such as Avanti and Yahsat launching a fleet of Ka-band HTS to start offering high throughput satellite services—the traditional satellite operators have quickly followed suit and are establishing HTS capacity in orbit to the point where the majority of operators now have, or are planning, HTS launches.

While initial HTS were focused on optimization of the cost per bit delivered, now being observed is that HTS payloads, often in Ku-band, are optimized for flexibility and reliability for a large variety of satellite services and markets.

The growing broadband market has led a demand for increased capacity, but currently represents three quarters of HTS capacity demand for just a quarter of the service revenues. As a result, higher value verticals are needed to yield better, quicker Return On Investment (ROI) on HTS capacity.

of service capacity demand, distributed over Ku- and Ka-band, but also including some C-band HTS.

Looking further into the distribution of services after broadband, the largest market noted are enterprise services—with 115 Gbps demand—followed by cellular backhaul and government and mobility services, using 76 Gbps to 57 Gbps respectively. The broadcast markets, with 18 Gbps, has lesser demand when used for regional Direct-to-Home (DTH) delivered over spot beams, but HTS also fits well for occasional use services, such as Satellite News Gathering (SNG) and IP SNG.

## High Value Verticals

If forecasted service revenues for each vertical are included, the data becomes even more interesting. Broadband represents 79 percent of HTS capacity demand but represents “only” 24 percent of the service revenues. Broadband is a high-volume, low-margin business which explains the lower revenue and margin per Gbps. The other applications represent 76 percent of the HTS revenues but only account for 21 percent of the service capacity. Markets such as mobility and government represent the highest service value per Gbps capacity.

## HTS Success Factor = Multi-Service Play

The conclusion is that key for HTS operators will be to address the demands for these various markets and verticals. The broadband demand is large and long term; however, time will be required to gradually grow the customer base. On the other hand, the higher value verticals are a good complement: these markets can yield fast ROI on HTS capacity as such involves less sites but with more bandwidth demand per site.

Such high-value services have a good return in regard to price and margin, but demand may be subject to more fluctuations over time, such as the slowdown today in the demand for Oil & Gas services. Supporting a good mix of customers in different verticals will maximize HTS service revenues and will also limit the business risk, both during initial ramp-up and in the long term, as demand from various verticals may change over time.

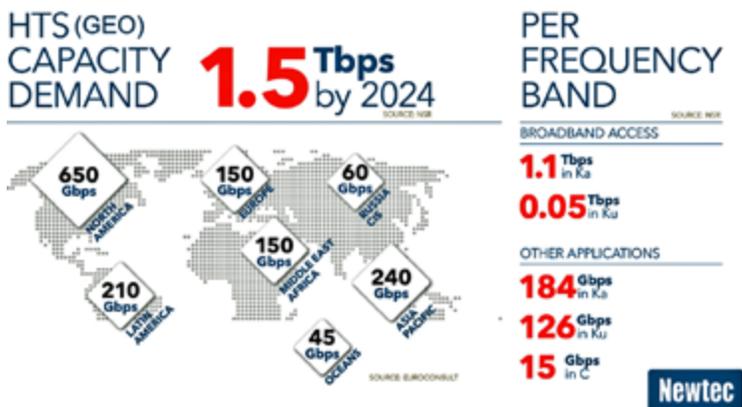
## VSAT 2.0—What’s Next?

Nexgen VSAT platforms addressing those HTS services will be required to support a wide range of verticals and applications, with unprecedented scale.

High-performance spot beams require the most advanced transmission standards. DVB-S2X forward link with wideband carrier support is one of the key elements to leverage HTS payload resources.

Using high efficiency MODulation and CODing schemes (MODCODs) up-to 256APSK, spot beam link performance can be leveraged, enabling high service availability. The large high throughput wideband carriers result in optimal statistical multiplexing, enabling delivery of very high throughput services to individual terminals. Also, the return link performance allows the use of 32APSK transmission schemes, providing unprecedented inbound IP efficiency as high as 4bps/Hz.

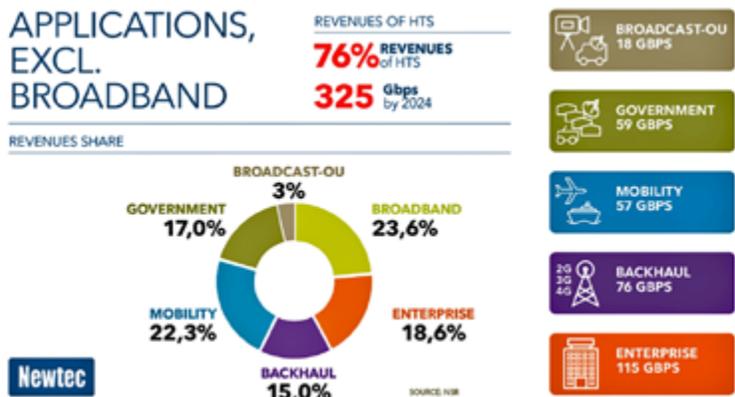
Dynamic bandwidth allocation schemes will need to be more efficient and scalable in order to sustain the next wave of growth. Modem hardware must be more powerful and future-proof, supporting higher data rates and extending upgrade cycles while still meeting the



## Broadband Leads Capacity Demand

According to studies from NSR and Euroconsult, the market demand for global GEO HTS services will reach 1.5 Tbps by 2024. As far as can be determined, demand is largely present in all regions: North America, as a mature and growing market, is leading but is followed by emerging markets in Asia Pacific, Latin America and Africa.

The majority of the demand is for broadband services, with forecasters predicting that 1.1 Tbps of broadband services will be delivered using Ka-band. Meanwhile, “only” 50 Gbps will make use of Ku-band HTS capacity. Other applications, alongside broadband, represent about 325 Gbps





# KEY CHARACTERISTICS OF A MULTISERVICE PLATFORM

## WIDEBAND OUTBOUND CARRIERS

Support for DVB-S2X wideband carriers shared across multiple markets

## WIDE RANGE OF MODEMS

Modems designed to meet diverse technical requirements and price points

## MULTIPLE RETURN TECHNOLOGIES

Multiple return technologies optimized for various traffic patterns and data rates

## MARKET-SPECIFICS

A feature set supporting dedicated markets via one platform (like mobility, cellular backhaul, broadcast & government)

## MANAGED SERVICES FLEXIBILITY

Supporting value chain and business model variants

## RICH API

Application programming interfaces to allow automation and customization

customer required price points. Satellite networks should also be more transparent and integrate more seamlessly with terrestrial networks.

Serving the higher value markets also requires highly reliable services even during rain fade conditions. Features such as Automatic Uplink Power Control (AUPC) and Adaptive Coding and Modulation (ACM) are essential, but need to be implemented in a sophisticated manner to enable delivery of the service reliability and Quality of Service (QoS) required by the customer.

Powerful spot beams will also create new challenges for mobility. Beam switching logic must become multi-dimensional, allowing network operators to continually manage factors like load balance, regulatory restrictions, cost and weather.

The value chain for HTS-based services is evolving to more managed services, driven by the required economy of scale to roll-out HTS service infrastructure. There has been much debate over the effectiveness of the so-called “closed” and “open” business models—meanwhile the industry has been adopting business model innovations that enable various players in the satellite services value chain to focus on their own strategy and strengths.

Satellite operators will more and more deliver a managed service (wholesale) to the service provider, which will be operating as a Virtual Network Operator (VNO). Using the elaborate VNO capabilities of the platform, service providers will be able to deliver tailored services according to the end-customer requirements, and still have all tools available to roll-out such services and manage the Mbps capacity and terminals.

### Future Trends

On the space segment, two key further trends are noted: the emergence of Low-Earth-Orbit (LEO) satellite constellations and more flexible, high-capacity GEO HTS payloads.

LEO constellations will further complement the GEO HTS capacity on orbit. On the ground segment, one of the key technologies to enable commercial success of the LEO satellites, is the availability of cost-effective, electronically steerable Flat-Panel-Antenna's (FPA) to follow the satellite movement and handover between two satellites.

For GEO satellites, the trend is to introduce new concepts that bring more flexible and software-enabled satellite payloads. Most of today's HTS have a fixed capacity and footprint allocation. Future HTS will be able to allocate the available capacity according to where demand is located geographically at any given time.

Along the same lines, Newtec is innovating the ground segment so that services can be delivered in an optimal and extremely cost-effective way.

### Addressing The Changes

With these industry shifts in mind, the company has launched the Newtec Dialog® multi-service platform. This platform is already being used by major satellite operators and service providers worldwide, including Yahsat, Intelsat, ABS, SES, Star One, Claro, Petrobras, Quantis, Talia, United Nations, Network Innovations, Marlink, RuSat and Liquid Telecom.

The platform is optimized for the delivery of broadband services and managed services for specialized verticals, such as enterprise, cellular backhaul, mobility, government and broadcast. Dialog® is perfectly suited for offering a range of managed services. These can either be offered directly as managed service profiles for end-users, offered as a service for a group of end-users (e.g., government network), or as wholesale capacity via other service providers. Those service providers will be able to define and sell their own services to end-users without the need for additional CAPEX investment in hub infrastructure based on the elaborate VNO functionality included in Newtec Dialog.

Wideband carrier in DVB-S2X delivers an optimized forward link, while the return link with three supported technologies can make use of the most optimal technology: MF-TDMA, SCPC and Mx-DMA®, the unique return link technology. Together with the new HighResCoding™, Mx-DMA combines the best of MF-TDMA and SCPC, enabling services up to 75Mbps to operate far more efficiently.

As the demand for HTS continues to grow, Newtec will continue developing and applying future-proof technologies that provide the best possible results in terms of performance and efficiency, all the way through the chain from the satellite operator to the end-customer.

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

*Jo De Loor is the Market Director for Multi-service, HTS and Enterprise at Newtec, developing the HTS and enterprise markets and assisting with large project sales as well as sharing his expertise in broadband and VSAT within the Newtec organization.*

*Jo has almost 20 years of experience in the industry and began his career at Newtec in 1996 with different assignments within the organization. In 2005, he became the systems architect for Newtec's DVB-RCS system and then moved on to become the product manager and later Product Line Director of the Sat3Play Broadband Platform. Jo holds a bachelor degree in electronics from HTISA-Gent, Belgium.*



# A Bridge Technologies Focus: Kvamnet: Overcoming The Challenges

By Simen Frostad, Chairman, Bridge Technologies

**In a remote region of Norway, an innovative network that provides Internet access, telephony and TV programming has been created to serve this area's scattered and often isolated population.**

Some 400 kilometers west of Oslo and 80 kilometers east of Bergen, on Norway's beautiful, fjord-jagged west coast, lies Norheimsund, the administrative center of the municipality of Kvam. A popular tourist destination due to the beauty of the scenery (the Steinsdalsfossen waterfall is reputedly Norway's sixth most visited natural attraction)—Norheimsund is also home to numerous small businesses, including factories as well as food and wood processing plants.

In 1970, a company was founded to provide accountancy services—payroll, invoicing, stock control and so on—to these businesses. Eventually, this firm found themselves offering those services on a computerized basis. Customers dialed in for offered services using what now seems to be an almost prehistoric technology.

A new company—Kvamnet—was formed with the realization that far greater bandwidth was needed than dial-up would allow. This company invested in the construction of two antenna towers that would deliver wireless access to their business system. Not long after the tower was built, the growing influence of the Internet witnessed the deployment of fixed cable connections that were capable of 2 Megabits/second speed, providing even more convenient access for customers.

With the infrastructure starting to fall into place, the opportunity surrounding the provisioning of Internet access to consumers became evident. Initially, Kvamnet deployed antenna masts throughout the surrounding area—more than 30 of these masts are now installed. Access, of course, requires line-of-sight from the receiving premises.

## Potential For Complexity

Although the total network was, at this stage, relatively small and simple, its potential for complexity was always apparent. Expansion of the network, the served customer base and the services offered would, unless carefully managed, create challenges. Maintaining simplicity—of technology, of operation and of access—were vital considerations.

In 2003, Kvamnet embarked on a program to lay fiber optic cable wherever possible, with the goal of providing a fast connection for every home. The company has managed to reach 50 percent of its customers so far even though the fiber optic network continues to built out. The remainder of the customers still receive access

to the Internet via the company's wireless network. With fiber optic, Kvamnet's customers achieve download speeds of 100 MB; wireless access provides 20 MB.

In 2005, Kvamnet realized there was also an opportunity to provide more reliable TV programming to the local population. The high mountains and deep valleys meant that the residents of Kvam were lucky to receive any sort of TV signal at all—and, if they did, that signal was mostly of poor quality.

At about this time, Bridge Technologies met with Steinar Foss Andersen, the driving force behind Kvamnet. At Bridge Technologies, the challenge was the need to turn technology complexity into solutions that made communications work in a far simpler manner. In many ways, the two companies were a natural fit and both companies realized quite quickly that working together to solve these challenges was highly desirable.

Steinar's vision was to create an infrastructure that would have, at its heart, satellite reception of some 30 TV channels and to then distribute these channels via the firm's IP network. Today, this doesn't seem so remarkable; however, 10+ years ago, this was indeed a pioneering, visionary project, one that was highly challenging, not in the least because the venture could potentially create an overwhelming support burden for a small team.

## Proactive Approach

Quickly recognized was that the key to success would be to take a proactive approach in managing the quality of experience for users. If potential problems could be identified and resolved before those users started to place service calls, then the support process would be, logistically, significantly simpler.

That's where the expertise of Bridge Technologies came into the picture. Satellite has long been an area of focus and expertise for Bridge Technologies. The company's intelligent redundancy switches for satellite uplink sites, for example, have the most comprehensive feature set, together with a completely autonomous operation in order for operators to have complete confidence in the performance and function of the switching process.

For headend sites where satellite ingress is used as the main signal, understanding the quality before re-distribution provides even faster fault-finding and complete visibility of the service as a whole—Bridge Technologies was able to providers as well as enable a proactive approach to quality assurance.



Panoramic view of Nordheimsund, Norway.





The track of the cable that was installed under the asphalt by KvamNet.



Fiber optics and related infrastructure are being gathered for deployment in Nordheimsund.

Kvamnet elected to deploy the Bridge VB272 dual-input probe for monitoring signal distribution, contribution and data traffic. This unit's RF performance, allied to its ETR analysis engine, are designed for monitoring of central headends or any satellite uplink application.

Also playing a key role in the management of Kvamnet is the Bridge VB288 Objective QoE Content Extractor, which performs objective video and audio monitoring of MPEG-2, H.264/MPEG-4 and H.265/HEVC streams and offers a unique web browser-based remote video-wall capability providing full visual status from anywhere.

What that means is that Steinar can view the performance of his entire network, know exactly what's going on as well as the capability to identify potential problems—not only from his office, but wherever he may be located.

The VB272 and VB288 are complemented by some 50 Bridge microVB network analyzers – and a number of VB110 probes which are still delivering reliable performance almost a decade after they were installed.

### **Making Complexity Simple**

Kvamnet proves what Bridge Technologies staff have always said: with the correct tools, and a user interface that is intuitive and easy to use, network operators do not need significant expertise in order to manage QoE.

Kvamnet now provides four services to their customers. Internet access is delivered to businesses and consumers; telephone services (primarily for consumers); TV programming; and computing services for the small business customers.

The company has plans to further extend the network. The Kvam area is home to numerous holiday cabins, with the owners typically wishing to benefit from reliable, high speed Internet access.

Today, TV programming is delivered to the Kvamnet headend via fiber optic cable from Oslo. The original satellite system for receiving TV signals remains in place and is used to provide redundancy.

Bridge Technologies believes the company has been instrumental in assisting Steinar Foss Andersen achieve his goal of making the complex simple—and also, perhaps, in enabling him to expand the Kvamnet business.

Creating high speed broadband network is challenging, even in ideal circumstances. However, to do so in an environment that is as remote and geographically challenging as Hordaland county, in which the municipality of Kvam is situated, is significantly even more so imposing.

The persistence and innovation that Steinar and Kvamnet have shown are to be admired. Kvamnet may just be the smallest digital TV distribution system on the planet.

[www.bridgetech.tv/](http://www.bridgetech.tv/)

*Simen K. Frostad is Chairman and co-founder of Bridge Technologies. With 22 years of industry experience, Simen founded Bridge Technologies in 2004 after creating the world's first IP/MPLS contribution network for Scandinavian sports coverage. Simen had previously built the first multi-camera hard disk recording system for episodic drama production in 1998 and the first nonlinear sports editing facility during the 1994 Winter Olympics.*

*All photos in this article are courtesy of Morten N. Almeland © Bridge Technologies 2016*



Steinar Foss Anderson in front of a Bridge Technologies Remove Data Wall that depicts the various POPs in Nordheimsund, Norway.



# The Forrester Report: Satellite Battles Over Europe

By Chris Forrester, Senior Contributor

**T**here's something of a 'battle Royale' going on in Europe between two rival shareholders in Spanish satellite operator Hispasat—this disagreement concerns Eutelsat and a Spanish infrastructure company, Abertis. Eutelsat owns 33.69 percent of Hispasat, Abertis owns 57 percent.

Eutelsat states bluntly that they have in place a "PUT" option to force Abertis to buy their stake, which is legally enshrined in a Shareholder Agreement between Eutelsat and Abertis and was exercisable in July of 2016. Abertis can be paraphrased as saying, 'No way, Jose,' and more properly that the PUT option can only be used a year from now. Plus, regardless, the Spanish government must give their approval; however, Spain is currently otherwise engaged on a general election, etc, etc, etc.

The history of Eutelsat's involvement in Madrid-based Hispasat goes back decades to 2001. Abertis—which mainly builds and operates motorways—was once Eutelsat's largest investor. In January 2012, Abertis sold 16 percent of their stake in Eutelsat for 981 million euros.

In June of 2012, Abertis sold a 7 percent holding in Eutelsat to China's CIC Investment Corporation (for 358 million euros). In March of 2013, Abertis sold 3.15 percent for 182 million euros. A year later, the company used the cash to acquire an extra 16.42 percent of Hispasat.

That action took their total holdings in Hispasat to 57.05 percent. In June of 2014, Abertis sold their remaining 5.01 percent slice of Eutelsat for 275 million euros.

Hispasat's other shareholders are Spain's State Society of Industrial Holdings (SEPI) and Centre for Technological and Industrial Development (CDTI), which hold respective stakes of 7.41 percent and 1.85 percent, respectively, in the operator.

Eutelsat's relationship with Hispasat has frequently been rather stormy. On the one hand, they are a shareholder, but at the same time they compete for business. This came to a head back in 2013 when the two satellite operators were contending with one another to buy SatMex of Mexico.

That strained relationship now comes to the forefront. Eutelsat has always said it has certain key "pre-emption" rights to any Hispasat shares that come onto the market. A spokesman from Abertis said that a compromise solution would be for Eutelsat to remain in the company, at least until the end of July 2017.

Abertis also said that the PUT option still had to be recognized in accordance with the agreement with shareholders in July 2013. Furthermore, any transfer of shares, and therefore Eutelsat's sale, would require the previous authorization of Spain's Council of Ministers.

Michel de Rosen, now chairman of Eutelsat but speaking in 2014 when he was CEO, said, "We also have in place a 'Put' position where, if we decide that we need the cash, or that things are not working out with Hispasat, the 'Put' allows us to exit in a relatively smooth fashion."

Mr. de Rosen, in that 2014 interview, explained how he saw the relationship with Hispasat. "Eutelsat has been a shareholder in Hispasat since 2001 and at that time was encouraged by the Spanish government that one day Eutelsat would be authorized to become the controlling shareholder," he said.



"However, patience was also advised. Then the Spanish government changed, along with a new chairwoman at Hispasat while at much the same time Spain's Abertis became the largest shareholder in Eutelsat.

"Later Abertis also became the largest shareholder in Hispasat. For these reasons it became more difficult to implement our initial vision. Spain thought that the 'nationality' of Hispasat should remain Spanish, and Abertis had their own ambitions to expand their interest in satellites.

"The third step came about with Abertis' decision to exit Eutelsat, and this was completed [in 2014] when they sold their remaining 5 percent. Telefonica also exited their holdings in Hispasat, selling portions to us and Abertis. Spain also had a decision to make as to what to do with their own stake in Hispasat. Do they keep it, or do they allow one of the remaining major entities to become the controlling shareholder?

"We respectfully expressed our interest in becoming that controlling shareholder, but also said that we would not be surprised if Spain chose Abertis as their preferred option. Indeed, that was Spain's decision and Abertis did buy some of the Spanish state's shares, and they are now the controlling shareholder with us at Number 2 with 34 percent.

"We are an active and collaborative shareholder in Hispasat and want it to succeed and develop. Very occasionally there are inevitable conflicts which we, and Hispasat's Board, resolve amicably and sensibly."

De Rosen added, "At the end of [July 2014], I spoke about how this marathon in Hispasat had started way back in 2001 and we believe it is possible—although not certain—that one day Abertis decides to exit, and if this happens as a satellite operator with a 34 percent stake, and knowing the company well, we would then be a natural, possible, lead shareholder. What makes this easier is that we have a pre-emption right on the shares if, one day, any of the two other shareholders decide to sell.

"We also have in place a 'PUT' position where, if we decide that we need the cash, or that things are not working out with Hispasat, the 'PUT' allows us to exit in a relatively smooth fashion."

Asked how the inevitable Latino competition between Hispasat and Eutelsat Americas (the new name for SatMex) was being handled and whether this was creating headaches, Mr. De Rosen insisted the answer was 'no'. "We are all mindful of the obvious challenges, and we do not share commercial confidences with them, but with us both in the same business, and the same geography, there must be the odd conflict. Indeed, this allows us to have more chances to touch one another. In some cases this means opportunities, in others potential conflicts which we know must be managed carefully."



### **Strained Relationships**

However, as mentioned, the relationship between Eutelsat and Hispasat/Abertis has—and perhaps still is—strained. Back in October of 2013, a Spanish business newspaper wrote a well-informed editorial that was highly critical of Eutelsat’s successful bid for SatMex (now Eutelsat Americas).

The 2013 article in *El Confidencial* accuses Eutelsat of “double dealing” in its purchase of SatMex. *“They have kept on their poker faces,”* stated the article, *“but both the Ministry of Defence and SEPI (Sociedad Estatal de Participaciones Industriales), which reports directly to the Ministry of Finance, have been stunned to learn of the duplicitous conduct of French multinational, Eutelsat, in our country. The French satellite operator has snatched the purchase of Satélites Mexicanos (SatMex) from the hands of its Spanish partner, Hispasat. SatMex is a strategic company for the development of the telecommunications business throughout South America.”*

The clearly well-briefed article then accuses Eutelsat of deliberately remaining silent during the period when the company was increasing their stake in Hispasat as well as adding to the number of nominated directors they possessed on Hispasat’s board. The newspaper stated that Spain’s government believes Eutelsat has “acted in an unfair way” and, in so doing, has scuppered Hispasat’s own plans to expand their services over South America. The phrases used against Eutelsat the article were described at the time as “near-venomous” and by any measure extremely strong and include “self-centered connivance” and “without shame.”

The 2013 article continues, *“Abertis also got what it wanted, which was to guarantee the full consolidation of Hispasat in its financial statements. In order to achieve this, the subsidiary of La Caixa needed to bring its shareholding above 50 percent, which it did with the support of the Defence Minister, Pedro Morenés, coupled with the indifference of Cristóbal Montoro—his counterpart at the Ministry of Finance—and the self-interested connivance of Eutelsat. However, what was not in the script was that the French multinational would remove its mask so swiftly and brutally reveal itself, with no shame whatsoever, as a direct rival in the race to gain control of SatMex.”*

*“The acquisition of the Mexican satellites was one of Hispasat’s last-ditch efforts to strengthen its position in South America. The Spanish company’s expansion plans are directly linked to the configuration of orbital positions, but these have now ended up in the hands of Eutelsat. The French company beat its competitor in the home straight of the international tender with an offer in which it went all out to beat Hispasat.”*

### **Confusion**

On July 29th, Eutelsat unveiled their end-of-year numbers, but the only questions that analysts wanted answered concerned the Hispasat stake. One analyst (from investment bankers Macquarie) asked when Eutelsat might expect to receive the valuable proceeds from the Hispasat sale.

Belmer said, "On Hispasat, we don't have a clear view on the calendar, even though it's very clear in the shareholder agreement we have with our partners in Hispasat. But for the moment, we cannot comment on specific dates when we receive the payments from Abertis. We have initiated, as to the PUT process and together with the PUT process comes a process of valuation of the company, which takes some time. The duration of the process as described and signed in the shareholder agreements lasts around three months."

The next analyst (from Kepler) had another go at much the same question and specifically the date that the put could be exercised.

Belmer said, "On Hispasat, the situation is very clear. We have a shareholder agreement with our partner that is in Hispasat with, as you mentioned very well, a lockup period until July 2017. But we have the right to exercise the put every year as of July 2016, it's very explicit in our agreement and this is a very clearly an explicit exception to the lockup period, meaning that we are completely entitled to exercise our put as of this July, as we did and that we communicated to you."

Another analyst (Deutsche Bank) asked whether Eutelsat's dividend was dependent on the Hispasat cash. But Belmer's response was softened, "We are pretty convinced we'll be able to dispose of our stake in Hispasat. It's true that it's dependent on the reaction of Abertis and their compliance with our shareholder agreement, it's true. But even though it takes time, it will not prevent us at all from delivering on our dividend policy and I want to be very clear on that."

Indeed, Deutsche Bank's Laurie Davison later in the day published a report to investors, stating, "We see major risks of a dividend cut next year, especially after what Abertis stated at their results today their legal advice that they do not need to buy ETL's Hispasat for another 12 months and still requires Spanish government approval when the political situation is in flux."

At the end of the day—and presuming the lawyers can sort out whether the PUT is valid—Eutelsat should receive around 400 million euros for its Hispasat stake; however, that accounting may well be 12 months or more from now.

*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), in recognition of his extensive coverage of the Arab media market.*





# SatBroadcasting™: Advancing The Technologies Of Broadcast Satellite Communications

By Jan Molter, Managing Director, Hiltron GmbH

**BC forms an important reference point in the business timeline of any broadcast equipment manufacturer or systems integrator.**

The 12 months since IBC2015 have been quite busy for Hiltron, both in terms of product innovation and system delivery. Last November, the company introduced SORBAS, a complete family of products designed to form the heart of customized satellite communication systems. These include Hiltron's HMCS monitoring and control software, HCS universal control unit, HSACU satellite antenna control unit, HMAM three-axis motorized satellite antenna mount and HDCU de-icing control unit.

SORBAS brings together into a unified product series a range of devices developed through the firm's twin roles of manufacturer and a provider of completed, customized systems. Central to this product family is the HCS-Core which was announced at IBC2015. This is used as a control element for tasks such as switching downconverters, integrated receiver/decoders, digital video broadcast encoders, high-power amplifiers and waveguides. The other products in the series are field-proven and in successful operation at many locations around the world, forming elements of Hiltron's own systems and those designed by systems integration partners in many countries.

The HCS-Core element of SORBAS is available in 2U high full-rack-width and half-rack-width versions. The full-rack-width model can accommodate up to 16 modules and is Hiltron's largest and most versatile SATCOM controller to date. The current range of cards includes a monitor, control and power supply for fiber optic devices, a fiber-optic

switch, LNB redundancy systems for C- and Ku-band, HPA redundancy control, redundancy for DVB MPEG encoders/modulators/IRDs and a generic monitoring and control module.

The Hiltron HACU is designed to control three-axis motorized antennas. The antenna control unit and associated motor-control electronics are contained in an IP65-rated weatherproof outdoor housing with a hinged front access port secured by dual key screws. The HACU can be operated from a PC running a graphic user interface compatible with standard web browsers. The control GUI displays all the information required to set and maintain azimuth, elevation and polarization, including current and target positions plus a database of potential accessible satellites.

HMAM is a high-precision motorized satellite antenna mount designed for two-way VSAT communication or receive-only downlink applications and can be used for a wide range of applications, including broadcast and telecommunication downlinks. An optional motorized feed changer allows the head to be moved quickly to a new position for switching between frequency bands.

HMAM comes complete with professional-grade drives for azimuth and elevation plus a high-accuracy polarization drive. The combined head and drive form a three-axis motorized mount with 180 degrees of azimuth adjustment, 90 degrees of elevation adjustment range and fully adjustable polarization.



The Dillberg transmitter site in Bavaria, located on the 595 meter high Dillberg Mountain. Photo is courtesy of Hiltron Communications.

The Hiltron HDCU-E is a combined ice-sensing and dish heating controller for use with large satellite antennas and is capable of handling up to 450 kilowatts of power across multiple heating groups. Each group is divided into three, independently controlled heater arrays. Each array, in turn, feeds as many as three antenna heater circuits.

A four-group configuration, for example, allows control of 12 arrays addressing a total of 36 heating circuits. This modular control approach permits easy configuration of parameters such as antenna size, number of heater pads and the power requirement of each pad.

Snow detection is via a reflective sensor with a polarizing filter. Each heater circuit is individually supervised and controlled via user-adjustable minimum and maximum thresholds. Sequential switch-on is performed within the controller to prevent rapid changes in current load when the antenna heating process is activated or deactivated. Sequence timing is user-configurable.

### **Recently Completed Projects**

Hiltron's projects activity over the past year has embraced broadcast SATCOM for signal contribution applications and technically comparable work in the wider communications field.

#### **DAB Distribution Uplink Project in Southern Germany**

In November of 2015, the company completed a project on behalf of a major broadcaster in southern Germany for the provision of two satellite uplink stations. These have been integrated in main and redundant roles as part of a nationwide expansion of the digital audio broadcasting network. The first station comprises a 2.4 meter



*Hiltron HMAM motorized antenna mount supporting a 2.4 meter dish.*



*Hiltron HMAM motorized satellite antenna mount with 3.6 meter dish.*

receive/transmit antenna with a 1+1 redundant signal processing and waveguide switching, two block-upconverter power amplifiers, two modulators and a low-noise block downconverter for return reception check. The second station is designed to function as a weather redundant backup.

The project included installation at ground stations in Ismaning near Munich and at the 595 meter high Dillberg transmitter site. Both stations are monitored and controlled by Hiltron HMCS software.

Using a modern graphical user interface with color-coded alarm message handling, Hiltron's HMCS provides a highly intuitive and efficient line-up procedure for professional satellite systems. This includes full control of contribution encoders.

#### **SNG For A Major German Public Broadcaster**

In March of 2016, the firm initiated a satellite newsgathering vehicle project for one of the largest public-service television and radio broadcasters in southern Germany. This project centered on the integration of a complete satellite communications system, which will allow news or outside broadcast crews to deliver video and audio content to the network's main studios from practically any location.

This order is the first of its kind for this alien and was won on the basis of recommendation after the customer recognized the excellence of an SNG installation Hiltron provided fairly recently for a public service broadcaster in northern Germany. A complete system has been designed, including a routing matrix and dual 250 watt solid state microwave power amplifiers that a 1.8 meter diameter dish antenna, which will be mounted on the vehicle's roof. A microwave receive channel will also be provided and integrated for this client.

The entire system is operated via a Hiltron HMCS monitoring and control unit in conjunction with a Hiltron HSACU antenna controller which is designed specifically for satellite newsgathering applications. Installation, technical integration cabling and testing will be completed ahead of scheduled delivery during Q3 2016.

#### **Hiltron HMAM Selected For Global Satellite Tracking System**

In May of 2016, the installation of a global satellite tracking system was completed for one of the world's largest aerospace companies. The system includes six Hiltron HMAM motorized satellite antenna mounts integrated with a Hiltron HACU antenna control unit and associated motor-control electronics.

Each of the six installations is configured to operate in main-plus-backup roles. Two are located at ground stations in the southern hemisphere, two in Europe and two in North America. Each HMAM mount supports a 2.4 meter dish and is fitted with a wind sensor which activates a safety lock if wind speed exceeds 80 km per hour. The system will be used in a variety of modes to ensure continuity of the client's satellite network.

#### **Navy Communication System**

In June of 2016, a data and voice communications systems was finished for one of the largest naval fleets in the NATO Maritime Group. The project was carried out in partnership with a major European company that specializes in naval electronics. This was the latest project in a series with this particular partner which has been ongoing on a ship by ship basis since 2011.

Each installation provides the codec facilities needed for secure satellite-based communication between vessel and land, including IP network access and vocal telephony. The previous systems have proven to be highly reliable and are based on Vocality codecs which are among the most efficient of their kind currently available.

Ship to shore communication is a vital aspect of naval operation and is much easier to achieve using satellite links than traditional radio technology. Vocality multiplexers provide the full range of user-facing connectivity, while managing the bandwidth used in multiplexing the services between locations.

Four variations are available: portable V25 and V50plus and rackmount V150 and V200. Each voice and data multiplex offers a different layout and density of ports such as voice, Ethernet, serial data or ISDN. As they all operate the same software, their management interface is nearly identical and they are all interoperable.

#### **Latvia Teleport Satellite Expansion Ahead of Rio Games**

In July of 2016, Hiltron completed a SATCOM project at a major teleport in Latvia. A combined endeavour with Danmon Group Sweden, the project includes a five-channel satellite link that will carry television content to Europe from the 2016 Summer Games in Rio de Janeiro. Central to the contract is the provision and integration of 3.6 meter satellite dish on an HMAM motorized mount plus a Hiltron HACU antenna control unit and an HDCU-E ice-sensing and dish heating system.



*Hiltron HSACU SNG antenna controller.*

**IBC2016**

At IBC2016, Hiltron will be promoting a full range of SATCOM products and system integration capabilities as well as showcasing the firm's ability to provide long term technical support for their own or third-part-designed systems. This latter capability is in growing demand, as system owners and operators are allowed to focus fully on their own core business. If attendance at IBC2016 is scheduled, come and visit Hiltron's latest offerings on stand 5.B80.

[www.hiltron.de/](http://www.hiltron.de/)

Established in 1979 Hiltron GmbH provides turnkey systems of any required scale for customers world-wide. Part of the Danmon Group, Hiltron operates from headquarters at Backnang near Stuttgart, Germany. These facilities include a large technical operations area with high access doors and ceiling, capable of accommodating satellite link vehicles and their roof-mounted antennas.

Solutions offered include the design, integration, and realization of complex ground stations for sending and receiving signals to and from satellites. The systems operate at all commonly used frequency bands, with antennas of up to 11 meters. Hiltron is also a leading supplier of premium satellite newsgathering (SNG) uplinks for the German market—broadcasters can use reliable, fully redundant satellite links mounted on their trucks or vans. Hiltron is a distributor for world class manufacturers of SATCOM technology for modems, encoder and decoders, solid state power amplifiers, TWT amplifiers, low noise block downconverters and upconverters. The company's technical solutions are complemented by fiber-optic systems, microwave point-to-point links and IP networks.

# THOR 7 – High Performance For The High Seas A Telenor Perspective

By Helen Jameson, Founder, SpaceScript

**A**fter the satellite's 2015 launch and an extensive testing period, Telenor's first growth satellite, THOR 7, is ready to initiate commercial service.

THOR 7's Ka-band payload, optimized for the maritime market, is set to deliver transformative capabilities and unprecedented high powered performance to customers at sea. Good things, obviously, come to those who wait.

This statement certainly rang true on May 12, as Telenor Satellite finally launched the long-awaited mobility Ka-band service on THOR 7. With more than a year of testing behind them, the Telenor Satellite Team can now look forward to delivering services on the highest performance satellite payload designed specifically for the maritime market.

Demand for connectivity on board vessels of all types has accelerated exponentially in the past few years and expectations are now higher than ever. Use of Internet protocol (IP) on board vessels has transformed the operational environment. Applications such as broadband Internet access, VoIP, video streaming, email, and access to corporate networks are all seen as priorities for shipping companies to run an efficient service and to improve life on board for crew. High performance, reliable connectivity is an essential element on board any vessel today. THOR 7 is designed to meet and exceed these requirements.

THOR 7 represents a milestone for Telenor Satellite. The team has understood the unique demands of the maritime marketplace, as Julian Crudge, Divisional Director, Network and Data Services explains: "We designed THOR 7 specifically for the maritime marketplace, to meet this demand for broadband connectivity. We started to design the satellite in 2008/9 so it has taken up until its launch in 2015 to become operational. It's been a long gestation period. Broadband demand at sea is booming, as people are used to accessing their regular apps such as Facebook, YouTube and Skype everywhere they go. The demand for cruise connectivity is huge, let alone commercial applications. THOR 7 provides this high quality connectivity at sea which is in such high demand."

The satellite serves the busy shipping lanes of the North Sea, the North Atlantic/Norwegian Sea, Baltic Sea, Black Sea, Caspian Sea, Red Sea, Persian Gulf and the Mediterranean.



The launch of THOR-7. Photo is courtesy of Arianespace.



The satellite's HTS payload offers 6 to 9 Gbps throughput, with up to 25 simultaneously active spot beams. Supported by the iDirect Evolution Platform, THOR 7 offers automatic and seamless spot-beam handover, assuring continuous connectivity across the entire satellite footprint, delivering cost-effective solutions and higher speeds for users with smaller antennas.

THOR 7 already provides an Antarctic service. Crudge explained, "There is a beam over the Antarctic which is backhauling traffic in Ka-band and is a good test of the technology. Our customer in Antarctica says it is the best service they have ever had. It has been designed specifically for them, and they are very happy with it."

## Beta Testing

The gestation period may have been long, but for good reason. After launch, the satellite was put through on orbit testing which ended in mid-June of 2015. Alpha testing then ensued as the team checked out the various infrastructure elements that included antennas, backhaul connectivity and the service platforms until all were satisfied with the integrity and functioning of the overall structure.

However, testing did not end there. Once Alpha testing was completed, Telenor Satellite invited existing and potential customers to start the process of Beta testing. This proved to be absolutely critical in enabling Telenor Satellite to hone the service—the gains made in performance during this time were impressive.

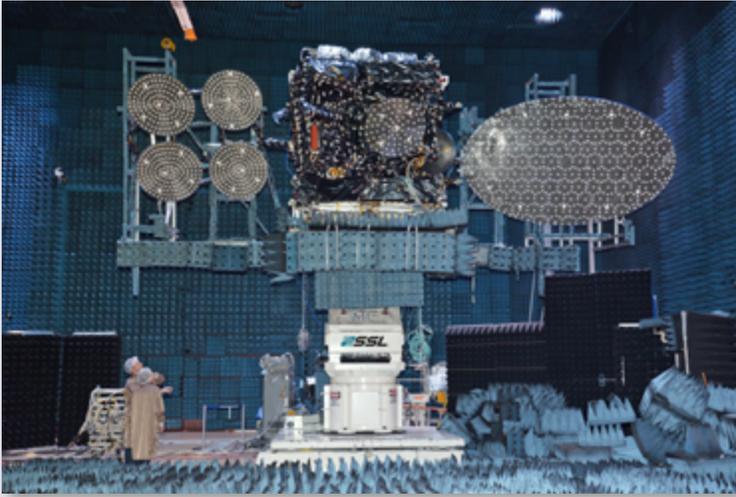
Beta testing involved more than 15 partners and 50 terminals on approximately 30 vessels, from trawlers, gas tankers and fishing vessels to luxury yachts, cruise ships and passenger ferries. This wide variety of vessels gave Telenor Satellite the opportunity to extensively test the services. For example, a fishing boat will pitch, roll and yaw a great deal more on the water than a cruise ship, and the antenna must be able to track the satellite even while such movement is taking place.

## Perfecting The Service

In February of this year, the Telenor Team identified two areas that needed improvement. Area one was the stability and uptime of the terminal. Area two was an improvement in the amount of hub-side issues. The team wanted to ensure that there were no hub-side issues for a period of several weeks so that they could ensure that the service was as reliable as possible.

By working closely with partner iDirect, and bringing their engineers over to work with the Telenor Satellite engineers, these issues were resolved. There have been no hub-side issues for almost three months and very high throughput figures were achieved with 70 Mbps download.

This figure is also expected to increase as modem technology gradually improves. In terms of the power, the satellite can handle higher MODCODs (Modulation and Coding) which are not yet available on TDMA systems, but that will develop over the next couple of years. Eventually, increasingly higher bandwidth will be accessible as the technology improves.



The THOR-7 satellite. Photo is courtesy of SSL.

Beta test partners were quick to praise the capability of the THOR 7 Ka-band service, with many staying on to become commercial customers on the satellite. Mark Sykes, Managing Director at AST, a satellite service provider, said of the service, *"We have been very pleased with it. We have used a lot of different systems and vendors, but if you blend all the factors together and assess the proposition as a whole—Telenor Satellite as a provider, the price performance, Ka-band, ease of installation—we are very excited by it. We think it has real market potential. We have already seen more uptake during the beta testing than we would have expected."*

The use of a much smaller, more lightweight 60 cm antenna has also been noted as a key benefit. Sykes continued, *"I must admit to being a little skeptical in the beginning, as to whether a 60 cm versus a 1 m could make that much difference, but it really does. The way you install a Ka-band antenna is much different to the way in which antennas used to be installed. That makes a big difference on some vessels."*

### Exceeding Expectations

In terms of performance, Beta testing has revealed that THOR 7 is exceeding expectations. This was evident early on in the testing phase, when Telenor Satellite benchmarked the performance they could get out of the platform.

Jan Hetland, Director, Datacoms Products & Services, Telenor Satellite, said, *"Even for the smallest antennas we were reaching download speeds of 70Mbps and upload speeds of 7Mbps. To us, that was a fantastic achievement and way beyond what we are able to do on our current Ku-band services. It really verified not just the satellite design, but the overall concept. We realized we had done something very right!"*

### Rain Fade? What Rain Fade?

During Beta testing, the issue of rain fade was also put to bed. Throughout the entire process, there was no impact from rain upon the signal. Technology has been implemented by Telenor Satellite to counter any effect that adverse weather may have on the signal.

Automatic Level Control (ALC), adaptive TDMA on the inbound, Adaptive Coding and Modulation (ACM) on the outbound and a diversity antenna all feature as part of the THOR 7 architecture. Mark Sykes emphasized this fact. *"A lot of people still talk about rain fade. On the two Ka- systems we have tested, we have not experienced any rain fade issues. All I can say is that physics says there should be, but in practice, there is no effect."*

### The Price is Right

The THOR 7 maritime service has also proved itself in terms of value for money. Telenor Maritime, another Beta test customer, provides GSM services at sea and the company has seen demand for data services rise rapidly since the mass adoption of smartphones. In the past, their struggle has been to deliver a high Quality of Service (QoS) at a price that people are willing to pay.

Jan Erik Norli, CSO, Marcom, Telenor Maritime, said, *"Through the THOR 7 Beta test, we have cracked the code in terms of pricing. The average price per Wi-Fi ticket on vessels is now affordable and fully comparable to Wi-Fi land-based tickets. The user environment on board is becoming more and more similar to that on land. This is quite an achievement."*

As a Beta test participant on THOR 7, Telenor Maritime now have a fully-fledged WiFi system up and running on the ferry Color Fantasy, with the capacity of roughly 68 Mbps supporting that one vessel. The system is highly reliable and works well but, moreover, people are willing to pay for it.

### Ka-band At Sea—Essential For The Future

There has been much discussion about Ka-band, especially when used for maritime connectivity. There have been many doubts and concerns raised as to Ka-band performance in the maritime environment; however, the THOR 7 Beta testing period has proved the absolute validity and the real need for Ka-band services at sea.

Jan Erik Norli stated, *"From the point we are at today, we couldn't have done what we have done without the access to Ka-band. It is as simple as that. If the Ka-band solution had not shown up at the time that it did, we couldn't have achieved what we have on board Color Fantasy."*

In order to facilitate mobility and to accommodate the massive growth in data-centric applications that today's modern world is becoming increasingly reliant upon, Ka-band is going to be key. The development of new services on board vessels for passengers, crew and business requirements will not stop and the bandwidth is required to support these demands. Satellites such as THOR 7 enable this development to continue and to give those on board any type of vessel a similar connectivity experience to one they would enjoy on land.

Telenor Satellite and THOR 7 are at the forefront of this development of the maritime connectivity business and will ensure that more and more customers are connected via satellite, no matter where they happen to be located.

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

*Helen Jameson started her career in the satellite industry with satellite organization GVF and has 12 years of experience in the sector. Helen edited the Satellite Evolution Group of magazines for more than eight years and today runs her own copywriting business that provides extensive writing services to the space and satellite industries. Helen also continues to contribute to a number of industry publications.*

## An Interview With Erik Otto Evenstad, Senior Adviser, Spectrum Management, Telenor Satellite, Regarding RFI...



### **Why did Telenor decide to recently host the IRG Workshop at your HQ?**

**Evenstad:** Telenor Satellite decided to host an IRG Workshop in early May as a part of the company's mission to provide our customers with high satellite link availability. The workshops continue to be important arenas wherein insight is acquired into technical solutions that are the most resistant to noise from interference sources. Plus, if interference is experienced in daily operations, what can defeat this occurrence. As satellite operators, we all need to face the reality of interference as a phenomenon and be proactive vis-à-vis our customers to take the necessary steps to avoid it.

### **How big of a problem is satellite interference for Telenor?**

**Evenstad:** Satellite interference (RFI) is normally not a problem for the DTH transponders that operate in the planned frequency bands. However, for transponders in the unplanned frequency bands that are used for data communications, and with many customers transmitting to and receiving from our satellite fleet at land and sea locations throughout Europe and in the Middle East, interference incidents do occur from time to time.

### **What processes and technologies do you currently have in place to tackle interference?**

**Evenstad:** Customer satisfaction is Telenor Satellite's target number one in our daily operations. We have dedicated intense efforts in educating our staff to handle interference problems and to follow up such incidents in close cooperation with our customers. It is crucial that staff handling the transmitting Earth stations are well educated in order for them to perform accurate line-ups by pointing the antenna toward the target satellite, adjust the polarization angle of the signal, adjust the power level, etc.

We have established an automatic monitoring RF system which is tracking power level and frequency stability on our 1 West satellite fleet and on external capacity at other orbital locations. The results are available as spectrum plots that help to identify the time of the event occurrence, the RFI type, determining relatives, and so on.

Moreover, independent Rx DTH monitoring sites are located in Europa to measure the signal as seen by our customers. This means that we are able to go back in time to control the status and quality of our satellite links.

We also engage in transmit monitoring of the main uplinks to maintain strict control and regimen for satellite interference mitigation. We utilize geolocation technology to help locate an interference source if we are unable to solve that problem using other means. We also employ coordination and capacity management tools to avoid interference from other satellites, services and carriers.

### **How does IRG help support your efforts in reducing satellite interference?**

**Evenstad:** IRG is important as this organization has brought additional attention to interference as an increasing problem among users and operators within the satellite community, and especially in focusing on how interference can be practically solved by motivating equipment suppliers to take steps to implement features into their products that could help us locate interference sources.

As the use of the geostationary arc is becoming more intense, the orbital separation between neighboring satellites decrease at the same time as the number of ground terminals increases, which significantly resulting in an increased number of interference incidents.

A common understanding of the impact of RFI is, therefore, vital. IRG has established an arena for bringing industry and operators together to learn about new technologies and products and to discuss the operational impacts of these upon this problem. The result is that, in the long run, we can all fight interference in a more intelligent and efficient manner.

### **What is the biggest cause of interference for Telenor?**

**Evenstad:** The biggest cause of interference we experience are power levels that exceed nominal levels, malfunctioning equipment, RFI caused by human error, mis-pointed antennas, intentionally induced interference and piracy.

### **What other initiatives would you like to see the IRG work on?**

**Evenstad:** We would like to see IRG continue to motivate the industry, the authorities and the operators to all work together so the industry may benefit from the enhancements resultant of new technologies that could fight interference.

By encouraging the actors in the community to continue to cooperate, we can achieve the best solutions for all. Moreover, operators, users and others should have access to an "education arena" (a web site) where interference scenarios around the globe are illustrated and described and where explanations are offered as to how those particular incidents were solved.

### **What additional topics were discussed at the Telenor sponsored IRG Workshop?**

**Evenstad:** The use of geolocation is a quick and absolutely crucial method to find the source of interference. There are many existing sites around the world that already have the equipment for geolocation installed in their locations. Although we are competing operators, all can benefit from the cooperation to assist in "finding the source" using existing equipment—that's the ultimate goal.

If Telenor Satellite can help in assisting another satellite operator with a particular interference incident, Telenor Satellite may well be aided by this same operator when another incident occurs. This is a win-win situation. Other issues to tackle include how to efficiently detect interference from moving sources, such as radio, vessels, cars, planes, and so on.



# Making The Invisible... Visible

By Russ Matijevich, V.P., HawkEye 360

**T**he world is entering a renaissance age for the smallsat.

Technological advancements of all types, including those observed by Moore's Law, coupled with greater speed and agility in smallsat manufacturing, have helped to reduce barriers to entry in space and allowed the space industry to increase processing power at a fraction of the cost. This increased power allows new access to untapped sources of data about the radio frequency (RF) portion of electromagnetic spectrum—and presents opportunities for improving the quality of life here on Earth.

Much of today's global economy uses the RF spectrum, from consumer electronics such as cell phones to communications networks that first responders rely on for emergency situations. However, there is currently no cost-effective way to monitor, locate, and visualize the use of this important, yet finite, resource whose channels are congested, competitive, and contested. Understanding and visualizing RF spectrum usage is critical to making decisions about future spectrum allocations and use. To develop the Big Data analytic capabilities needed to dynamically manage spectrum, the first step must be to efficiently collect the RF source data.

The need for a system that collects and analyzes information associated with RF spectrum utilization helped to inspire the formation of HawkEye 360 in September of 2015. Thanks to the recent evolution of smallsats, the company has been able to develop a new, space-based global intelligence network that will help to make visible what was once invisible about the RF spectrum and unlock the true value of Big Data.

HawkEye 360 is developing a Pathfinder Cluster mission of three smallsats that is scheduled to launch to Low Earth Orbit (LEO) by the end of 2017. Within two years of that launch, the company plans to have an

operational constellation deployment of another six, three-ship clusters.

Each of the smallsats will have receive-only software-defined radios running proprietary software, allowing us to detect, characterize, and geolocate a wide range of RF emitters. HawkEye 360's ground-based analytics platform will then fuse open-source data, commercial satellite imagery, digital terrain elevation data, and RF data to generate tailored analytics reports for customers.

The HawkEye 360's satellite constellation is being designed to be able to detect a wide range of signals with a high degree of precision and minimal latency. Once operational, it will be able to provide visualization and tracking of a variety of activities on Earth, support to RF signal geolocation efforts, and add resiliency to today's space infrastructure.

## Making The HawkEye 360 Possible

### Smallsat Propulsion: A Key Enabler

One of the challenges facing smallsat designers is developing a propulsion system that is on par with those in operation on larger spacecraft. For HawkEye 360, finding the appropriate propulsion solution was just as important as the microelectronics going into the software-defined radios and was a key decision point for selecting Deep Space Industries (DSI) and their partner, Space Flight Laboratories, as the prime spacecraft supplier.



The DSI Comet-1™ electrothermal micropropulsion system provides the necessary thrust and stored delta-v to support HawkEye 360's station-keeping requirements throughout the planned, three-year smallsat design lifespan with enough of a margin to surpass that estimate as well as to de-orbit the satellites, if necessary, for debris mitigation compliance. The use of water as the propellant in the Comet-1™ also greatly simplifies the satellites' pre-launch ground processing and launch procedures.

### Open Standard Software-Defined Radios

Another important enabling technology was advancement in the open-standard software-defined radios (SDR). Using GNU Radio as the foundation for the RF receiver payload, HawkEye 360 is combining proprietary code with advanced Field Programmable Gate Arrays (FPGA), allowing for signal detection, characterization, and geolocation capabilities updates throughout each spacecraft's three-year design lifetime.

### Big Data: A Revolution In Situational Awareness

As interesting as the spacecraft are, the real value of the HawkEye 360 system will be in distilling RF spectrum utilization data into actionable information that customers can use to solve hard problems. Over time, the expectation is that the satellites will become increasingly autonomous through the development of robust machine learning capabilities. This will, for example, allow the system to predict future behavior and trigger commercial satellite imagery or receive similar tip-off information from the imaging systems. Ultimately, an integrated machine-to-machine (M2M) system that facilitates new levels of situational awareness in the transportation, maritime and wireless communications (terrestrial and satellite) markets is expected.

### A Different Way To View The World

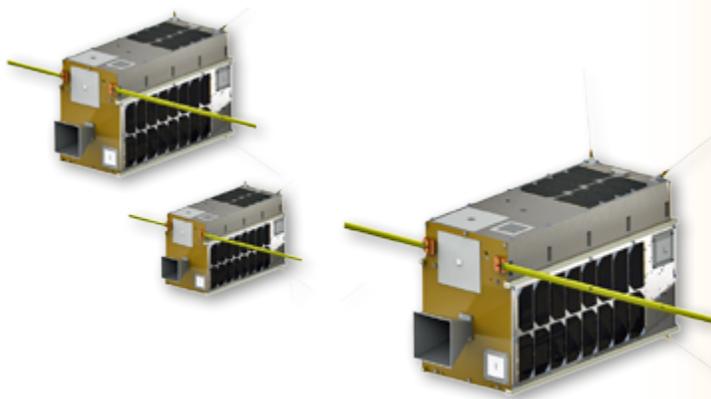
Thanks to the growth and availability of remote sensing systems and their data, the geospatial industry is thriving and evolving beyond only images of objects. Activity Based Information (ABI), looking at why something is happening in addition to where it's happening, is driving new methodologies for observing activity on Earth. Combining various data sources allows the geospatial analyst to infer additional insights beyond just the static snapshot of the scene.

HawkEye 360's RF data will take ABI a step further by creating contextualized activity-based information (CABI). For example, if there is a commercial satellite image of various ships in a specific maritime economic exclusion zone (EEZ), several questions would come to mind:

1. *Who are the ships?*
2. *What are they doing?*
3. *Are they supposed to be there?*

The static image, depending on resolution and cloud cover, may allow for answers to some of these questions—HawkEye 360's data analytics are being developed to provide those answers and more.

The company's Maritime Domain Awareness line of analytic products is designed to determine a ship's identity and self-reported location from the Automatic Identification System (AIS) broadcast. This ability is differentiated from other commercial sources of AIS data by also providing an independent geolocation of the AIS broadcast itself to verify that the ship is at the reported location. This is important as a nefarious actor could easily spoof that reported location.



What occurs if the AIS-identified ship is not on the EEZ owner's authorized list and the ship's captain turns off AIS believing such would enable avoidance of detection? At HawkEye 360, the planned system will be well positioned to address this real scenario.

In addition to AIS, the system has been designed to collect and geolocate other sources of RF data, such as from the ship's navigation radar or satellite communications. This information, can be used in combination with AIS if available, to dynamically observe the ship's heading, speed, and course, thereby allowing for an inference as to the nature of a vessel's activity and to provide the missing context of that original satellite image.

Tip-off messaging will also be supplied to commercial space imaging partners in order for them to provide a current image of a suspect ship. HawkEye 360's watch center will take the updated image, combine that image with the RF track data, and produce data analysis that the customer could then use to pursue legal recourse against the trespasser.

Assisting the fishing, shipping and other transportation-related industries with geolocation services is just one example of potential applications for the HawkEye 360 system. Others include:

**Emergency Response/Search and Rescue:** Minutes matter in an emergency. With the incorporated data analytics, Search and Rescue teams will be able to better pinpoint people in distress. HawkEye 360's technology will be able to collect information from emergency locator beacons and independently locate those beacons to account for a damaged GPS receiver or locations with poor GPS reception. The HawkEye 360 team will work with First Responders and emergency government agencies to quickly gather critical intelligence and offer multiple services to support Emergency Response and Search and Rescue efforts.

In the chaotic aftermath of a natural disaster such as a hurricane landfall, one of the necessary tasks is to establish reliable lines of communications between First Responders, disaster response agencies, rescue organizations, and survivors. HawkEye 360's RF mapping design is being developed to quickly identify what wireless communications technology (e.g. radio towers) are still working and what the available communication mechanisms are.

**Spectrum sustainability and security:** Today's global communications systems are plagued by a variety of interference, both intentional and unintentional. The ability to respond quickly and efficiently to such interference is often critical to avoid a negative impact to operations and human lives. Existing methodologies to determine the location and source of the interference can be expensive to use and generally take a long time to produce precise location data on the interference source. HawkEye 360 seeks to improve this process with precision geolocation

algorithms. This capability has the potential to increase the global resiliency and operational efficiency of communications systems with the development of a broadband monitoring satellite with a high revisit rate and low latency to combat growing interference issues.

**Spectrum management:** New concepts, such as shared spectrum usage, can change quickly based on demand and availability. These types of systems require special tools and data to efficiently operate in a dynamic spectrum environment. Emerging tools for managing these dynamics typically utilize ground-based RF sensing systems which have very limited range and high operating costs. They must also be physically present in the location in question. HawkEye 360's approach essentially takes that limited ground-sensing system to orbit. The satellites are designed to collect RF signal information over an area that is hundreds of miles in diameter. This will allow services that offer cost effective, rapid spectrum usage data.

Because the satellites can be updated on a regular basis as technologies change via their SDRs, HawkEye 360 will be able to efficiently and accurately collect the necessary information to visualize RF spectrum usage in near real-time. This data can be used to create one of the first-ever global spectrum inventory and mapping processes that will have the ability to provide accurate and cost-effective utilization data to government regulators. This tool could help accelerate spectrum knowledge and enable broader and more rapid adoption of spectrum sharing policies.

The demand for access to additional RF spectrum will continue to grow and HawkEye 360 plans to be there to support that growth with capabilities that have the potential to redefine how governments and industries view and use the RF spectrum, with a cost-effective approach to precisely mapping spectrum usage. That knowledge is a key enabler and could bring about a renaissance in spectrum allocation and use.

### **A Bright Future**

At HawkEye 360, the future is exciting. The firm thrives on solving big problems in collaboration with industry and government partners. With successful airborne demonstrations this year to the planned Pathfinder Cluster launch next year, HawkEye 360 is moving forward at a rapid pace in an effort to bring commercial RF sensing from space to market and to help change the way we all look at the world.

[www.he360.com](http://www.he360.com)

*As Vice President of Sales, Russ develops and manages relationships with commercial, government, and international clientele. He is a retired US Air Force Lieutenant Colonel with more than 25 years of space, satellite, and aeronautics experience. During his military career, he led teams on world-wide deployments, integrating space-based solutions into tactical environments; routinely briefed high-level military and civil officials on complex national security issues; and managed high-budget aerospace technology programs. Since his retirement from active duty in 2011, Russ has served in key business development positions with SAIC and Northrop Grumman, and owns his own consulting firm focused on aerospace technology market analysis. An accomplished competitive sailboat racer, he also enjoys songwriting and playing his guitar in church.*

### **HawkEye 360's Vice President Russ Matijevich Insight...**

*HawkEye 360 is developing a space-based global intelligence network that will use radio frequency (RF) technology to help monitor transportation across air, land and sea and assist with emergencies. The company's envisioned constellation of smallsats in LEO will collect information on specific radio signals worldwide to provide high-precision radio frequency mapping and analytics that can be customized to clients' needs.*

#### **What applications do you see as most valuable to HawkEye 360's business?**

**Matijevich:** *Initially, our Maritime Domain Awareness application will be of primary interest because it directly addresses many of the hard problems facing the maritime industry, such as illegal fishing. But in the long term, we expect the data analytics that we'll distill down from this massive amount of RF-related data we'll be collecting will be helpful to a variety of industries — from wireless carriers to emergency responders and transportation and logistics providers. Ultimately, we believe that our system will help change the way folks look at the world.*

#### **You've alluded to parallels about what HE360 is trying to achieve with advances in the satellite imagery market. Can you elaborate?**

**Matijevich:** *When commercial satellite imagery first became available, most folks looked at it as nothing more than an unclassified version of Government-produced imagery. And in the early days, commercial satellite imagery was mostly used in unclassified settings, filling a basic need for images. Since that time, we've seen a revolution in the applicability and usability of commercial satellite imagery bolstered by the widespread use of geospatial information. In the RF signal collection world, I think we'll see a similar evolution. We'll begin by performing traditional observation tasks of "this signal was active at this time from this latitude and longitude," but eventually we'll see advances in data analytics and machine-to-machine automation.*

#### **Please discuss how a service like HE360's can help with recent policy discussions at the FCC about new ways to dynamically share spectrum.**

**Matijevich:** *RF spectrum is a finite resource that is becoming increasingly congested, competitive and contested. As the FCC and other regulatory agencies work to manage it, they're lacking a key piece of information: How is the spectrum truly being used? They have databases of license holders, but they don't have a cost-effective way to verify that the license holders are using the spectrum in accordance with their license. And they don't have a cost-effective way to independently determine what spectrum is available in any given area. One of our goals at HawkEye 360 is to provide them with that cost-effective mechanism to develop a national spectrum inventory.*

#### **You mentioned how smallsat speed and agility are changing the face of commercial space. How does HawkEye 360 plan on harnessing those qualities?**

**Matijevich:** *Our pathfinder mission is on a schedule to go from on-contract to ready to launch in 12 months. The goal is to have our follow-on missions go even faster, combining speed with the agility of updating our payload, either through hardware for a new satellite or via our on-board software-defined radios. Let's think about it in terms of cost savings while still being able to perform a mission. For a full-size government-sponsored satellite, those programs tend to take upwards of 10 years to get on orbit and can cost close to \$1 billion over that decade. By comparison, we expect to be ready to launch in 12 months with cost savings by an order of magnitude of 100x.*

#### **Why did you select DSI for your satellite manufacturing?**

**Matijevich:** *DSI initially impressed us with the propulsion systems they've developed. We anticipate needing a good amount of on-demand, impulsive delta V during our three-year design life, and the DSI system really stood out. As we got to know the teams at DSI and Space Flight Labs, we realized that we all shared a vision of using smallsats to conquer hard problems in space — and the relationship just clicked. We're working well together and excited about what the future will bring.*



# Expanding Smallsat Capabilities & Making Them Affordable

By Vytenis Buzas, CEO and Co-Founder, NanoAvionics



**D**uring recent years, the smallsat (below 150 kg) market has rapidly expanded—from 180 launches in 2014 to an expected 630 launches in 2018—such an expansion signals some exciting changes are ahead for the industry.

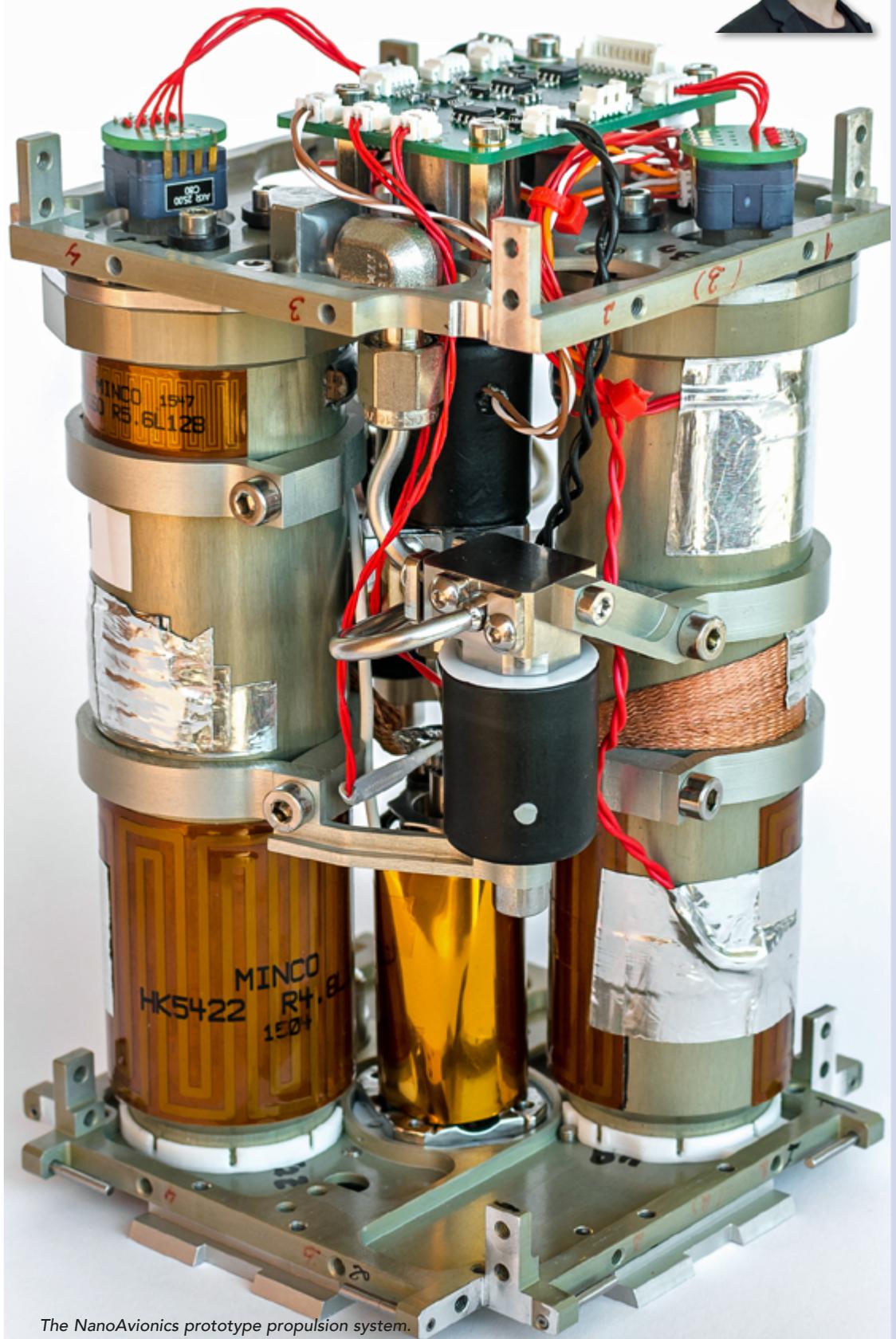
In the past, space access was a privilege for those individuals and firms who had sufficient financial resources. The others remained on the sideline, dreaming about such opportunities and waiting for better times and newer technologies to arrive that would change their situation.

Today, even smaller countries are able to reach space with their own satellites. In 2014, Lithuania launched their first 1U CubeSat LituanicaSAT-1, which allowed Lithuania to join the space league. This launch also introduced that nation to the global small satellite industry and demonstrated that countries without special space programs or significant investments can become competitive.

The smallsat industry has emerged as way to lower the cost of access to space. However, the popularity of smallsats continues to be limited by technology. Many deficiencies and limitations were associated with smallsats in the past. Even nowadays, some critical subsystems and other important technologies are not quite fully developed to enhance this market's full potential. The good news is that technological advancements have opened new opportunities and are transforming the market for the better.

## Big Challenges—New Approaches

Smallsats, especially within the micro/nano size, face significant challenges concerning integrity, propulsion, attitude control, communication and computational systems in order to perform dedicated missions. There are limitations when it comes to

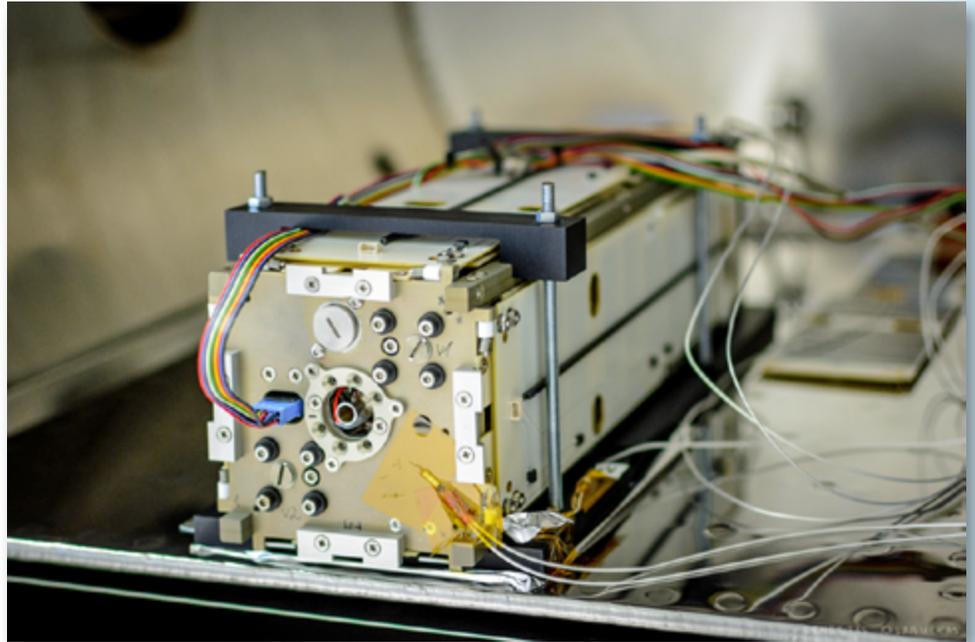


The NanoAvionics prototype propulsion system.

scaling and miniaturizing existing technologies to provide suitable electronic and mechanical systems for smallsats. Manufacturers are being forced to implement the latest of these technologies even though those solutions may be, at best, poorly tested.

NanoAvionics was established to commercialize the knowledge and the experiences gained from the LituanicaSAT-1 mission. The company's team faced many challenges during this mission, including the integration of various components from different manufacturers—valuable experience was gained thanks to working cutting-edge technological solutions into smallsats. NanoAvionics derived a new plug-and-play approach that offers highly integrated products that save customers' development time and costs, as well as the reliability and functionality to create more payload volume on board the spacecraft.

Today the company works on the development of new products for the growing, global, smallsat market, addressing the most significant factors of price, durability, reliability, integrity and lead time. NanoAvionics' goal is to make smallsats affordable to a wider range of companies and organizations around the globe and to expand smallsats capabilities as these craft will play a leading role within the future satellite market.



*Photo of the LituanicaSAT-2 smallsat, courtesy of NanoAvionics.*

### **The Big Change**

Smallsats remain waiting for some critical subsystems to be fully developed. High-performance propulsion systems are one of the technologies required by smallsats to take advantage of their full market potential. Propulsion

systems enable orbital maneuvering, attaining the correct attitude and orientation, drag compensation and longer system lifespans for satellites.

Propulsion also permits satellites to perform orbital missions such as crucial Earth Observation (EO) missions, high frequency and data throughput communication, accurate weather forecasting, constellation and formation flights, interplanetary missions and many other applications. There are currently no technical solutions available on the market to empower smallsats with propulsion systems that are low in cost and possess the required level of functionality and technological adaptability.

NanoAvionics is the first company in Europe to address this acute need for a low cost solution to smallsat propulsion. The company has already developed a prototype of a miniaturized, high performance, chemically fueled propulsion system (EPSS) and received an EC Horizon 2020 SME-instrument Phase-1 grant to commercialize this solution.

The purpose of phase 1 of the EPSS project is to engage in a feasibility study of the firm's novel propulsion system. The potential of the proposed product is recognized worldwide and the awarded grant demonstrates the robustness of this business idea. Typically, NanoAvionics' product would be necessary for EO and for nano and micro class communication satellites.

The proposed system from NanoAvionics makes use of a contemporary "green," non-toxic, monopropellant which has a higher specific impulse as compared to classic hydrazine employed systems. The latter is normally used in large scale satellite technologies and permits significant levels of thrust to be stored within a relatively small storage tank.

NanoAvionics' novel solution corresponds to the European Space Agency's (ESA) and the National Aeronautics and Space Administration (NASA) Clean Space Initiative and opens up a wide range of possibilities for cost reduction and safety, while simultaneously empowering new space start-ups with an affordable space propulsion systems.

The prototype propulsion system is able to perform high impulse orbital maneuvers and drag compensation as well as an ability to outperform hydrazine. In order to manage the thermal properties of the various propellants in space, the propulsion system includes an active thermal management system for the pressurized tanks as well as propellant management systems to ensure the smooth flow of the propellant blend. Furthermore, the micro-thruster assembly contains a pre-heater for improved heat transfer to the catalyst to provide a maximum thrust of 0.3N. This propulsion unit is designed with a blowdown propellant supply mode, which saves weight and ensures system reliability.

The initial prototype is an enabling and integral plug and play design. The on orbit testing campaign will occur with the LituaniaSAT-2 mission at the close of 2016 to demonstrate the technology. Prototype components, such as valves, fuel tanks and the propellant management system, are designed and manufactured in Europe. The final product will be scalable according to client satellite mission requirements and will also be compatible with the CubeSat standard as well as suitable for smallsats below 150 kg.

## **Lowering The Cost**

Recently, NanoAvionics signed a contract with Kubos Corporation, a leader in open source satellite software, to develop the software for the NanoAvionics flight computers. The expectation is that this agreement will assist both companies to achieve their goals of making the smallsat industry far more affordable for more players. NanoAvionics considers specialization, professionalism and successful collaboration as means to leading to more specialized, customer-oriented solutions at affordable prices.

Kubos has been commissioned to design and develop a pure software Single Event Upset (SEU) solution to correct the errors that can occur in the satellite's memory due to the bombardment of radiation. Whereas most SEU solutions are hardware based, Kubos' solution is software based and is open source.

The SEU will be used on the LituaniaSAT-2 mission, which is the part of the "QB50" initiative led by the Von Karman Institute (VKI) for fluid dynamics (Belgium), under the European Commission's research and innovation program FP7 (2007-2013). The goal of the mission is to run science experiments in the lower thermosphere and ionosphere, as well as to perform a technology demonstration of the new "green" propulsion prototype and the new command and data module, SatBus 3C1, which will run the SEU.

The CEO of Kubos, Marshall Culpepper, agrees that collaboration with NanoAvionics opens up several new opportunities that will be provided through the combination of quality integrated electronics and open source software. This is most important as innovation and new approaches lead to significant progress that will transform the satellite industry as such is known today. This mission will act as a blueprint as to how open source and affordable technology can be used in space to benefit the many, rather than the few.

*Vytenis Buzas is Chief Executive Officer and Co-Founder at NanoAvionics. Vytenis holds M.Sc. in Mechatronics from Kaunas University of Technology (Lithuania) and B.Sc. in Aeronautical Engineering from Vilnius Gediminas Technical University (Lithuania). He was a head of the first Lithuanian satellite LituaniaSAT-1 mission. He also holds an experience as an employee at NASA AMES research center where he was involved in projects related to liquid mono-propulsion systems for small spacecrafts. Vytenis has worked in the space industry for more than seven years.*

*NanoAvionics is a fast growing aerospace company that is focused on delivering new generation electronic and mechanical smallsat system solutions and components. The company's team has already implemented several successful smallsat missions, including the first Lithuanian CubeSat mission LituaniaSAT-1 and the nextgen smallsat LituaniaSAT-2 mission for the European "QB50" project. NanoAvionics' smallsat solutions offer high reliability and functionality while providing more volume for onboard payloads. The company also offers a new plug-and-play approach that offers highly integrated products to save development time and costs for customers. The product range consists of components and subsystems, such as complete satellite buses, communication systems, onboard computers, attitude determination and control systems, power supply systems, as well as structural and deployable elements.*

**[www.n-avionics.com](http://www.n-avionics.com)**

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## An EARSC Case In Point: Winter Navigation In The Baltic



**P**eople around the world are seldom aware of how satellites are truly beneficial to their everyday lives.

In example, the citizens of Finland directly benefit as satellite imagery is helping to keep their supermarkets supplied with goods and by keeping the nation's factories open. EARSC (European Association of Remote Sensing Companies) wanted to examine these benefits in more detail and to calculate exactly how much the use of satellite imagery is worth to the Finnish economy.

Not many people realize that Finland is an island—clearly, not an island in the classical sense; however, as more than 90 percent of Finland's imports and exports pass by sea, the nation has one of the key characteristics of an island nation. In addition, all of Finland's ports freeze over in a normal winter—helping cargo ships navigate the sea-ice is of strategic importance to the Finnish government and the citizens.

Another nation seriously affected by sea-ice is Sweden and this challenge has led to close co-operation between the two governments to run an effective and efficient ice breaking service. In 1971, the Finnish government decided to keep 25 major ports open throughout the year. This led to investments in ice breakers. Until 2003, each ice breaker was equipped with a helicopter which flew over the sea-ice to seek the best route for ship passage. Then, in 2003, helicopters were replaced by the use of satellite radar imagery which offered a number of charting advantages.

First, helicopters can only cover a limited area around the ship, whereas satellite images show a synoptic view of the entire Gulf of Bothnia. This allows routes to be plotted through the ice directly to the port, a major benefit to the operation. Second, just when the weather gets bad and ice conditions are most changeable, the need for an accurate picture is most

acute—but helicopters cannot fly in such conditions. With radar satellites, such is not the case—images can also be taken at night and the imagery cost is far less than operating helicopters.

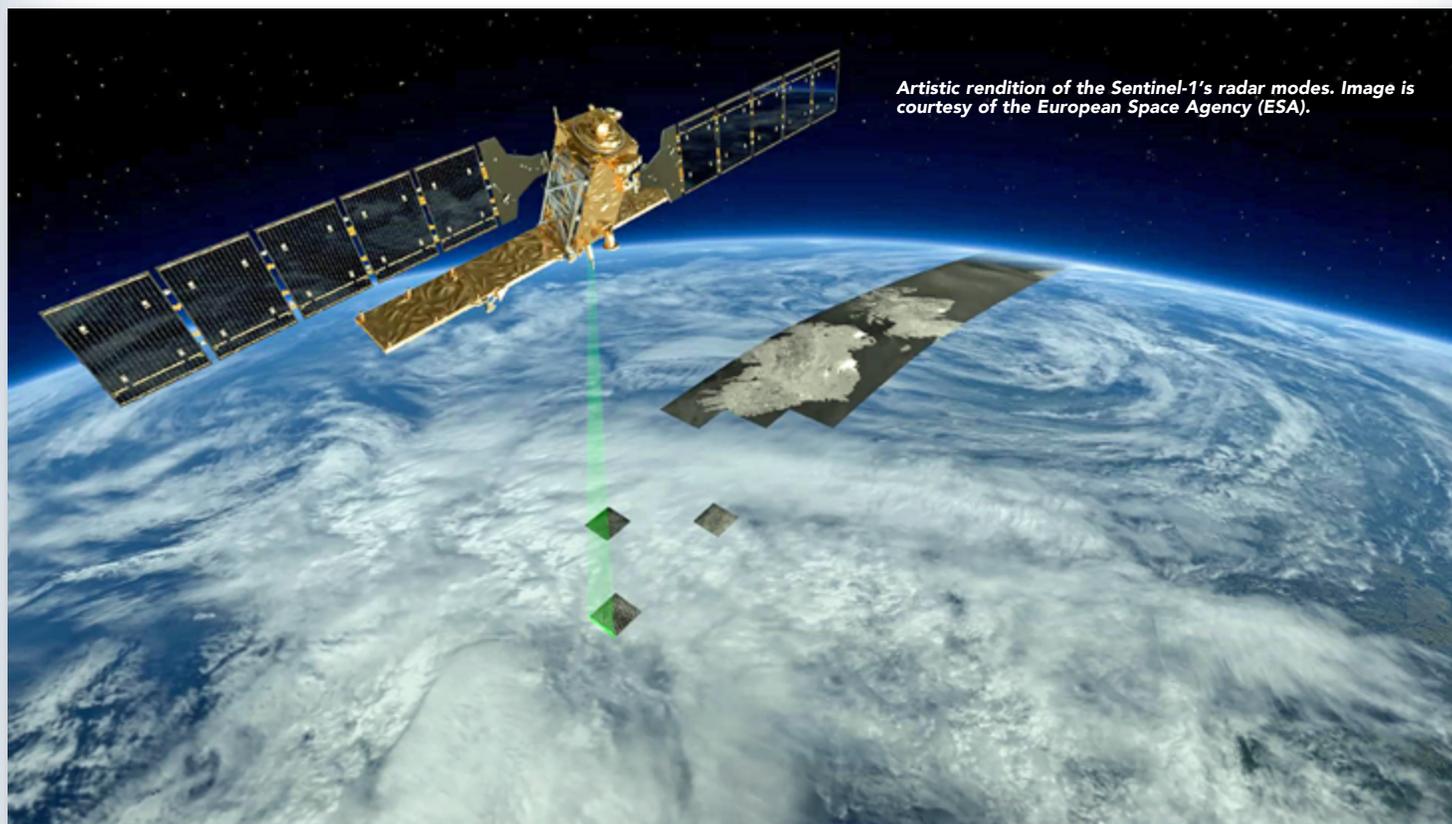
The use of the imagery allows ship captains to plot shorter and more efficient routes to their ports, which helps the both the ice breakers and the ships being guided to save fuel. The ships are also saving time, which translates into lower charter costs and better use of the ship to carry cargo.

Without the use of icebreakers, ships can become stuck in the ice and may be required to take many days to reach their port of destination. Hence, the clearing of sea lanes (DirWays) allows operators to know the time of ship arrivals with more certainty.

This helps the ports to operate more efficiently and, in turn, the factories which are being served by the ports to better plan their just-in-time production. Indeed, without the icebreakers, the factories would probably not be able to operate at all, or at best, they would be working only eight or nine months of the year. The impact of the ice-breaking services on the factories and on the local economy is extremely important.

Lacking any prior analysis of the impact of the ice-breaking services on the Finnish economy, the EARSC was forced to develop a new model and to make some assumptions. The analysis led to a calculation of a total economic benefit to the Finnish and Swedish economies of at least 24 million euros and as much as 116 million euros per annum.

Of the total benefit, 2.3 million euros comes directly from the cost savings of ice-breaker operations and lower fuel costs from taking shorter more effective routes versus the helicopter operation costs. A further 2 to 3 million euros comes from similar savings of fuel and lost time for the ships serving the Finnish and Swedish ports.



*Artistic rendition of the Sentinel-1's radar modes. Image is courtesy of the European Space Agency (ESA).*



Further benefits accrue to the ports (6 to 9 million euros) through more efficient operations. However, the main gain is to the local economy—the estimate for the factories is between 6 million and 63 million euros.

The cost of using satellite imagery for such work is rather low. Imagery currently costs around 250,000 euros per annum but this will fall to zero through the use of the Sentinel 1 satellite. The processing costs and the images are sent to the ice-breakers through the existing IBNet information system.

Satellite imagery is positively touching every citizen living in Finland. With the greater certainty of ship arrivals, citizens are employed throughout the year and can be more assured of having the fuel on-hand to

heat their homes and to power their power cars as well as being able to visit fully stocked supermarkets and pharmacies.

*Thanks to satellites, citizens truly benefit.*

**[earscl.org/](http://earscl.org/)**

*The European Association of Remote Sensing Companies (EARSC) is the European organization which, on a non-profit basis, promotes the use of EO technology and especially the companies in Europe which offer EO-related products and services. We are a membership based organisation with the mission to foster the development of the European EO geo-information services industry.*

*Editor's Note: This article first appeared in Geoconnexion Magazine.*



# Paving The Way For Global Smallsat Innovation

## A Tyvak International Perspective

By Dr. Marco Villa, CEO, Tyvak International

**S**pace-based research and utilization are at an all-time high right now, and the industry is only growing.

To meet growing international needs, Tyvak International has leveraged the recognized leadership of Terran Orbital within the small satellite (smallsat) sector to assemble a diverse team to develop European-made, state-of-the-art solutions, solutions that are not yet being offered by others in the marketplace.

Through contracts with organizations across the globe, Tyvak International is developing nexgen spacecraft that will raise the company's profile in the international market. Following requests from local customers, these platforms maintain the characteristics of their American counterparts, but adopt non-US technology and manufacturing.

By being widely adaptable and easily customizable up to 100 kg, and having radiation-tolerant architecture—as well as low power consumption built in—these platforms are capable of supporting multiple applications that are at the epicenter of today's space utilization market.

From formation flying to interplanetary missions, maritime domain awareness to weather monitoring through GPS radio occultation, comparable solutions able to reach the same level of optimized performance, assurance and cost would be difficult to locate. Through inter-satellite communication and data fusion capabilities, these platforms can work together as a network or in an isolated manner. The potential is truly limitless with this type of smallsat technology—and the world is taking note.

Earlier this year, the European Space Agency (ESA) selected Tyvak International to demonstrate the feasibility of having smallsats provide autonomous inspection and support services on the International Space Station (ISS). The company was selected as the prime contractor for the "Multi-Purpose CubeSat at ISS" study, conducted under the ESA General Studies Program (GSP).

Tyvak International is responsible for developing a design for the ISS-bound platform, identifying innovative methodologies for the platform's launch to, or deployment from, the ISS, all of the safety needs and to pinpoint any possible constraints of having smallsat units operating autonomously in the ISS environment. Additionally, Tyvak International will develop and recommend an optimal path forward to ensure full flight readiness within a short timeframe. The ESA study is expected to be completed by early fall 2016.

In parallel to satellite development, within the launch integration domain, Tyvak International has already won an open competition from the ESA Educational Office to integrate three European cubesats into the Soyuz launch that is slated to carry the Sentinel-1B.

The mission, part of the "Fly Your Satellite!" program, was successfully completed in April of this year and was executed in only five months. In addition to this incredible effort, Tyvak International has signed additional contracts to broker, integrate and launch commercial satellites from Italy and other EU countries in early 2017.



In order to be ready to provide customer support and to manage program execution from day one, the team spent the last few years engaged in extensive research within the European market. The team met with key government and commercial players to determine the market's immediate needs in the smallsat space. As a result, the company has been purposefully structured to provide one of the most advanced suites of smallsat products and services available in the world...

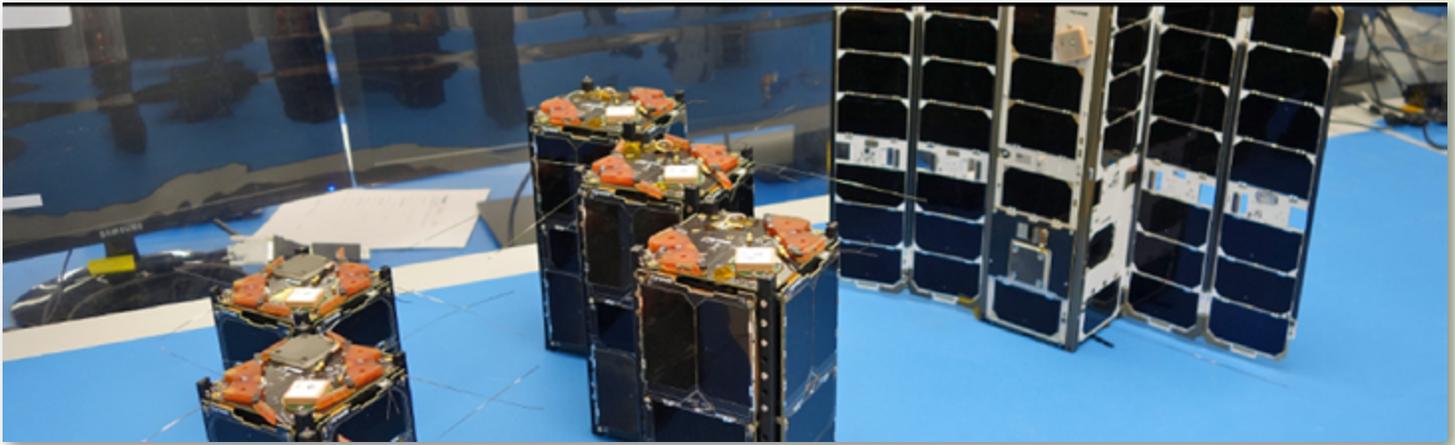
- Tailored consulting services for each mission type and vehicle design
- Launch integration services, leveraging close relationships with global launch providers to garner the best value for each customer
- Customization of components to support unique projects
- Flight-proven, miniaturized, low-power electronic boards that are scalable in number and size
- High performance attitude determination and control hardware and software solutions and multiprocessor embedded Linux software architecture
- Launch and satellite insurance

Created to address unfulfilled and growing smallsat needs, Tyvak International supports companies who may be unsatisfied by the currently available, legacy options for spatial missions. Newer companies such as Tyvak are now offering complete program lifecycle expertise, mission development, hardware and software, all under one roof. These products and services are available at far better price points and timelines than the current smallsat customer might expect to receive.

Tyvak International selected Turin for the location as their first European office due to the area's strong aerospace industry focus and proximity to Politecnico di Torino (one of the largest engineering universities in Europe). Turin's location also provides easy access to the multitude of high-technology companies available in Italy, France, Germany and Switzerland.

The new Tyvak International office is located within I3P, the leading small business incubator in Italy and one of the Top Five Incubators in Europe. As part of its low-cost strategy, I3P has been the perfect partner to offload administrative tasks, which then allows the team to focus on the





The Endeavour product line is Tyvak's solution to the needs of high-performance cubesat missions. The system incorporates all spacecraft bus subsystems including high speed communications, 3-axis high performance attitude control and high power options. All the Endeavour components were designed and engineered in-house to ensure that all subsystems interact flawlessly and provide a single interface point for development of a mission.

capture and execution of contracts. The company is ahead of schedule to reach 50 full time employees and a secure and larger, independent office. The firm's long-term potential has been confirmed by requests for Tyvak to open additional offices in other countries as the seed to develop a local ecosystem focused on smallsats.

Tyvak International will work closely with US-based Tyvak locations, but will operate independently and grow in response to European Union (EU) and European Space Agency (ESA) commercial needs, as well as requirements from other European-based small satellite programs.

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

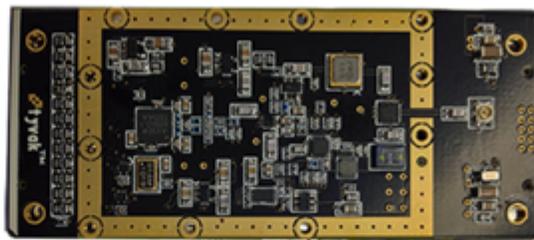
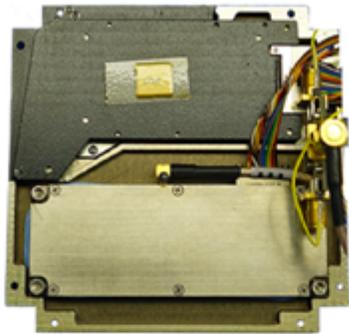
Dr. Marco Villa is a seasoned aerospace executive. He currently serves as the CEO of Tyvak International SRL, as well as the COO of Terran Orbital Corporation. His responsibilities are day-to-day company management, strategic efforts and the acquisition and execution of all smallsat opportunities for government, commercial and university customers worldwide.

Dr. Villa has worked on some of the most advanced and cutting-edge programs in the aerospace industry, from technology demonstration satellites to leading commercial efforts, and has developed a unique expertise that combines business management, finance administration and technical knowledge.

Previously, Dr. Villa served as Director of Mission Operations at SpaceX and managed the missions of the Dragon spacecraft to and from the International Space Station. Additionally, as a founding partner of mv2space, Dr. Villa continues to provide broad business development expertise to the aerospace industry, including strategic planning, investment capture, and program management.

Founded in February 2015, Tyvak International SRL, based in Turin, Italy, is a wholly owned subsidiary of Terran Orbital that provides small satellite products and services to enable new capabilities for both government and commercial customers.

## Communication Systems



	UHF	S-Band
Frequencies	400-470Mhz, 800 to 930Mhz	2.2 - 2.4Ghz
Data Rates	1.2 - 250kbps	0.1 - 46mbps
Modulation Schemes	FSK, GMSK, BPSK, OQPSK	FSK, GMSK BPSK, OQPSK
Encoding	AX.25	CCSDS
RF TX Power	Up to 2W	Up to 2W
DC TX Power	7W	12W
DC RX Power	130mW	n/a
Antenna Configuration	1.9dBi Omni-Directional Deployable Dipole	5dBi Patch Antenna/s
Operating Voltage	3.3V	6.5V
Data Interface	SPI	UART and Synchronous Serial
Mass	20 grams	40 grams
Volume	70 x 30 x 7mm	32 x 87 x 8mm

# SatBroadcasting™: RF Interference Is No Longer A Titanic Disaster For Satellite Broadcasters

By Itzik Wulkan, CEO, NovelSat

**O**ne hundred and four years ago, the HMS Titanic embarked on an historic first—and last—voyage.

While the iceberg is generally blamed for the disaster, at least some of the guilt can be attributed to outdated communication equipment that was improperly used. As Bill Kovarik explains in *“Revolutions in Communication,”* approximately 15 minutes prior to impact, the ship’s radio operator was catching up on sending a backlog of passenger telegrams when a radio call was transmitted with an ice warning.

According to Kovarik, *“Technically, the problem with the Titanic’s radio telegraph system was that Marconi’s ‘spark’ system soaked up virtually all of the frequency bandwidth and created interference for all other ships within signaling distance.”* The ice warning was lost. The rest of the story is well known.

Today, ships are safer and communication technologies have improved by leaps and bounds. However, two elements have not changed since the Titanic disaster: Lives and livelihood still depend on reliable communication and weather and man-made obstacles can still foul up even the most cutting edge technology. Whether the satellite technology is used for saving lives or providing valuable communication and broadcast services, the overall communication success is subject to the ability to mitigate the impact of RFI (Radio Frequency Interference) on satellite transmissions.

## A Growing Problem

RFI is a growing problem for the businesses and organizations who rely on satellite transmission. RFI reduces bandwidth efficiency and can lead to service degradation, which can endanger reputations and customer relationships. This trend is expected to expand in coming years as a result of reduced orbital spacing, with more and more launches (including the LEO and MEO constellations that have barely started to fill the skies). Even if an RFI incident has not been experienced recently, the chances of transmissions being affected grow almost daily.

Broadcasters are especially sensitive to RFI incidents during live transmissions, such as major global sporting events with millions of viewers and hours on end of live transmissions at high resolutions up to 4K. In addition to the costly reduction in bandwidth efficiency that RFI can cause for any satellite user, interruptions during these widely viewed events can lead to significant penalties for broadcasters who hold valuable transmission rights.

Mitigating an RFI incident is not necessarily simple. Before knowing how to reduce the effects of RFI, the nature of the RFI and the location of the source must be known. This can be quite complicated and resource-consuming.



In some cases, RFI cannot be mitigated at all. That results in dead-capacity, where the satellite frequency band is abandoned. There are also global interference events where RFI impacts the satellite as well as the entire beam. As satellite operators are usually responsible for global RFI, this is the type of RFI has the most statistical data collected for cataloging the problems. The major sources of RFI are unwanted-carrier, X-Pol and Adjacent Satellite Interference (ASI).

### **Unintentional RFI**

Other types of unintentional interference, however, are somewhat random in nature and are often only reported internally or to equipment vendors when a satellite user needs mitigation assistance. Unintentional RFI can be caused by incorrect operation of SNG (Satellite News Gathering) or VSAT terminals or equipment malfunction. To help reduce unintentional RFI incidents, there is an ongoing effort in the satellite industry to certify equipment in a more comprehensive way and to develop and implement operator training programs.

### **Jamming**

In addition to unintentional RFI, intentional jamming incidents, while rare, are increasing around the globe, and in particular in the more volatile regions of the world. The bulk of these incidents are related to highly visible events and political conflicts.

These are especially hard to mitigate in a timely manner, due to the lack of cooperation from the jammer. In a well-known example of intentional jamming in October of 2012, the reports was that forces in the Syrian government were believed to have joined Iran in jamming the satellite frequencies of international broadcasters. The targeted jamming cut off radio and television feeds from broadcasters that included the BBC, Deutsche Welle, France 24, and the Voice of America.

### **What Can Be Done?**

In addition to the sources of RFI already mentioned, there are also many local interference types, such as LTE and cellular signals, that can impact signals at a receiving Earth Stations. Regardless of the source and type of RFI, clearly, there is no way to stop radio waves from entering into a field of operation.

What can be done? Depending upon the source and severity of the interference, different approaches are used to mitigate the impact of RFI on satellite services and their performance.

When service is interrupted by severe global interference caused by unwanted carriers, such as VSAT, radar, and so on, the first course of action for the satellite operator is to shift the service to an alternative frequency and to then locate the source to try to eliminate the RFI at the point of origin. This is difficult and not always possible.

To locate the source of RFI, the operator can use geolocation methods, requiring coordination between adjacent satellite operators and access to expensive tools. Convincing those responsible for the RFI to cease their activity can also be a challenge, especially in certain parts of the world.

### **Carrier ID—A Good Start**

DVB-CID is a new standard, developed by industry consortium Satellite Interference Reduction Group (IRG) that has been embraced by many satellite equipment vendors and is now mandatory for all mobile satellite stations (DSNGs) in the US.

New modulators equipped with the standard encode a Carrier-ID (CID) containing contact information for the service's operator, into the satellite transmission signal. This simplifies and speeds up the process of finding the source of interference.

However, the CID standard is useful only for new services and specific types of RFI. While CID is an important step in the correct direction, this is just one piece of the puzzle.

### **What Else Can Be Done?**

RFI impact can also be lessened by reducing transponder gain, which also reduces RFI signal power. This process, while often effective, is problematic and cannot be used in many cases, due to link-budget limitations.

Instead, local interference is usually handled by moving or protecting the receiver antenna or, if the RFI is not on the exact service frequency, by adding a band-pass filter. Unfortunately, the downside to these methods is that they are resource-intensive and can lead to major breakdowns in service delivery.

Fortunately, new innovative technologies have been developed in recent years to help combat RFI: Robust interference mitigation receivers include advanced receive algorithms to cancel interference. As there are many types of RFI, each with distinctive characteristics, no single receiver algorithm is applicable. For example, mitigating CW RFI is completely different from canceling Radar RFI. Therefore, a set of advanced mitigation algorithms and detection mechanisms are needed to be able to handle all RFI types.

Another powerful set of tools against RFI are advanced satellite transmission waveforms. These new waveforms have built-in mechanisms to further increase resilience to interference, as well as other signal-disrupting impediments such as phase noise and weather fluctuations.

In addition, enhanced RFI analysis tools can be embedded in the satellite terminal to enable satellite users to identify RFI incidents in real-time. This is mainly useful for local interference sources which are not visible to the main teleport or broadcast hub. These technologies enable satellite service providers to continue high-quality transmission even while various types of RFI are present.

### **The Tip Of The Iceberg**

There is no question satellite RFI incidents will continue to grow, potentially causing a major impact on revenue and customer satisfaction for satellite broadcasters and other service providers. On the other hand, satellite solution providers and industry groups such as IRG have developed new RFI handling technologies and continue to create new ways to mitigate the impact of interference on satellite signals.

As operators continue to launch new satellites and more services come online, these emerging methods and technologies will enable satellite users to deliver continuously reliable satellite services even when RFI appears—and that's just the tip of the iceberg.

**novelsat.com/**

*Itzik Wulkan has more than 30 years' experience in the telecom industry. Prior to founding NovelSat in 2007, he served as CEO, VP R&D, VP Sales & Marketing, and VP Corporate M&A at companies such as Audiocodes, Comverse and Tadiran. He has been awarded five patents and several others are pending. Mr. Wulkan holds a BSc (Cum Laude) from the Technion as well as an MBA from Tel Aviv University.*

*This article's opening abstract image is licensed from Dreamstime.com.*

# Tackling The Challenges Of Satellite Communications Bandwidth

By Lars Christensen, M.Sc.C.S, Chief Architect, GateHouse Telecom A/S

**F**rom the various experiences all have had with landline Internet connections, a general understanding is that a satellite Internet connection is performance limited to a given bandwidth.

The following chart offers examples of bandwidths that are offered by Inmarsat:

Bandwidths offered by Inmarsat	Data rate	Allocation
<b>BGAN Standard IP</b>	<b>Variable data rate</b> Up to 512 Kbit/sec (shared channel)	<b>On-demand</b>
<b>BGAN Streaming</b>	<b>Fixed data rate</b> (e.g., 128, 256, 384 Kbit/sec, reserved capacity)	<b>Static</b>
<b>Global Xpress</b>	<b>Committed &amp; maximum data rate</b> (shared channel with minimum service level)	<b>On-demand</b>

The total satellite communication channel bandwidth is shared with other users in order to maximize frequency spectrum utilization. As a consequence, each user's terminal is at a particular time only allocated the bandwidth actually in use.

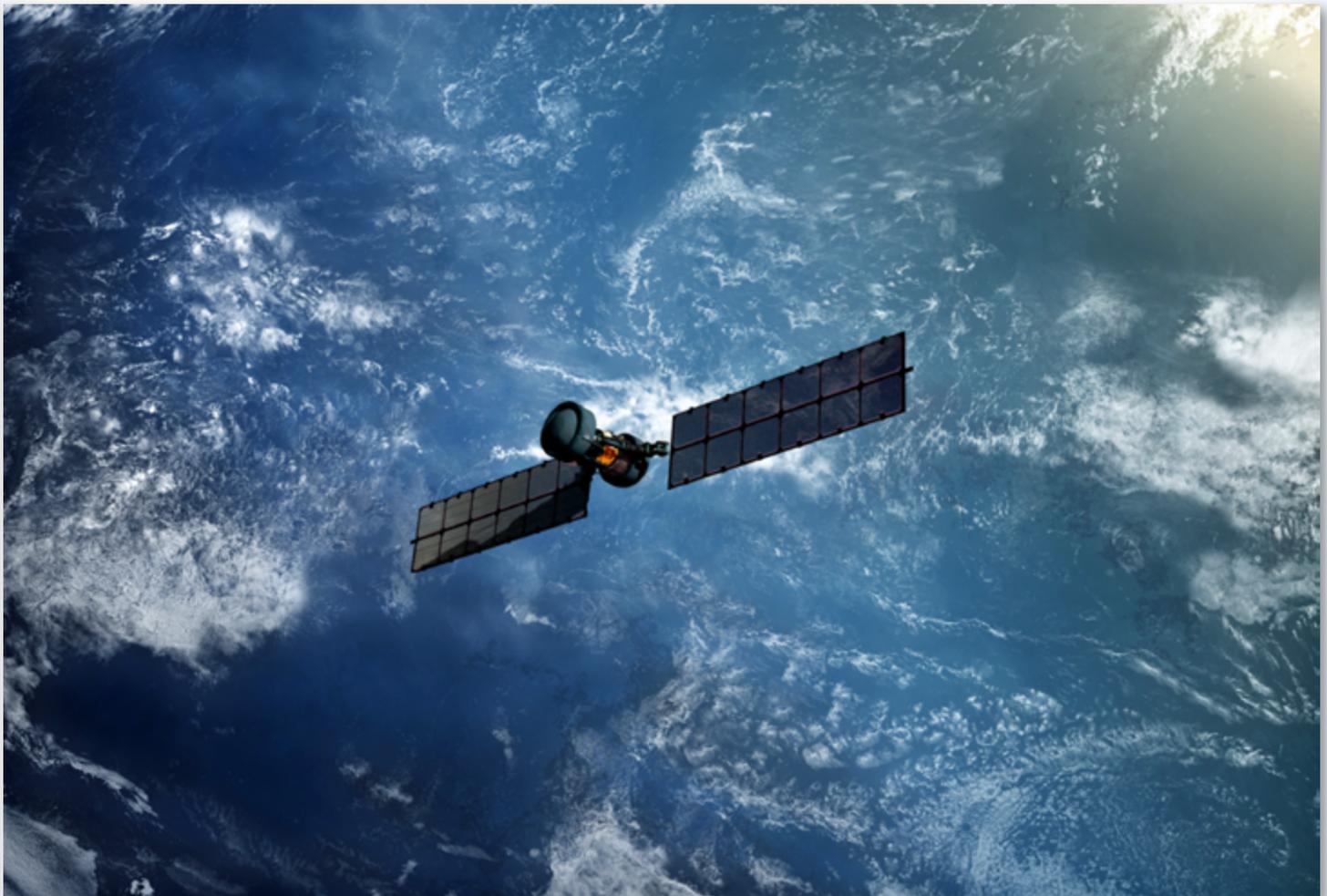


If there is no transmission, no bandwidth is allocated, and the terminal needs to resort to random-access bursts in order to send requests for bandwidth to the ground Earth station. Other users in the same channel for the bandwidth must also be managed.

If the total demand is greater than the capacity, the users obtain only their share of the available bandwidth. This is all done to use resources efficiently and to provide the best service at the lowest cost. The ground Earth station makes the decisions about bandwidth allocation, with forward link capacity divided between the terminals that have data actually being sent to them.

Return link capacity is divided between the terminals that have data to send. In order to get information about which terminals have data to send, the terminals must first request bandwidth by sending a random access burst, which indicates the need for bandwidth capacity.

Due to the long path delay between the ground to the satellite in geostationary orbit and back to the ground, at least around 500 milliseconds are required before bandwidth becomes available.



This bandwidth scheduling mechanism has several effects. Ramping up to the bandwidth that can actually be obtained and utilized requires time—if bandwidth is available, and there is a lot of data to send, the bandwidth which meets the demand will require round-trip times of around 500 ms. In many situations, longer time periods may be required.

Many applications use TCP as their transport protocol in order to deliver data reliably between hosts. TCP is designed to adapt automatically to available bandwidth, but the design of TCP is conservative and will adapt slowly due to the high latencies.

TCP will cautiously send a little bit of data, wait for acknowledgement, then send a little bit more data. This will require several round trip times to ramp up to full bandwidth—meanwhile, data will sit in the queue in the terminal, awaiting transmission.

In some cases, the extra delays induced by the satellite communication protocol will cause TCP to believe that packets have been lost, even though they may still remain in the queue. This has two effects; TCP will reduce the data throughput, and reduce user demand and bandwidth, and will retransmit the packet, which wastes bandwidth.

TCP is typically affected by highly variable latency and bandwidth. TCP's internal algorithms can, themselves, exacerbate the problems and cause reduced performance because of the underutilization of the available bandwidth.

Other TCP features include early retransmission of lost packets that can be incorrectly triggered due to buffering and high latencies. Packets may be retransmitted while they are still waiting in a queue somewhere, resulting in wasted bandwidth.

Whenever TCP believes a packet has been lost, the belief will be that this loss is due to congestion and throughput will be reduced. If the packets are not really lost, but just slow to be acknowledged, TCP will fail to use the bandwidth that is available.

These effects and others can decrease performance for end-user applications. TCP-based applications may be challenged to achieve optimal performance, suffer long delays and timeouts.

UDP based applications, such as a VOIP service, may experience highly variable delays, resulting in poor audio and long delays. Ensure a positive end-user experience by verifying that the application can adapt to the varying satellite link conditions and produce meaningful feedback, regardless of the circumstances, to the user.

#### What does shared bandwidth mean?

1. You are only allocated the bandwidth you can use
2. If terminal is not transmitting, it's bandwidth is 0 Kbit/sec
3. You are contending with other users for the available bandwidth

#### How does it work?

1. The Ground Station decides; terminal has to 'ask' for allocations
2. Allocation latency is at least one round-trip time (480 ms)

#### Effects

1. Ramping up bandwidth takes time
2. Extra delays when bandwidth doesn't meet the demand
3. Buffering causes extra delays
4. TCP performance is affected

#### Validating Application Performance

Ensuring an applications good performance in the face of these challenges requires careful testing. Network conditions on the BGAN system will vary over time. Depending on the current congestion, contend for bandwidth with many other users or capture all of the bandwidth. Testing or demonstrating solutions on the live network also involves airtime costs and the logistical issues of setting up terminal, antenna, and test equipment for the test that is to be performed.

Testing with a network emulator, such as the GateHouse BGAN Application Tester, provides complete control over the test and demonstration conditions. The BGAN Application Tester is a full implementation of the BGAN protocol, which accurately implements all the scheduling mechanisms of the BGAN system, giving a truthful representation of the live system. The tester is used with an actual, normally operating, physical BGAN terminal, just as would occur on the BGAN system, and the terminal operates normally without being aware that a simulated system is the actual operating environment. The BGAN Application Tester can be configured to apply traffic congestion according to an individual's test requirements, which greatly increases the number of possible test scenarios and boosts the test coverage.

#### [gatehouse.dk/](http://gatehouse.dk/)

*Lars Christensen, M.Sc.C.S., is an experienced BGAN engineer and Chief Architect at GateHouse Telecom A/S. Lars' main areas of expertise are system architecture, computer system design and development, particularly within computer networking, including TCP/IP, satellite communications (Inmarsat BGAN) and UMTS.*

*GateHouse Telecom A/S is a wholly owned subsidiary of the GateHouse Holding Group. For more than a decade, it has provided the satellite communications industry with a range of market-leading software products for commercial, government and military use. With deep knowledge and understanding of global communications infrastructures and platforms, GateHouse Telecom also offers consultancy services for software, hardware and system integration as well as for the preparation and evaluation of international tenders.*



# Accurate Pointing Is Crucial For Transportable Antennas

By Tony Wilkey, Senior V.P., AvL Technologies

**T**ransportable VSAT antennas are used in many places—on the roof of a news truck, on the ground next to an emergency response trailer at the site of a natural disaster, in a parking lot at a large special event, mounted onto a camouflaged army transporter in a war zone, to name but a few locations.

In most cases, the person responsible for establishing satellite communications from the remote location is faced with multiple challenges. First of all, h/she usually has other crucial roles to perform than only to set up the satellite link. The task needs to be straightforward, simple and almost effortless—even in conditions where terrain, weather, satellite line-of-site obstructions and location “dynamics” can create challenges that can distract from the primary job at hand.

Transportable VSAT satellite communications antennas used for SNG (satellite news gathering), emergency response and military applications are often communicating with traditional Geostationary (GEO) satellites and new GEO High Throughput Satellites (HTS). With O3b Networks’ recent satellite launches, there is now a new constellation of Medium Earth Orbit (MEO) satellites and a new class of transportable satellite antennas that have been introduced to acquire and track satellites across the sky every 40 minutes.

Regardless of the communication applications, antenna operators are transferring tremendous amounts of data and have extremely tight pointing requirements that are governed by the networks they’re using as well as by governing entities such as the ITU (International Telecommunication Union), which is the United Nations’ agency for information and communications technologies.

Well-made antennas enable proper satellite alignment, tight beams and pointing accuracy and minimize the likelihood for adjacent satellite interference or cross-polarization interference. However, operators who don’t follow procedure, or have poorly performing antennas, run the risk of interfering with other operators’ signals—with the possible results of being fined by the ITU or FCC, having signals jammed by the network or, worse, losing their operating license.

## Transportable Antenna Direction & Positioning

Antennas with parabolic reflectors require positioning systems to orient the reflector in terms of azimuth and elevation. Azimuth positioning moves the antenna on a horizontal plane and is measured from 0 to 360 degrees moving clockwise, with True North typically used as a reference point and measured at 0 degrees. Elevation positioning



An AvL antenna getting set for a wind test using an air boat’s fan. Photo is courtesy of AvL Technologies.

moves the antenna reflector up or down, with Earth’s sea level typically used as a reference point and measured at 0 degrees, and pointing straight up (in “bird bath” position) measured at 90 degrees.

Antenna positioning systems vary by size, weight, power requirements and duty cycles. Small, lightweight transportable antennas have minimal power and duty cycle requirements and the reflector can be positioned manually or with a small motor. A larger rooftop SNG antenna, though used intermittently, requires more power and more powerful motors. Large, trailer-mounted military antennas may require significant amounts of power and powerful motors to position the antenna and maintain pointing.

Antennas also require polarization positioning. For antennas with linear polarization, the feed is physically moved for proper alignment with the satellite’s receive signal. This movement can be motorized or manually directed in degrees—motorized feed movement is determined with an Orthogonal Mode Transducer (OMT). For antennas with circular polarization, the feed transmits polarized signals with the aid of an electronic phase shifter, which means physical positioning is not required.

Most transportable antennas are used by operators classified as “occasional use” because the antennas are moved from one location to another, used for a few hours and then moved to another location again. Accordingly, these antennas require the same precision pointing as “continual duty” operators such as teleports. However, transportable antennas do not require heavy, bulky, continual duty positioner systems.

AvL Technologies’ patented cable drive positioner is popular with SNG, disaster recovery, military and other customers due to the unit’s small size, light weight, precision pointing, zero backlash (no inherent play or give with mechanical parts) and high stiffness for maintaining an accurate point. AvL’s Cable Drive Positioner and the unit’s high-stiffness capabilities are especially important for Ku-band antennas with apertures of 1.0 meters or smaller, C-band antennas with 2.0 meter apertures and Ka-band antennas of all sizes.

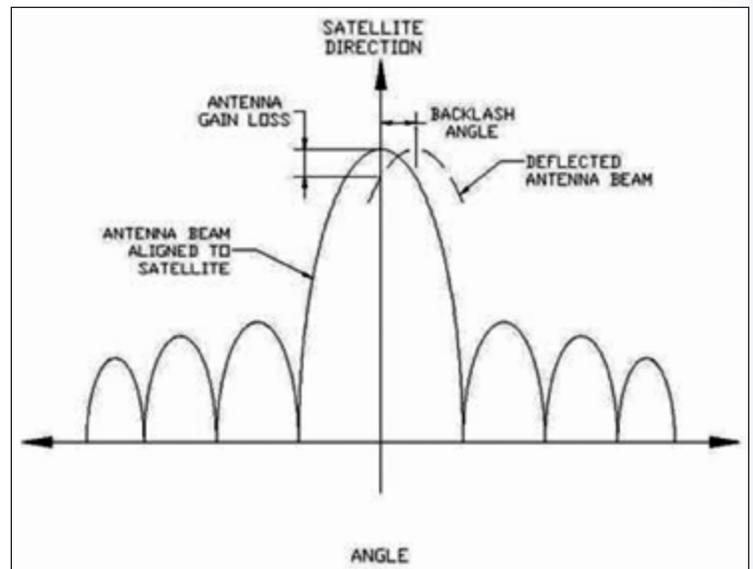


Figure 1. Antenna gain loss due to backlash.

## Why Is Polarization Important?

Polarization is a property of electromagnetic waves that enable waves to oscillate in a given direction, and antennas use both hardware and software to direct waves as required. SATCOM antennas typically operate with linear or circular polarization, depending on the application and network requirements.

Regardless of the type of polarization used, an antenna that is transmitting to a satellite without being accurately pointed toward the satellite's peak signal can create off-axis (off-peak) cross-polarization interference. This interference creates transmission issues for other operators communicating with the same satellite.

Linear polarization enables an antenna to double transmit capacity by simultaneously operating with two signals at the same frequency—with one signal being vertical and the other horizontal. But an antenna must use a good OMT to properly align polarities at 90 degrees—otherwise improper alignment will cause interference with other operators using the network.

Circular polarization also enables double transmit capacity by simultaneously operating with two signals traveling in opposite rotary directions—right hand (clockwise) and left hand (counter-clockwise). Circular polarization always causes cross-polarization issues when the signal is off-axis; when this happens, an off-axis right hand circular polarization user will then cause interference with other users operating with left hand circular polarization.

## Relationships

As frequencies go up, from C-band (4 to 8 GHz) to Ku-band (12 to 18 GHz) to Ka-band (26.5 to 40 GHz), for example, beams become narrower and pointing requires more precision. C-band's lower frequency mandates a larger aperture (at least 2.0 meters for offset optics, per the FCC) to form a narrow beam and the beam is fairly simple to point and peak. Ka-band's higher frequency enables a small aperture (such as 60 centimeters) to communicate but requires high-precision pointing that must remain on target despite environmental or other factors.

SNG trucks typically operate with C-band and/or Ku-band antennas and some newer news trucks have transitioned to Ka-band. The transition to Ka-band provides SNG operators with significantly more bandwidth and throughput, but also required is additional stabilization for maintaining continual peak position on a satellite.

## Wind Compensation

An additional challenge with accurate antenna pointing is the windy environment on Earth. Strong wind can wreak havoc with satellite communications by physically moving the antenna to the point that signals are interrupted or lost—or begin to cause adjacent interference with nearby satellites. Many antenna control systems have adapted to this challenge by adding wind compensation capabilities.

AvL Technologies' AAQ antenna control system relies on data from an inclinometer (measuring angles of tilt), pitch and roll sensors (antenna angles relative to gravity), a resolver (tracking degrees of rotation for the antenna positioner) and encoders (translating the antenna's linear position to a digital signal for the AAQ). When the data from these sensors misaligns, the antenna is instructed to physically move to compensate for the force of the wind.

## Antenna Design & Materials

Antenna design is another important consideration. An antenna positioner lacking stiffness can easily be pushed off-point by strong winds. A reflector made of aluminum is susceptible to changing shape due to extreme heat or cold temperatures, whereas a carbon fiber reflector will maintain shape through nearly any weather extreme. A poorly-designed or manufactured feed will not be able to manage two signals with dual polarization. A poorly-designed or manufactured OMT will not ensure linear polarities are separated by 90 degrees.

As with most technological products, the lowest performing component determines the highest level of performance for the overall system—the quality of materials used in an antenna is of the utmost importance to ensure high performance and minimize opportunities for causing interference.

## Antenna Control Systems & Auto-Acquire Capability

Though parabolic reflector antennas can be manually pointed, most motorized antennas operate with an antenna control system. Antenna controllers are complex, dynamic systems that receive numerous data inputs from antenna sensors and subsystems, align this data with other information such as satellite location tables and direct the antenna toward the target satellite.

AvL's AAQ Antenna Control System also enables multiple tracking technologies to track moving satellites, such as GEO satellites in sub-optimal orbits with analemma patterns (the figure 8 path the sun travels in the sky), and maintain continual alignment.

When target satellite parameters are pre-loaded into the controller, the antenna also can be directed to auto-acquire the satellite signal without operator assistance. AvL developed and introduced the first "one-button" auto-acquire controller in 2002 and began shipping all motorized AvL antennas with the trademark "green button—go, red button—stow" buttons on each positioner cover. The AAQ enables one-button auto-acquire and also employs dynamic sensors and algorithms to maintain the point regardless of orbit changes, the environment or other factors.

## The Collaboration

Today, most transportable antenna operators use one-button auto-acquisition—those antennas, along with their controls systems, have operated problem-free while broadcasting events, restoring post-hurricane communications, or enabling service men and women to call home and to enjoy streaming video. For most, the foregone conclusion is that the auto-acquire antenna they're using will properly peak and maintain signal and not cause interference with the satellite itself or other users on the network.

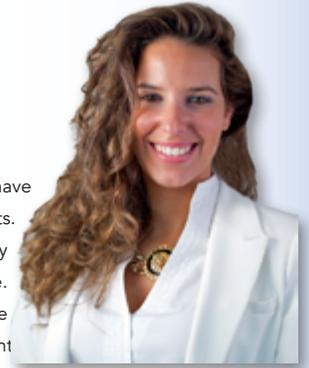
The importance of proper alignment between a satellite and an antenna cannot be overstated. Proper alignment is not an easy feat—it's a collaboration of antenna design and materials, antenna size, positioner accuracy, and antenna control systems that makes the impossible... possible.

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

*Tony Wilkey is Senior Vice President at AvL Technologies with responsibility for US Sales, Marketing and Customer Service. He earned his Bachelor's degree in Mechanical Engineering from Georgia Tech in 1981 and his Master's degree in Mechanical Engineering degree from Stanford in 1983. He has worked his entire career in the satellite industry, most recently with ViaSat, Inc., before joining AvL in 2008.*

# The Digital Era: Ship To Shore

By Leticia Diaz del Rio, Global Business Manager, Maritime, Thuraya



**L**ife is changing at sea and competition in maritime communications is driving that change.

Operational efficiency, safety and crew welfare are being enhanced by technology that had previously seemed inaccessible to entire swathes of the market. Once there had been unchallenged and extortionate prices, which created a “take it or leave it” approach to sales. Now, there are opportunities to invest in equipment that had previously seemed out of reach for many players.

These days, digital and IT solutions play a crucial part in the environment on board more vessels than ever before experienced. From advanced navigation systems to permanent tracking devices, ships have never been so connected.

Today, the majority of vessels are finally enjoying the benefits of the digital era. This transformation has been energized by the availability of flexible plans, radically shorter installation processes and flexible contract periods.

## Europe’s Maritime Sector

According to Eurostat, the total gross weight of goods handled in EU ports was estimated at close to 3.8 billion tons in 2014. This makes Europe the most important exporter in the world and the second largest importer on the planet (behind the United States).

The Netherlands has recorded the largest annual tonnage of maritime freight in Europe every year since 2010 when that nation overtook the United Kingdom and remains the largest maritime freight transport country in Europe.

Rotterdam, Antwerp, Hamburg, and Amsterdam have maintained their positions as the four largest ports. Italy comes third and Spain follows in fourth; Germany has climbed to fifth place, narrowly overtaking France. It is plain to see why Europe’s established and mature marketplace is naturally one of the most important regions for the maritime sector and, in particular, for satellite communications.

Europe may have one of the lowest number of vessels addressable for satellite communications purposes (around 30,000). However, European ship owners and seafarers are well-versed in the benefits of technology and what makes life onboard a vessel easier, safer and more efficient.

## Fishing Solutions

In 2014, there were 85,154 fishing vessels in Europe with a combined capacity of 1.6 million gross tons. The largest fishing fleets among the EU member states, in terms of power, were those of France, Italy, Spain and the United Kingdom. Spanish fishing fleets were by far the largest in number: close to double that of the United Kingdom.

Some fishing vessels are state-of-the-art and possess tremendous IT systems onboard. These vessels use weather applications to study the ocean floor (bathymetry). When fishing maps are combined with high resolution satellite images, skippers can estimate if a specific area shows a certain quantity of fish.



These solutions help locate the fish more quickly and, when combined with the appropriate tools, they help find the optimum route to the fish, thereby saving time and fuel.

Satellite communication is also being used in buoys that are left adrift in the middle of the ocean. These buoys possess a satellite transponder and are equipped with a solar panel. Depending on the type of buoy, information such as the quantity of all fish or of a certain species will be sent to the vessel and to HQ.

Such information is obviously extremely valuable for a skipper or ship owner. When combined with satellite images and weather information, the crew has the full picture of what is occurring at sea.

Nor are these buoys used exclusively for fishing. A satellite transponder simply provides the communication link, but the detail of information gathered depends on the solution developer. Some governmental organizations want to use the same system for scientific purposes to monitor ocean temperature and endangered species numbers, or even to detect tsunamis.

### The Need For Data

In the past, seafarers chose the traditional circuit-switched voice option for ship to shore and shore to ship communication. It is not difficult to find customers who were generally charged around \$400 for 10 minute calls to family and friends.

At the start of the decade, the voice to data split was 80:20. Now it's the other way round, with data very much the preferred choice.

The transition to data has forced satellite communication operators to become solution providers. This is due to the high level of expertise needed to optimize bandwidth and to deliver an overall better user experience.

Today, vessel owners prefer to opt for a data allowance that provides email, Internet, and Voice over IP (VoIP) applications that benefit crew.

In recent times, the cost of airtime over L-band and VSAT communications has dropped significantly, giving ship owners more choice and flexibility (depending on the type of vessel and level of IT integration).

Some customers prefer an exclusive voice line to the captain that allows them to speak to him directly whenever there is need to do so. Others require a local number that will help reduce the bill. This is a typical requirement for

crew welfare as some ship owners want to offer the most cost effective solution for their crew. Some crew are given scratch cards to use to call family and friends from abroad at a local rate.

Data solutions are flourishing and have contributed enormously to the new onboard digital era. While data connectivity has opened the floodgates to innovate solutions, also ensured is that providers continue to create technology at affordable prices.

### Remote Monitoring

Satellite M2M units can control and monitor individual containers while they are being transported. This is driving tremendous telemetry and M2M growth—installing cameras inside containers and then accessing the feed remote is not uncommon these days.

A monitoring system onboard a vessel is another interesting development—tracking devices connect to sensors that trigger a camera, which then records onboard activity. This footage can be viewed remotely by ship owners and maritime authorities. These systems are becoming more and more popular onboard specific fishing vessels.

Some solutions are designed specifically for fishing equipment. A sensor on the equipment when being used triggers a recording. This offers notable support in emergency cases, especially in the event of a pirate attack.

### Security Measures

With access to modern technology on the rise, piracy attacks could become less frequent with the sharing of data from ship to shore. The future of marine safety and security lies in video surveillance systems that can transmit 'real time' information such as speed, course, location and fuel to the relevant authorities.

This vital information can be shared directly from the ship to headquarters, and subsequently to surveillance vessels and marine patrol aircrafts, when ships are in distress. This is all made possible by satellite communications. While in the past this level of communication was extremely expensive and, therefore, unavailable to many, satellite operators have now created competitive offers to suit most budgets.

Satellite technology in the marine sector has come a long way over the last decade. Operators and developers continue to innovate by creating equipment and devices for the safety and security of crew.

As awareness of the new competitiveness in satellite technology continues to increase, of interest will be to see how far the digital era penetrates across the maritime sector and what else can be achieved to the benefit of all involved in the maritime sector.

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



Thuraya Orion IP.



Thuraya Atlas IP.



Thuraya SF2500.



# HTS & DTH – A Symbiosis Of Service

By Anver Anderson, General Manager, STN

**M**any comments have been made regarding High Throughput Satellites (HTS)—and some of them are even true.

However, these dialogs rarely discuss the matters associated with Direct to Home (DTH) distribution. Certainly, the effective re-use of the satellite space segment spectrum over a wider geographical area is to be applauded, but that is not without a variety of challenges.

The idea of the throughput-multiplier effect of multiple-beam technology is a good one, provided a good market price can be offered (as has so often been promised) and the support for all of the associated businesses can be counted on—the satellite operators, the teleports and the content suppliers; and not forgetting the equipment manufacturers.

HTS designers firmly had/have data distributors in mind; VSAT networks for IP backbone, Enterprise, Government, Offshore and even some Maritime and Aeronautical markets. All of these sound pretty sexy, but even a cursory glance at the current market place will tell you that the data-centric side of the industry has been going through some pretty tough times recently.

The most recent WTA report, *“Inside the Top Operators,”* clearly shows that data revenues over the last couple of years have diminished, and significantly so for some teleports. The withdrawal of troops from war zones worldwide, the introduction of major fiber routes to major satellite markets (such as the west coast of Africa), a slower than expected uptake in the overall Maritime markets are but a few areas that the WTA report highlights as having significant impact on overall revenues.

This may well be heresy, but could it be that at a time when we finally are seeing the kind of capacity we have always wanted/needed, that the market may no longer be there to support such in the long term? That question carries some heft and not one that is lightly asked...

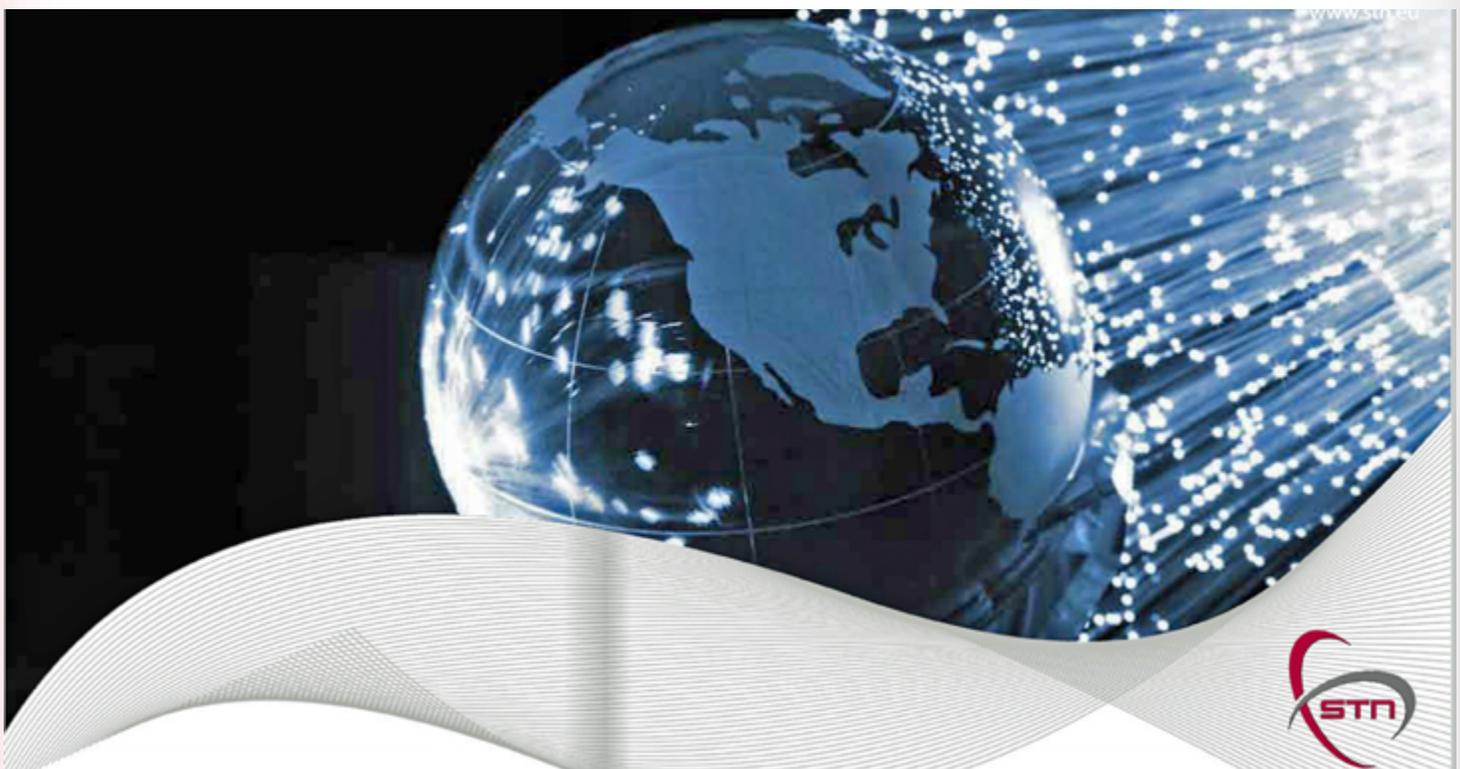
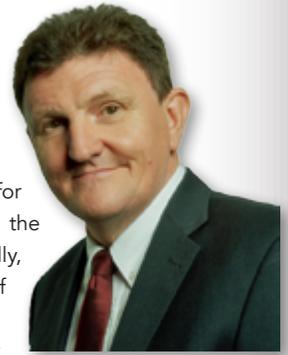
Another dynamic which is evident for HTS service provision is the movement along the value chain of the satellite operators. Traditionally, the satellite operators were the purveyors of healthy MHz of bandwidth.

However, technology will out, as they (don't) say, and the latest encoding and modulation techniques have led to ever more Mbit/s per MHz. This sounds all fine and dandy until you come to grips with the implications of such a simple equation.

More bits per Hertz is great for the data customer and broadcaster alike for the obvious reasons—more bits moves them toward a better business case as their costs are reduced (or they use more data for the same costs). New markets for smaller users are opened (for DTH distribution, for example, these would include thematic channels aimed at certain diaspora markets, based on language, cultural, religious or general entertainment).

For HD providers, excellent visual results down to 4Mbit/s are offered. But this is not the greatest news that has ever happened to satellite operators. Many additional channels need to be sold, as there is a quite evident reduced return per element of their supply—the MHz—no surprise to note that many satellite operators are moving down the value chain, ever-closer to the end user, by installing their own hubs and selling the Mbit/s into the market place.

Although this service is made available to the current teleports to provide services in the traditional fashion, end users are also availed of the offerings. The teleport operators are similarly impacted by this philosophy. Some satellite operators have purchased teleports simply to enable them to get ever closer to the end user.





This market dynamism is not a surprise and is what ultimately feeds what is done on a day to day basis. But... as far as anyone can see, no one has yet really opened up the conversation on what can be done with the HTS satellites for the broadcast market—for distribution.

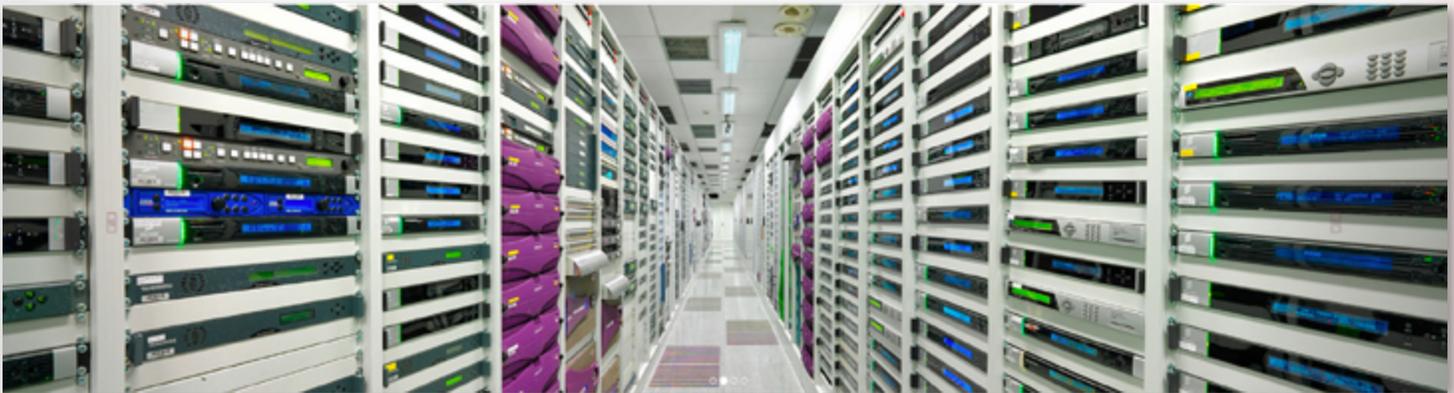
Clearly, there is a contribution market. Feeding DTT networks or cable head ends using smaller-bandwidth channels with better-priced space segment is bound to be an obvious option for distributing such content. This has a double impact on the customers' choice.

Also, it can be largely IP-based, which is good news for the data-centric teleports of the world. This is also good news for the satellite operators who, in fairness, need all teleport operators to be successful in

DTH distribution platform in the face of a rapidly changing delivery contribution network—for DTT and OTT?

There might be one or two options to cover countries which have a small geographical area—but my concerns are that such countries wouldn't bring sustainable levels of eyeballs to generate the necessary advertising or sponsorship revenue levels.

Of even greater concern is that DTH for HTS (or should that be HTS for DTH?) appears to be an oversight or even exclusion from the future satellite services debate. Perhaps this assumption is incorrect, as reading all of the industry press is an impossible task, but a substantial debate on this particular issue in the magazines and newsletters or from the podiums



order to secure investment for future satellite launches. We are, if nothing else, a symbiosis of service provision, but one which is constantly in flux!

Why, when the broadcast market has shown itself to be relatively robust against its data-centric counterpart, has there been little or no discussion about DTH for HTS.? Is this because of the choice of frequencies (not all HTS satellites are Ka-band)? Might independent teleports have to illuminate several beams in order to reach a particular geographical region? Surely that would not help the distribution business model that is based on a less expensive space segment. Has no one the will to develop a new

resident in the plethora of conference sessions has not been encountered as of this writing.

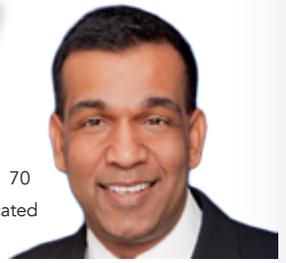
If service provision symbiosis is to continue successfully across all industry sectors, debate on HTS for DTH must be opened. Who knows? Perhaps someone might take the opportunity to raise this issue during the upcoming IBC2016.

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



# Partnership With Understanding: Forming Relationships That Drive Success In The New Era Of Satellite

By Rajanik Mark Jayasuriya, V.P. for the Satellite Network Group (SNG), ST Electronics



**A** new satellite era has arrived, one in which the dynamics of the industry are in continual transformation—the manner in which business is conducted will never again be the same.

Today, more powerful satellites are handling throughput levels that are hundreds of times faster than ever before experienced. Mass-produced fleets of LEO telecom-class micro satellites are set to launch, adding even greater coverage for untapped markets around the globe. Terminal prices are now on par with the average smartphone, while the cost to launch satellites continues to decrease and bandwidth prices are becoming quite competitive with that of terrestrial connectivity.

As a satellite service provider, all of these factors are changing the meaning of success. An entirely new perspective on what is necessary to compete for the business of highly demanding end users around the globe is mandatory.

A new approach to business relationships is necessary for today's market. The need is to forge partnerships that are built around understanding all the unique challenges being faced—from a technical and business perspective. Having a partner that understands the full breadth and depth of the marketplace as well as a firm's unique business drivers can go a long way in determining a business's success in this new landscape of opportunity.

## A Study In Understanding

Looking specifically at how this changing dynamic is playing out in the current market, take a look at SpeedCast, a key Agilis partner. Among the largest and most successful satellite service providers in the market, SpeedCast operates a highly complex communications network with multiple access technologies that support multiple applications for a range of customers.

Key to SpeedCast's success is the ability to determine how best to harness the influx of capacity coming online in order to uniquely serve each of these customer segments. This task grows increasingly complex as, for each customer, there is, potentially, a different design and solution that must be cemented together.

Today, the company is using more than 70 satellites around the world via 39 strategically located teleports. The network is also growing in terms of the geographies that must be covered, with the number of countries where customers being served now eclipsing 90, worldwide.

While many of SpeedCast's customers rely fully on satellite communications (SATCOM) for core communications, different access technologies, such as cellular, fiber and microwave link, must also be incorporated into the mix.

One might say that SpeedCast has become the model as to how the business of the satellite service provider is transforming into a hybrid platform, where the need for multiple pieces of equipment operating across mobile, fixed and satellite network, integrated in a manner that addresses application-specific needs while providing value to the core business, is necessary. As customers become more demanding and seek extremely high communication standards, they want to be informed immediately if something does go wrong.

In order to strike the correct balance, SpeedCast holds the idea of a 'partnership with understanding' in high regard, ensuring all aspects of the company's operation are in tune with this goal.

## Two Sides Of Understanding

Step inside any of the aforementioned SpeedCast teleports around the globe and there is an excitement and energy that reflects a vibrant global network in action. In order to make this a reality, a broad range of technologies and equipment are required to serve customers in all areas of the globe. All of the technologies must flawlessly come together in order to address the needs of each individual customer.

This means, from a technical perspective, a partner is required that possesses the necessary experience and in-depth understanding to design complex end-to-end solutions, as well as provide hardware and software products that will meet customer needs.

*For its new teleport in Singapore, SpeedCast trusted the professional services of Agilis to help install and commission 10 satellite antennas on the roof of the facility—the first teleport to have an antenna farm located on the roof.*





As network footprints increase, complexity also increases. The requirement is for more and more data connectivity and, as a result, more and more available capacity.

From a business perspective, network growth is mandated, as the need for data connectivity accelerates—more capacity to manage, more applications to support and more data being tied to critical business decisions.

A partner on the business side understands this dynamic and works to always become more proactive in the management of the global network. They work diligently to provide deep analysis across networks to provide the best quality of service to customers at all times.

With this level of insight, the overall quality of service also improves, continuing to meet highly complex SLAs (service-level agreements) and to ultimately reduce operational costs across the business.

### **Build The Partnership**

Being able to strike that correct balance between technical knowledge and business understanding is far easier said than done. As a satellite service provider, the ability to maintain pace with the changing demands on equipment, all the while keeping a meticulous eye on the business, requires a partner that has experience at both ends of that spectrum, along with proven results.

A trusted partnership is one that comes with the understanding of the impact they have on a particular business, but also on their clients' customers, as well.

As part of this three-part series, an in-depth look will be offered to *SatMagazine* readers as to what is meant to truly develop a partnership with understanding. The correct approach to both the technical and the business perspective, along with how to develop the right strategy for properly addressing each, will be examined.

In the next issue, the spotlight will be placed on the technology approach, unpacking the ways whereby the appropriate partner can help navigate through the complexities and create a complete solution, fully optimized for the business needs.

Such a partnership must be formed with this well-rounded approach in mind to help propel a business forward. As a satellite service provider, consider this the ultimate key to success during this exciting time in satellite communications.

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# A Comtech EF Data Focus: Performance Challenge Of 3G Over Satellite

By Richard Swardh, V.P., Market Development, Comtech EF Data

**M**obile telephony has been in existence for more than 40 years—the first generation (1G) developed in the 1970s was based on analog standards, including Advanced Mobile Phone System (AMPS) and Nordic Mobile Telephone (NMT).

In the early 1980s, standardization of a second generation (2G) digital circuit switched mobile telephone system based on the Global System for Mobile Communications (GSM) standard began. The first GSM-based voice call was made in 1991.

With the advent of the Internet, the International Telecommunications Union (ITU) set out to standardize a third generation (3G) mobile service under something called the IMT-2000 specification. 3G standards are required to meet the technical requirements of IMT-2000 for speed and reliability.

The most common 3G standard today is called Universal Mobile Telecommunications System (UMTS) and is based on re-using most of the core network elements of GSM while introducing a new radio interface based on Wideband Code Division Multiple Access (WCDMA). The first UMTS network was launched in Japan by NTT DoCoMo in 2001.

Since then, the standard has evolved and introduced additional functionality primarily enabling higher data rate services also known as High Speed Packet Access (HSPA). The WCDMA standard has been a big success and is set to overtake 2G as the largest mobile standard within the next two years.

On request by Mobile Network Operators (MNOs) wanting to recover significant investments made in 2G during the 1990s, UMTS is re-using many core network nodes from the GSM standard; the 3G standard share the same hierarchical architecture as shown in *Figure 2* on the following page.

In the 3G standard, Radio Base Stations, called NodeBs, connect to a Radio Network Controller (RNC) over an interface called IuB. The RNC further connects to the Core Network (CN) through interfaces called IuCS and IuPS. Handsets, also called User Equipment (UE) connect to NodeBs over a radio interface called Uu.

As mentioned above, 3G and 2G have a lot of nodes in the Core Network in common. The two standards also share a common design philosophy to keep most of the network intelligence and management centralized to a few key nodes rather than distributing it out to the edge as in a flatter network architecture like 4G LTE.

The RNC plays a very important role in the UMTS Radio Access Network (UTRAN) as it is responsible for controlling all the NodeBs and UEs connected to it. The RNC carries out the radio link management setting up the Radio Access Bearers (RAB) used to connect UEs over the air interface, as well as performing Radio Link Supervision, Power Control, Encryption, Cell synchronization and other key tasks all aimed at using the UTRAN and the limited radio spectrum resources available as efficiently as possible.



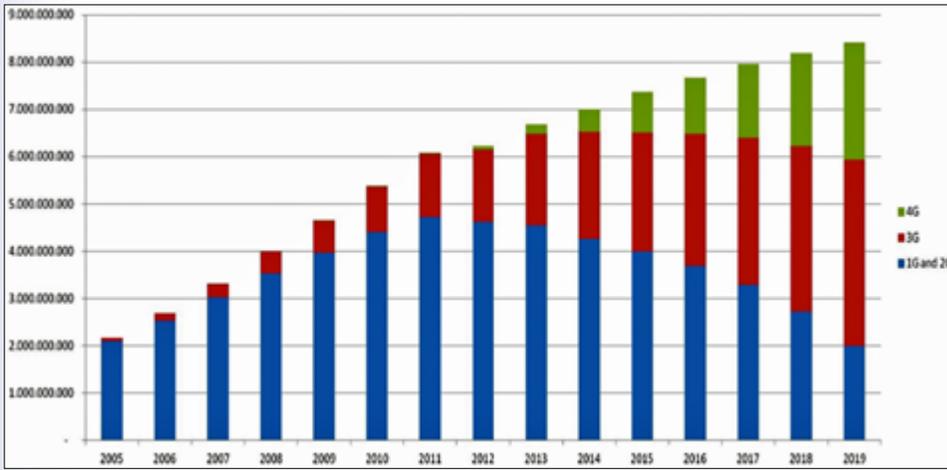


Figure 1: Subscribers per Wireless Technology. Source: Ovum.

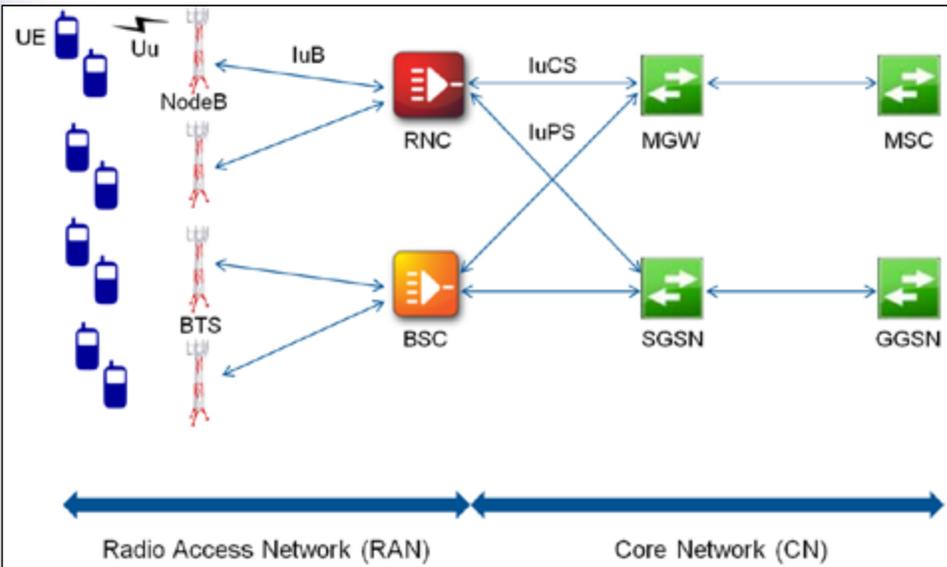


Figure 2: 2G/3G Network Architecture.

This is by no means an easy feat and the standard governing the IuB interface between the NodeB and RNC is called TS 25.433 and is no less than 1,378 pages long.

When the IuB interface was first drafted, it was decided that transmission delay between a NodeB and RNC should be kept to less than 30 ms. Among other things, this was to ensure that key protocols like Radio Link Control (RLC) and Media Access Control (MAC) from the UE would arrive over the radio interface via the NodeB and be managed at the RNC in timely and precise manner to make the best use of the limited spectrum resources in the UTRAN.

Needless to say, no one from the satellite industry was present during that meeting. As the UMTS standard has evolved over time and new RABs supporting even higher modulations and data rates have been introduced, the requirements on the RLC and MAC layer has increased even further.

The constant quest to achieve higher and higher data rates and a more efficient use of spectrum makes a stable, error and jitter free IuB connection between a NodeB and RNC even more important.

services as a significant portion of the bandwidth used over a TDMA satellite link will have to be reserved for re-transmissions, which does not generate any revenue.

Where does that leave satellite backhaul when used in 3G? Well, all the major UTRAN vendors have been able to implement proprietary adaptations to their respective IuB interface that goes beyond the limits set by the IuB standard and can now support most 3G services also when used together with satellite backhaul.

However, it has come at the cost of less efficient resource management and an increase in synchronization/framing errors on RLC/MAC layer compared to when using terrestrial transmission. This causes re-transmissions to occur more frequently between NodeB and RNC as the UTRAN tries to interpret the information from the UE.

This can, in a long delay backhaul scenario such as when using satellite, make up a significant part of the available backhaul. Furthermore re-transmissions on the RLC/MAC layer has an adverse effect on applications further up in the protocol stack running TCP, which can cause even more re-transmissions to occur.

This almost perfect storm of issues occurring in the IuB protocol stack is especially common in a shared resource backhaul scenario, like in a Time Division Multiple Access (TDMA) environment where bandwidth is on-demand and delay and jitter is far greater than in a Single Channel per Carrier (SCPC) environment. TDMA systems offer a shared outbound channel received by all remotes and bandwidth on demand on shared aggregate return carriers. The key drawback of TDMA in a 3G backhaul scenario is that with a TDMA access scheme comes significant delay and jitter on the return link.

Because of this, measurements from a major 3G vendor have shown that over 30 percent of allocated bandwidth on the IuB interface has to be reserved for re-transmissions in a TDMA networking environment to make sure all the functions of the UTRAN operate properly and the end user performance is acceptable.

This, of course, has a major impact on the margins a Mobile Network Operator can achieve from providing 3G

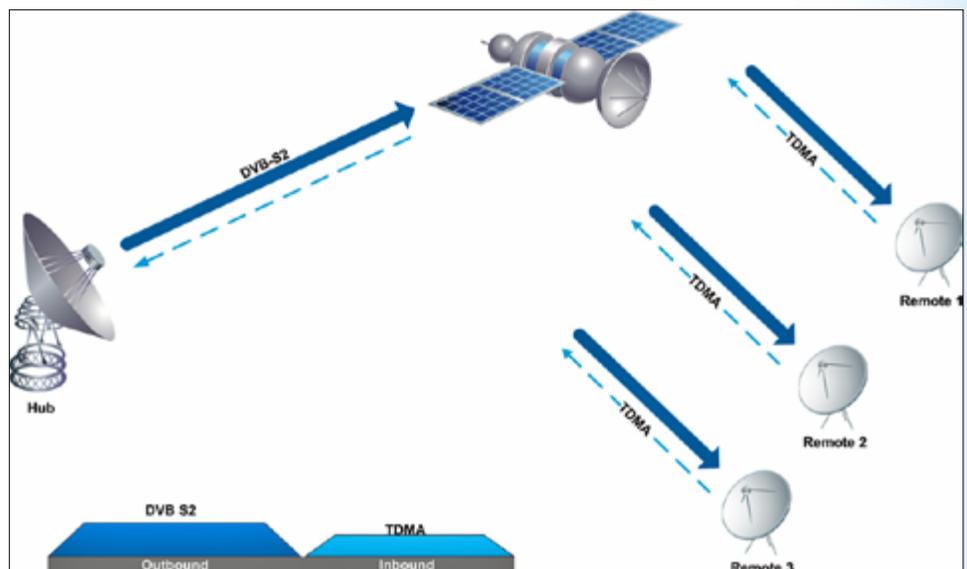


Figure 3: TDMA Access Method.

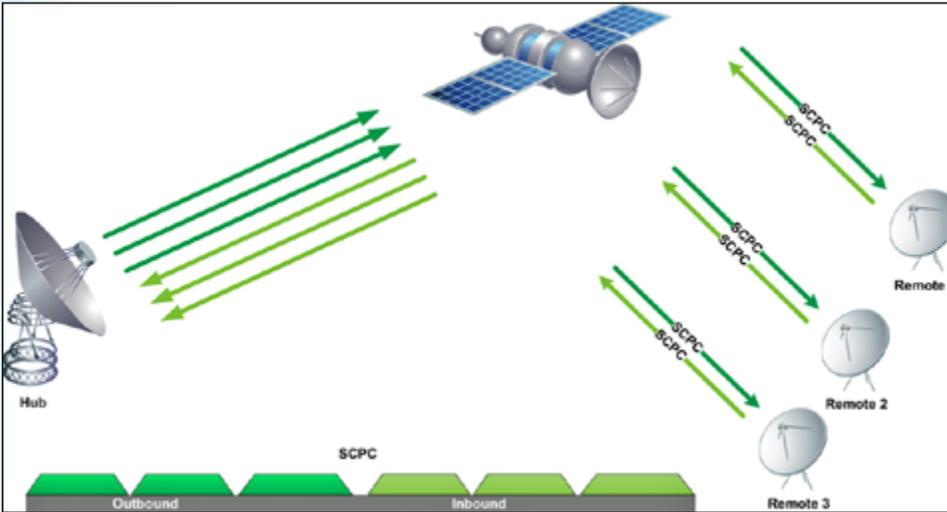


Figure 4: SCPC Access Method.

Each remote requires its own fixed space segment -> Bandwidth is sometimes under utilized because space segment is designed for peak period

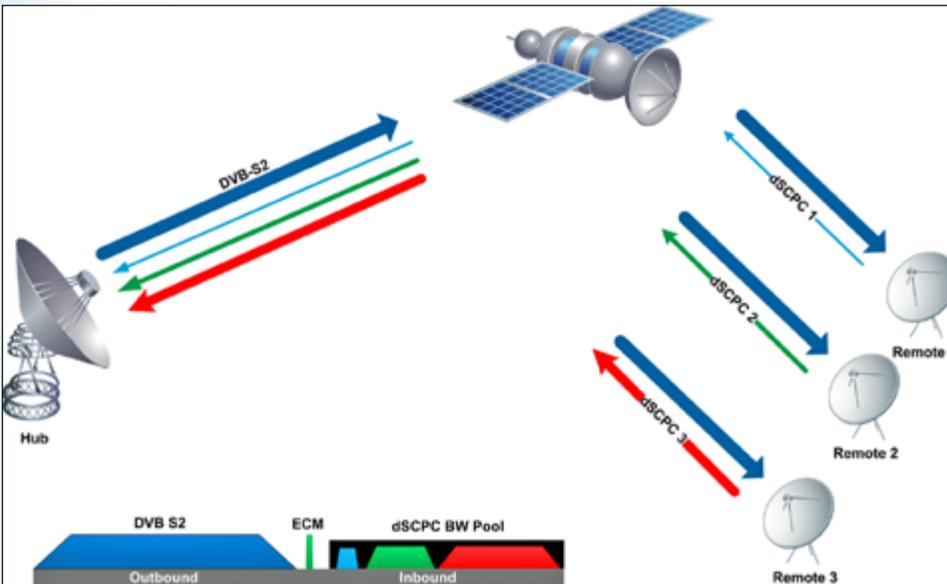


Figure 5: dSCPC Access Method.

Each remote has all the benefits of SCPC (Advanced Modulations & FECs, Header and Payload Compression and Bi-Directional ACM) while supporting changes in bandwidth demand -> the best solution for 3G backhaul.

### Methods For Increasing Revenue & Quality Of Experience

Comtech EF Data understands this challenge well. We have thousands of Mbps of luB backhaul in service that are low in both jitter and delay, and exhibit significantly less of the issues described above and introduced by the use of TDMA-based backhaul. Two primary solutions for luB backhaul are offered by the company.

An SCPC point-to-point system offers dedicated bandwidth channels to each individual remote with guaranteed bandwidth. Jitter, delay and IP overhead are kept at minimums, and this topology lends itself especially well for 3G networks with a high share of symmetrical services like voice and Short Message Service (SMS).

Comtech EF Data's Heights Networking Platform offers a shared outbound channel received by all remotes and dynamic SCPC return carriers. This architecture brings out the best of SCPC while supporting dynamic bandwidth in both directions.

Jitter and latency are still kept at a minimum while supporting a wide range of modulation and coding schemes plus Adaptive Coding and Modulation (ACM) in both directions. This topology lends itself particularly well for Mobile Network Operators with a high degree of 3G data traffic and changing bandwidth requirements.

Even without considering greater efficiency in terms of header and payload compression, as well as RF performance and packet per second capabilities, both Comtech EF Data solutions for 3G backhaul over satellite deliver more value per Mbps than TDMA. With SCPC's low jitter and latency and with everything else equal, 3G performance can be significantly improved compared to a TDMA system.

Applications function better with less retransmissions, which improves Quality of Experience for end users and translates into higher usage. Additionally, more revenue-generating traffic can traverse the network in a given Mbps, increasing margins and revenue for Mobile Network Operators.

The result is a win-win for everyone involved.

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

Richard Swardh is Vice President, Market Development for Comtech EF Data. In this role, he leads the Company's market development, business development and product marketing functions for the 2G/3G/LTE mobile backhaul market.

A mobile network backhaul veteran, Swardh's background includes strategic and operational positions at Ericsson with business development, partnership management and strategy execution responsibilities. He holds both a Bachelor of Science degree in Mechanical Engineering and a Bachelor of Business degree in Administration and Logistics from Vaxjo University in Sweden.



# Winning The Frigid Fight For STN Teleport A W.B. Walton Perspective

By Dan Freyer, President, ADWAVEZ Marketing LLC

**S**TN, the Satellite Telecommunications Network, transmits more than 600 TV channels and delivers global services via satellite and fiber from their massive, cutting-edge, teleport facilities in Dob, Slovenia, in the European Union (EU).

STN provides SD/HD/UHD video and audio broadcast and IP point-to-point data services over satellite with extensive coverage over Europe, the MENA region, Asia, Africa, Australia, as well as North and South America. For their video customers, STN provides playout, encryption, and channel localization services and supports a range of customers, from startup channels to global media leaders, all with rapid and efficient deployment service success.

As of this writing, STN operates 21 transmit antennas that range in size from 2.4 to 9 meters as well as 65 receive antennas from 1.8 to 9 meters in diameter. STN accesses dozens of C-, Ku- and Ka-band satellites for worldwide coverage. More than 5,400 Rack Units of equipment at the teleport provide signal processing in support of a wide variety of services, including network security, and state-of-the-art video format transmissions. STN's L2 fiber network and IP infrastructure access worldwide POPs at major, global, metro data centers and direct fiber access to two tier 1 ISPs with multi-Gbps connectivity options.

## De-Icing System Crucial

As is the case in many locations around the world, winter at STN's facility means the occasional snowfall. Winter storms can accumulate snow and ice on buildings and structures. Satellite Earth station antenna performance can be severely degraded by the accumulation of snow and ice, causing signal degradation—even outages—if not managed properly.



STN Teleport keeps snow and ice off their antennas through the use of Walton De-Ice systems

## A Warming Solution

STN has extensively deployed Walton's Plenum Hot-Air De-Icing systems (Walton De-Ice Plenum, Snow Shield and Ice Quake systems) to help provide the highest level of uptime during winter at STN's teleport.

W.B. Walton Enterprises, perhaps more famously known as Walton De-Ice, is now in its third decade of providing solutions to help protect critical satellite networks from degradation and outages due to weather and is the leader in this segment. The company designs and manufactures the broadest and highest performance line of



de-ice equipment available for satellite Earth station antennas: the firm's original Hot Air (Plenum) design mounts behind antennas from 3.7 to 32 meters, while the Walton De-Ice Snow Shield, Rain Quake, and Ice Quake, electric and gas forced air De-Icing systems protect 0.6 to 6.3 meter antennas. Walton De-Ice has refined their field-proven, Hot-Air De-Icing system with a unique hot-air enclosure that mounts directly behind the antenna. STN employs this system on transmit dishes, such as those in this photo.

## Technical Challenges

Pad Heating and Heat Tape methods offered by some other anti-icing manufacturers can use heated elements attached to the rear of the reflector. These units can produce high antenna gain losses (up to 6 dB). Non-uniform heat applied to the antenna structure can cause de-focusing and reflector efficiency degradation.

This kind of performance degradation can reduce signal availability, worsen link margins and even increase the required space segment resources and cost of delivering acceptable services to end-users as well as consume more cumulative energy in order to warm up and operate in an effort to combat the effects of snow and other inclement weather.

## It's All Hot Air

The Walton De-Ice plenum solution offers several advantages over electric pad or heat tap anti-ice systems—the circulation of hot air provides uniform surface heating of the antenna's reflector, radial supports and hub. Heaters (Gas or Electric) are attached to the antenna structure and plenum to heat the air that circulates through the Plenum.

The reflector surface is heated, thereby preventing snow from accumulating. The heating results in a totally effective elimination of ice. As a result, the plenum Hot-Air De-Ice technique minimizes the negative impacts of heat distortion, and offers the most energy-efficient and powerful options mitigating snow and ice on antennas.

Plenum systems re-circulate hot air into an enclosure behind the antenna reflector. Automatic temperature sensing and integrated control of the Walton De-Ice Plenum ensures that sufficient heat is uniformly applied to the reflector surface, radial supports and hub to minimize the thermal effects on antenna gain.

The design itself minimizes thermal expansion of an antenna structure. Temperature distribution is controlled with the use of circulation fans and heat distribution systems within the plenum. A Temperature Balance Controller is integrated into the standard automatic Monitor and Control Units to measure, control and optimize surface heat distribution in real-time.

## Ka-Band Challenges

STN's teleport includes several Ka-Band systems which require uniform surface heating. Ka-band RF signals are far more sensitive to rain, ice and snow on the Earth station antenna.

Ka-band Earth station design challenges include requirements for extreme reflector precision, optimized de-icing systems in cold climates, rain-shedding and rain diversion systems for antennas. Ka-band Earth stations require high-accuracy tracking and a high accuracy reflector due to the narrower Ka-band beam width, as compared to Ku-Band. The narrow beam width requires more precise antenna surface regularity, and wind loss compensation.



*"To ensure our clients' continued and uninterrupted transmission during strong alpine winter conditions, a reliable de-icing system is crucial," said Jurij Blazin, Technical Director for STN. "Having enjoyed successful experiences with prior Walton De-Ice systems, we upgraded to the gas version, keeping the previous electric based system as back up support," explained STN's Jurij Blazin.*

### Striving For Energy Efficiency

Pad or heat tape-based anti-icing systems employ electric heater elements. In order to provide maximum flexibility, Walton offers electric, natural gas, methane and liquid propane gas heaters which enables the customer to make the proper selection based on the cost and availability of the fuel source at their location. Depending on the specifics of an Earth station location, electricity, liquid propane, methane, or natural gas may be among the most cost-effective and energy efficient choices. Teleport operators concerned about ISO 50001 energy management qualifications may prefer to use natural gas or liquid propane.

One of the first considerations when deciding which type of fuel source to use is the availability of the fuel source. Electricity may be more available than natural gas, methane or propane gas; however, the gasoline fuel option can be more cost-effective in a large number of locations.

Factors that Earth station operators need to consider in deciding which type of energy source to use include: the cost and ease of reliable fuel delivery to the satellite facility, type of electrical cabling (above ground or underground) and availability of sufficient gas line pressure to power the required number of antenna heaters and de-icing systems in a teleport.

Natural Gas is measured in cubic feet or hundred cubic feet (CCF) and typically sold by the therm, while liquid propane gas (LPG) is sold by the gallon or weight—electricity is sold by the Kilowatt-hour. These different ways of measuring and selling the energy sources, coupled with multiple heaters in different sizes, makes the comparison of various energy costs difficult to judge. In order to simplify the comparison, design engineers and planners can convert resources to cost-per million-BTU's and then calculate the cost of operating the number of heaters needed for their facility.

An uplink planner also needs to compare the cost of running a natural gas line out to the antennas versus the cost of using liquid propane tanks and running lines out to the antennas versus the CAPEX (capital expense) costs with an electric system of adding additional switch gear, piping and wire.

With electric heater systems, an electricity bill will increase even when the de-icing systems are not running during off-season months, due to higher peak usage during winter months for the de-icing system operation. After making the various calculations, and considering all of their needs, STN decided to move their primary de-icing heat method to gas heaters.



Walton De-Ice Plenum Systems on STN Antennas

### Results

According to the company, Walton's CE-certified gas heaters combined with the Walton De-Ice Plenum system offer higher performance and reliability than prior releases and deliver the most rapid and cost-effective solution for preventing snow and ice buildup 24x7 at the lowest operational cost for an Earth station antenna. For existing antennas, the new Walton Gas Heater is also easy to upgrade as the same wiring and mounting configuration as Walton's original heaters is used.

<b>Energy Price Examples (per 100,000 BTUs or 1 Therm)</b>	
<b>European Union sample prices*:</b>	
NG:	0.996 Euros
LP:	2.40 Euros
Electricity:	3.48 Euros
* Source: STN. (100,000 BTUs = 29.31 kWh.)	
<b>Current US commercial averages**:</b>	
NG:	\$1.10
LP:	\$2.73
Electricity:	\$2.93
** Source: US Department of Energy. (100,000 BTUs = 29.31 kWh)	

## Walton De-Ice Systems Deployment By STN

When STN (Satellite Telecommunications Network), a major satellite broadcasting and data center in Europe, needed to maintain the highest uptime during winter conditions, the company turned to Walton De-Ice to protect their antennas' systems from snow and ice buildup using the firm's Hot-Air system. The Plenum attached to the area of the antenna circulates hot air to uniformly heat the reflector. A larger antenna may require several heating units to be activated during a snowstorm.



Valerie Lovsin, Director of Marketing, STN.

The latest CE-approved Walton De-Ice heater and control units enable maximum energy efficiency for STN while reducing operating costs and protecting critical Earth station services from snow and ice effects.

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

The STN upgrades are expected to yield operational efficiency benefits in the future, according to Blazin. "As STN's antenna farm is growing year-on-year, power consumption increases. To maximize energy consumption efficiency, we decided to upgrade our systems with Walton De-Ice's latest gas heaters, which not only reduces costs but also provides redundancy and reliability."

STN teleport managers can enjoy the peace of mind that comes from knowing that their antennas are "weather protected," thanks to automatic de-icing operation with moisture and temperature sensing and thermostat-like activations and de-activation, along with Walton's technical and installation support services available that are available worldwide. This allows the STN staff to focus on other teleport projects, such as delivering the highest levels of customer service and the teleport's expansion to an adjacent 10,000 square meter property to meet future growth.

[www.de-ice.com](http://www.de-ice.com)

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# COTS For Smallsat Spatial Success

By Jaime Estela + Martín Canales, Spectrum Aerospace Group

**Space-COTS are Commercial-Off-The-Shelf components that have been qualified for space applications and that follow international standards. Thanks to a new industrial test concept, Space-COTS match small satellite mission requirements efficiently and offer the best Price/Quality ratio for space hardware manufacturing.**

The space environment is surrounded by different physical phenomena and electronic space systems will be affected in one way or another. For a space mission, the environment must be well understood in order to avoid damages and malfunctions in onboard electronics.

The exact behavior of such physical phenomena in a specific space mission depends on the satellite's orbit. The behavior can be accurately simulated with software tools and these results assist satellite developers in appropriately designing their systems.

In the space environment, the following physical phenomena can be found:

## Atomic Oxygen

UV light break the O<sub>2</sub> molecules in single Oxygen atoms. The atomic Oxygen is very reactive and erodes the surface of the satellite structure. This rust affects the thermal behavior of the structure and of the satellite. This is an important issue as spacecraft thermal control will be impacted.

## Plasma

The ionized gases generate electrostatic charges and load onto the surface of the satellite. The discharge of such loads can affect the operation of the satellite and of the instruments.

## Radiation environment

A variety of effects belong to this phenomena. Gamma rays degrade the electronic components. Protons and heavy ions can literally destroy the electronics of the satellite or in the best case corrupt digital data.

## Micrometeoroids and space debris

The most dangerous elements in the space environment are small artificial or natural bodies. The impact of a micrometeoroid or other space debris can damage or destroy the satellite. Such situations have already occurred and the consequence was spacecraft loss.

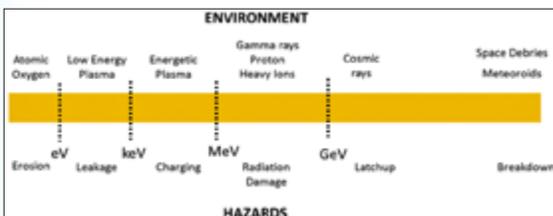


Figure 1: Space Environment and related Hazards. Source: Spectrum Aerospace

space. In that process, complementary tests were achieved and those with the best results were selected for implementation in the mission.

In 1973, the Skylab hardware was manufactured using military components. After the qualification test, the hardware had to be improved several times due to malfunctions that were encountered during the qualification process. These improvements required the further investment of more than three million dollars to obtain system redundancy; new electronic components and further qualification campaigns were then additionally required.

The electronic systems of the first space shuttle mission (1981) were also based on military components. In order to increase the reliability of the system, most of them were built with sixfold redundancy. The valid data was verified using an elective process. The inclusion of redundant systems also meant an increase in weight and power consumption which, in turn, presented additional hardware and software challenges.

Due to the fact that these earlier military electronics were not good enough for space applications, and that the up-screening did not always improve the parts being considered, in the 60's the systematic development of space electronics was initiated, as they had to meet or exceed high quality production process standards. In the US, military components were selected and then qualified after running additional tests. This strategy allowed for the reduction in production costs. As the demand for space components was, and is, minimal, the price of these units remains high.

Today, the qualification of a single component that follows the ESA or NASA standards implies an investment that starts from an expenditure of one million dollars and a certification time of approximately two years [1].

The experience gained over the last 60 years in many space missions and with different technologies has allowed organizations such as the ESA and NASA to develop sound qualification guidelines and standards. These are manuals to be followed and used for the qualification of electronic parts for space missions.

The standards defined by the ESA can be found in the European Space Components Information Exchange System (ESCIES) website ([escies.org/webdocument/showArticle?id=167](http://escies.org/webdocument/showArticle?id=167)).

A database of qualified electronic components, including their test reports, is also available at the ESCIES Website. (<https://escies.org/labreport/radiationList>).

The validation and qualification process is comprised of the hardware and device preparation (Device Under Test or DUT) to be tested, the execution of the test and then the evaluation of the results. The results are then published in a test report.



Figure 2: Space shuttle (1981) IBM CPU - AP-101. Source: NASA

Depending on the mission, in some cases the screening of a few parts is not enough to guarantee the qualification of the entire system (e.g., radiation tests)—in other cases, the complete batch (outgassing) has to be tested.

During the tests, the relevant parameters of the devices will be characterized under space conditions. One important point for a successful qualification is to guarantee that the tested components were each produced using a similar manufacturing process—all of the qualified parts should be identical (geometry, size, materials, etc.) and, consequently, they then belong to the same batch. After the qualification, a test report and a datasheet will be generated containing the parameter values and limits relevant for the use of the electronic parts in space.

A full qualification of a component is quite laborious, requires a few years and demands a high financial investment. A full qualification is called a “Screening Test.” The following tests must be performed:

- Electrical test
- Seal test
- Visual inspection
- Mechanical shocks
- Vibration test
- Constant acceleration
- Thermal test
- Radiation test
- High Temperature Stabilization Bake
- Temperature cycling
- Thermal Shock
- Solderability

Following the ESA Standards that are described in the document “ECSS-Q-ST-60-13C\_ Space product assurance” three different classes are defined [2].

The difference between the classes depends of the depth of the qualification process. In summary, Class 1 represents a full qualification. Class 3 represents a light qualification, mainly radiation testing.

To show how a qualification test is conducted, here is a short description of the Total Ionizing Dose (TID) test:

—Preparation of the DUT test boards. Here, two configurations (Bias Condition) are important. One is the “Off-Mode,” where all the pins are connected to ground.

—The second one is the “On-Mode,” where the device is configured in a specific operating state but will be retained without function, such as in “Stand-by” mode. This mode means no signal will be processed during the test.

This two test configuration will be used for the irradiation of the DUTs. Cobalt-60 will be used as radiation source. During the irradiation, the DUTs will be characterized in time intervals with a tester (Automatic Test Equipment – ATE). The characterization results will show the degradation of the devices during the test. The

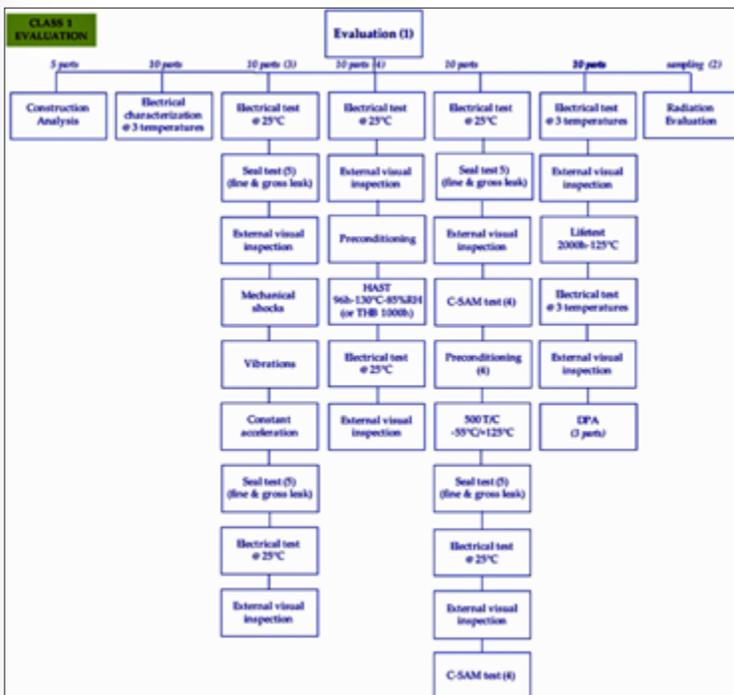


Figure 3: ECSS-Q-ST-60-13C Evaluation tests flow Class 1. Source: ESA.

degradation depends on the accumulated radiation dose. For example, the power consumption will increase the higher the radiation dose received. Upon completion of the test, it is possible to observe the variation of some electrical parameters and, in some cases, where a specific radiation dose results in the destruction of the device.

### Over-Qualification? Are COTS Robust Enough?

ITAR components comply with severe requirements and offer high reliability for their usage in extreme environments. An ITAR component can have a radiation tolerance of 300 krad.

During an LEO mission, a total dose of 1 krad will be accumulated in one year [4]. In this case, the use of ITAR components does not match the mission requirements—ITAR components are over-qualified for LEO missions is a valid statement.

Problematic are the ITAR export restrictions. The export licensing process takes approximately six months to complete and there is no guarantee permission will be obtained in the final run. This is definitely a major problem for small and medium-sized enterprises (SMEs) and retards their business processes. Another disadvantage—the ITAR EEE parts are based on a robust, albeit old technology, and do not satisfy the latest high-tech electrical and functional levels.

Another important point is the price of ITAR components, which are high and financial obstacle for SMEs that wish to enter the space business but are not in possession of major capital resources.

### Evolution Of An Era

The new space era began with the birth of smallsats. In February of 2000, Stanford University launched their OPAL smallsat. OPAL was the mothership for six picosatellites and demonstrated the feasibility of new space platforms for research experiments [5].

These new space platforms have been in use by many universities, research institutes and space companies for a variety of research missions, technology demos and validations as well as commercial services. In order to keep costs low, COTS components are being used. These components support the missions for a limited period of time. Now, however, the use of COTS components in space has experienced a rebirth [6].

Many institutions continue developing and launching smallsats that are built using COTS. Most of these missions never qualify the electronic components being used—there is trust that the pre-launch simulations are accurate and a certain amount of luck is required.

In the best case, the developing teams test the electronics. During this process, the electronic board will be irradiated with gamma rays and run with test software until errors appear. Should nothing untoward occur, the test will be considered as having passed.

This is not a professional way to develop space electronics. The standard procedure from the ESA and NASA for testing each component is the recommended method to implement in the design of electronics for space, especially as it is necessary to understand the behavior of all components under such harsh conditions.



Figure 4: ECSS-Q-ST-6-13C Standard. Source: ESA

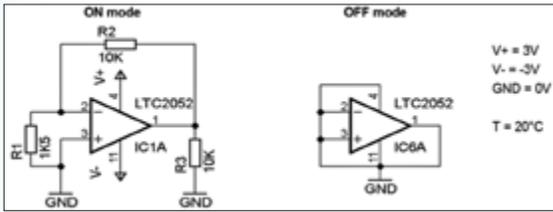


Figure 5: BIAS Condition TID Test for the LTC2052. Source: Spectrum Aerospace.

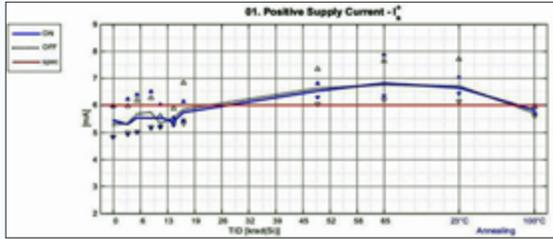


Figure 6: OPAMP power supply degradation. Source: Spectrum Aerospace.

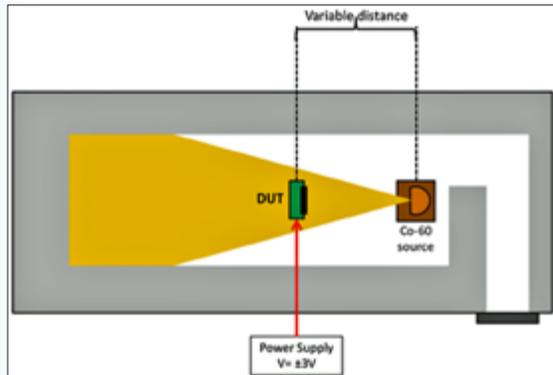


Figure 7: Co-60 facility. Source: Spectrum Aerospace.

low-cost policies.

Through these efforts, space technology will become a mass market product and will be practically accessible to everyone [7]. An important note is that ITAR solutions currently do not match the NewSpace philosophy and, in consequence, new solutions must be found.

One of the most interesting parameters for devices in space is radiation robustness. This parameter cannot be found in commercial parts datasheets. All electronic components could certainly survive in space—but the questions becomes... for how long?

In the datasheet of a commercial component, the behavior of the electrical parameters under normal conditions (on the ground) will be assessed and the limits described. For instance, in a datasheet it is possible to read the Absolute Maximum Ratings such as the temperature limits, let say, from  $-10^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . This doesn't mean that under or above these limits the component will not function.

A test in a thermal-chamber will reveal the true limits of the component. This means the same components could be used for a broader temperature range than specified in the datasheet. In general, it is possible to see how robust an electronic component is by measuring its behavior under specific environment conditions.

The NewSpace philosophy and the approach described above are merged into the Space-COTS project and the emerging, private, space industry.

Each component of the system should be tested in order to comply with mission requirements—the components must be selected prior to the implementation of the mission design.

The uncertainty of not knowing the life expectancy of the electronics will slow the professional development of smallsats.

### NewSpace

NewSpace is a term that relates to the emerging, private space industry.

This community is mainly comprised of space companies that are involved in the development of low-cost space technologies and the establishment of

### The Story Behind Space-COTS

The term—Space-COTS—and the concept were invented by Jaime Estela from the German/Peruvian company Spectrum Aerospace. The research work was completed with Martin Canales Romero and Avid Román-Gonzalez in support of smallsat projects in Europe and in South America. These projects have paid off in a deeper knowledge and understanding of smallsat technology and the technology's requirements and constraints.

Furthermore, the experience of these three researchers corroborated the use of commercial electronics in the space business. Working for the German Aerospace Agency (DLR) in satellite projects, with close reference to the ESA standards, has resulted in an understanding of the long and expensive pathways required for the traditional qualification of EEE parts.

The DLR' Standardization and EEE-Parts Division and the ESA Component Space Evaluation, as well as the Radiation Effects Section, all instructed the Spectrum Aerospace team in the concept and philosophy of the test procedures for EEE parts. These experiences crystallized in the concept of Space-COTS finding the middle point between having no qualified parts whatsoever and fully qualified ITAR parts. Looking at smallsat history, many commercial parts can work in space for several years even though many were not designed for space applications.

Reliable, commercial EEE parts must be identified. In mid-2015, due to the participation in the Horizon-2020 program, a feasibility study was conducted, where author Jaime Estela evaluated the components used in different satellites and identified the most used parts.

The result of this study led to the first edition of the Space-COTS catalog, which will be soon be published in the community portal at [space-cots.com](http://space-cots.com). The aim of this catalogue is to list the major qualities of active and passive electronic, electric, and electro-mechanic parts that cover almost all space mission needs.

Space-COTS will be tested and qualified in different levels, depending on the depth of the qualification as follow:

- **Class A: Full screening test**
- **Class B: TID and SEE test**
- **Class C: TID test**

These classes follow the ESA/NASA Standards and also the new standards coming from the International Organization for Standardization (ISO). The more intensive the test, the higher the cost of the qualified devices and equipment. Regardless, this solution is much less expensive than for ITAR products. The Space-COTS catalog is classified in component groups. Each group involves the same type of components. The following groups were defined:

- **Diodes**
- **Bipolar**
- **Transistors**
- **FET**
- **Power**
- **MOSFETS**
- **OPAMP**

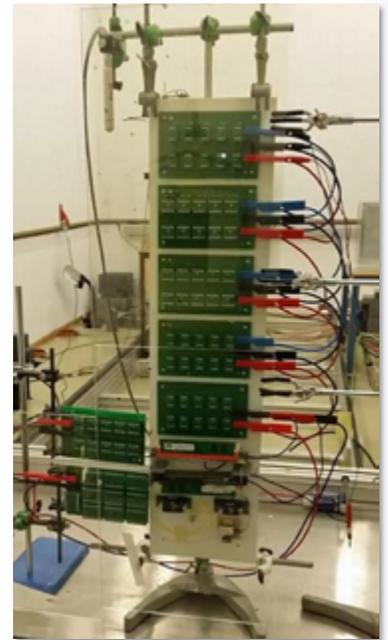


Figure 8: Stand of DUTs ready for the irradiation. Source: Spectrum Aerospace.

- Comparators
- AC/DC converter
- Voltage regulator
- Voltage references
- ADC/DAC converter
- Logic devices
- Drivers
- Memories
- Controllers
- FPGAs
- Sensors
- Image sensors
- Optoelectronic parts
- And more...

The qualification of COTS inside one project, where one or few exemplars are needed, does not justify the qualification of each component as the test cost will considerably increase the project budget. Taking such into account, Spectrum Aerospace will achieve the qualification of representative numbers of COTS and will bring these into the space market at competitive pricing. Spectrum Aerospace has designed test environments that allow for the qualification of a large number amount of parts and within a short time period.

One important point to mention is that new generation components will be included within a short timeframe in the Space-COTS catalog and this information will be quickly become available. Spectrum Aerospace identifies the best COTS, qualifies the product and then offers the product to the smallsat community at the best price possible.

### The Smallsat Market

The market for smallsats is rapidly growing and new technical solutions and services are necessary to satisfy increasing demands. For the manufacturers of smallsat electronics, ITAR components are not the correct solution—Space-COTS could certainly fill this important role.

A similar case holds true for satellite launchers. Smallsat will never fly a space mission as long as there are no dedicated launch services available to push them into their required orbits. The piggyback solution is an emerging solution.

Forecast studies completed by the research company NSR indicate that more than 2.500 smallsats up to 100 kg will be launched within the next 10 years [10]. Another forecast by the Spacework predicts that from 2014 until 2020, three thousand small satellites (in weight up to 50 kg) will be launched [11]. In both forecasts, future satellite constellation were also considered. The use of constellations promises several benefits, such as:

- A smaller number of satellites needed
- Reduction of mission costs
- Reduction in the number of launches and the size of the launcher
- Higher performance due to availability of redundant satellites

More electronic parts will be required and Space-COTS will be able to satisfy this future demand, thanks to efficient qualification processes (quality assurance), competitive prices (cost reduction) and a broad portfolio.

### Future Activities

Space-COTS represents the efficient investment of funding and provides each project with EEE parts that satisfy exact mission requirements, with attractive prices, with a corresponding quality level and, especially, without over-qualification.

In order to support the entrance of new solutions into the space field, new standards must be defined. The ISO organization began to treat this situation starting with the edition of new standards. On the ISO website under the term "Design Qualification and Acceptance Tests," the defined standards related to the space field can be found.

The document related to the components qualification topic is the "Space Systems—Design Qualification and Acceptance Tests of Small-scale Satellite and Units Seeking Low-cost and Fast-Delivery." Topics such as qualification test, acceptance test, retest, test plan, test report, test requirements, test levels and duration, Total Ionization Dose test, Single Event Effect test, Electrostatic Discharge test, Electromagnetic Compatibility test and others will be handled in this document [8].

### New Methods For Qualification Tests

Looking into the future, Spectrum Aerospace is planning and coordinating technical solutions to improve the effectiveness of the qualification process via dedicated methods in order to reduce cost and time yet, all the while increasing quality.

Some of these selected technologies will be used soon and others will still require research activities to bring the technology to industrial standards. Spectrum Aerospace will continue this work and will regularly present the progress of these activities, especially as the evolution of Space-COTS is now underway.

The future of the space industry is in the hands of disruptive technologies which match smallsat mission requirements. Space-COTS is one of the disruptive technologies that will aid in the creation and expansion of NewSpace.

[www.spectrum-aerospace.com/](http://www.spectrum-aerospace.com/)

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# Developing Technologies For A Bright Future A Datum Systems Perspective

By Dave Seeman, Director of Sales, Datum Systems

In a recent Northern Skies Research report, the company stated that “the global market for Commercial Satellite Ground Equipment will grow from \$5.6 Billion in 2015 to \$11.5 Billion in 2025, generating over \$100 Billion in cumulative revenue”—certainly such an analysis offers ground equipment manufacturers a reason to be optimistic as well as motivated for the future of their businesses and prompts them to develop and deliver the latest, most efficient technologies to address these growing markets.

From the inauguration of commercial satellite communications, the burden to improve performance and efficiency in a satellite link was placed on ground segment equipment manufactures.

This was believed to be the most cost effective sector for researching, developing and implementing the next great leap in technology for a satellite connection.

Manufacturers, however, have not always been of this opinion, as they knew it was not inexpensive, quick or easy—but what choice did they have? The benefit has been to witness great advances in all aspects of the capabilities and efficiencies in ground station equipment that actually reduce the Total Cost of Ownership (TCO) to the service providers or end users.

And Datum Systems has delivered many of these leading edge capabilities to their customers via their satellite modems, many under the names of Radyne, Vipersat and additional OEM providers.

The cost of these development efforts are not always directly reflected in increasing the price of ground station equipment such as antennas, high powered amplifiers or modems—these costs must be spread across manufacturing.

The companies that accomplish this feat will still be in business in 2025 to share in a piece of the projected \$11.5 billion in revenues.

Today these manufacturers have developed, produced and implemented many new technologies, such as antennas with smaller apertures, high gain reflectors and flat panels for fixed and mobile applications. RF power amplifier manufacturers constantly introduce smaller, higher powered, more efficient and reliable consumer amplifiers.

These new amplifiers must also support whichever frequency band is the hot new ticket. Modem manufacturers continue to develop and implement new, high order modulations, robust and highly efficient forward error correction methods and also carrier cancellation capabilities that increase overall Shannon efficiency by 100 percent. Modems now support Internet Protocol (IP) interfaces with integrated routers that optimize, compress and accelerate IP traffic.

The tides recently shifted and satellite manufactures began making investments in research and development of new technologies and capabilities for use on board spacecraft. These advances have highly increased the value of space assets.

Using onboard processing for DAMA system as well as frequency reuse capabilities allows for more users on a single transponder. The life span of a satellite can now be one of many decades by building systems that are capable of being serviced on orbit and outfitted with new, highly efficient electronic propulsion systems.



Datum Systems is located in the heart of Silicon Valley, California, and is solely focused on the innovation and manufacturing of satellite communications modems, specializing in the most spectral and bandwidth efficient SCPC modems.

Datum produces the industry's only one-half rack modem (8.5 x 11-inches and weighing less than 5 lbs), while capable of 350 Mbps TX and RX in the model M7. This compact design allows for lower part counts and less heat production, thereby increasing the MTBF to previously unreachable numbers. The M7 serves worldwide IP requirements and solutions for Mobile Backhaul, Trunking, Enterprise, Oil & Gas, Maritime, Local and International Government needs. Solution architectures include Point-to-Point, Point-to-Multipoint, Mesh, On-the-Move and SCADA.

Recently, Datum Systems released their patented Smart Carrier cancellation in the M7 modem series. The unique design of Smart Carrier Cancellation is engineered to perform cancellation at the baseband signal level of the demodulator. This allows the demodulator to acquire and reacquire carrier lock faster than any other cancellation techniques available. Long acquisition times were a constant burden and complaint from users of cancellation technologies, but Datum has solved this frustrating issue.

With the most recent release of the Datum DVB-S2 / DVB-S2X extensions in the M7 modem, the M7 now outperforms all other modems when operating at like modcodes and filter roll-offs. The M7 DVB-S2X, combined with Sharp Carrier roll offs (5, 10, 15, 20, 25, 30, 35 percent), allows for near Shannon limit performance and total throughput capability of 700 Mbps and symbol rates of 72 MHz bi-directional. These combinations equal the most bandwidth efficient and ease of set up available today, allowing the highest bits/Hz for the lowest bits/\$ in the industry.

## SMART Technologies

Datum offers a group of Smart Technology Features that when combined provides the industry's most efficient modem available. These Smart Technologies include our FlexLDPC FEC, Sharp Carrier, Smart Carrier Canceling, Advanced 8QAM, End-to-End Modem Communications and our fully featured Web Browser Interface with Diagnostic capabilities.



Datum Systems M7 product family.

Inter-satellite links allow for huge constellations by intelligently connecting large numbers of satellites that comprise a constellation into acting as a single entity. Some of these spacecraft have been launched and many are on launch schedules just around the corner, with a few starting to provide services. These new birds with increased capabilities offer a variety of forms: High Throughput Satellites (HTS), Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and constellations that are composed of hundreds of small satellites (smallsats).

In the launch industry, where the business is truly rocket science, there has been significant advances—payload capacity has increased and the ability to launch multiple heavy satellites with one vehicle is now possible. This spreads the cost burden across multiple satellites and operators.

With the ability to reuse launch vehicles, this is definitely a game changer and will certainly reduce the economics involved in satellite launches and will allow for more frequent deployments and additional opportunities to attract new players. These advances in spacecraft technology, combined with the developments in efficiencies in the ground station equipment, have set the stage for meeting the growing demands of higher and higher throughput.

Now the operators and service providers must be creative with new services and capabilities that appeal to users with technical advances as well as possessing the ability to solve problems. Of course, this all has to meet the economies of scale and make business sense in order to attract new business opportunities and to expand current markets. The potential for nexgen ground station equipment is here and the skies are primed to support viable and profitable new services.

With the significant reduction in bandwidth cost in most regions, the largest barrier to entry has been reduced. The repeated warnings from MNOs, multinational enterprises and maritime operators of OPEX costs that are excessive have waned. Using the new tools developed by operators, service providers and equipment manufactures are able to now clearly show the TCO of a satellite network a profitable Return On Investment (ROI).

Developing new efficiencies and capabilities in a cost effective and reliable manner has never come inexpensively or quickly enough. Ground station equipment manufactures know this first hand. For them, the daily challenge is to develop and implement new technologies to meet growing client demands and to work within budget restraints and customer schedules.

In the satellite modem development and manufacturing sector, Datum Systems has been meeting such challenges and delivers new technologies. Although one of the smaller businesses in the modem market, the modus operandi for the firm has been to develop and implement new technologies in a methodical and highly economical way. A privately owned company with low overhead and proven high efficient manufacturing partners, Datum Systems is able to offer the industry's latest technology with improved performance over competitors, at a very substantial cost savings.

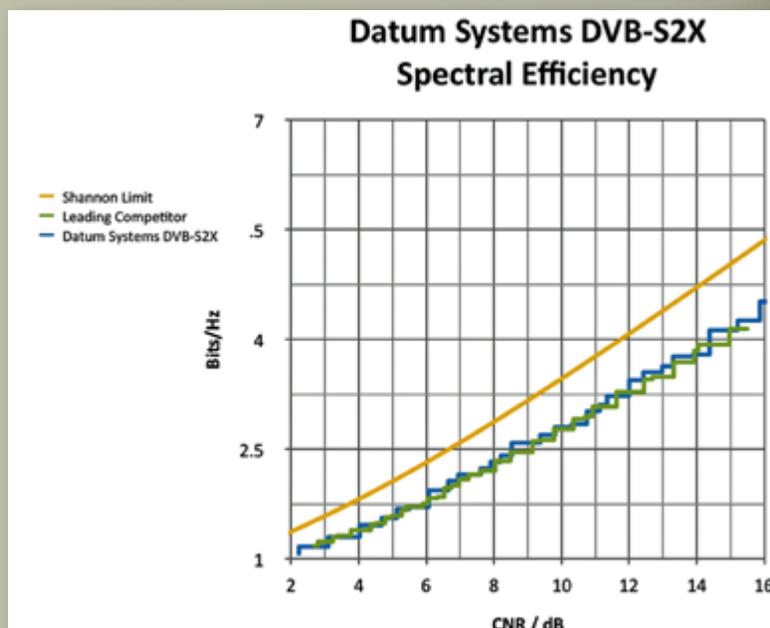
[datumsystems.com/](http://datumsystems.com/)

*Datum Systems Inc. is a wholly privately owned company that has been in business since 1986, and incorporated in 1995. Originally, Datum Systems designed modems and various communications gear as an OEM supplier for other companies.*

*All features work together to provide the most feature loaded, reliable, spectral efficient and affordable modems on the planet. All M7 Series models support these Smart Technologies as standard features or upgradable options in the most modular modem available. The M7 universal platform was designed with flexibility in mind to support Point-to-Point and Point-to-Multipoint networks.*

#### **Experience & Know-How**

*With more than a century's worth of electronic design experience and familiarity with sophisticated communications systems and satellite modems, Datum Systems continues to expand its advanced technology and capability portfolio using techniques that are supported by the most reliable, cost effective and power efficient FPGAs available. These designs have supported the fastest acquisition modem on the market, the first to develop and market a flexible LDPC "FlexLDPC", Smart Carrier cancellation and much more, including our new compact and low cost professional high-speed DVB-S2X Modem.*



#### **Product Design Philosophy**

*Datum Systems manufactures the highest quality and most reliable modem by concentrating solely on satellite modems. The modem products are rigorously designed to provide the absolute best performance at the lowest cost. Datum Systems equipment is also engineered to be built extremely efficient. Testing is virtually all automated, from initial checkout through final testing, drastically reducing system test time.*

*The electronic design features zero adjustments and comprehensive digital processing. Extensive use of Digital Signal Processing and FPGAs keep the complexity hidden inside high reliability chips. Direct modulation and demodulation is the firm's hallmark, which offers customers superior performance with fewer parts and higher integration with modulation and demodulation at 70 MHz, 140 MHz and also at L-Band. The design of these incorporates communications and logic processes written in high level hardware design language.*

*The name "Datum" refers to the reference or reference line from which other measurements are made.*

# SatBroadcasting™: Overcoming The Challenges Of Satellite News Gathering (SNG)

By Juan Martinez, Technical Area Director, Integrasys



**W**ith the rise of Over The Top Content (OTT) delivery and an ever-more competitive landscape, satellite broadcasters are under increasing pressure to deliver the targeted content at the correct time to the right platforms.

Consumers expectations in terms of content, choice, and quality have drastically increased over recent years with the advent of new technology—they also expect the news and latest, unfolding sporting action to be delivered directly to them, wherever they may be located.

This places extra pressure on Satellite News Gathering (SNG) operators to capture live content from across the globe, from anywhere in the world, is not an insignificant achievement.

## Live News

The recent Brexit vote in the UK is a prime example of broadcasting stretched to the limits. Over a matter of days, the UK political scene was awash with breaking news and unexpected twists and turns. More than that, the Brexit vote and everything that followed (and is continuing to follow) has massive

implications for the rest of the European Union and, indeed, many other countries across the globe. For news teams, this has meant a constant rush to ensure they are at the correct place at the right time to capture the latest developments in order to broadcast live and, in many cases, to multiple countries and regions across the world.

Not only were viewers demanding “instant” news, they also wanted the highest quality viewing resolution possible. This is also true for other live events, such as major sporting events, where viewers want to watch the action unfold, not hear from another source who won a race before watching that event.

## The Challenge Of Satellite

Satellite technology unquestionably offers many advantages as the technology can work in every corner of the globe, even if other communication infrastructure may be lacking. This is particularly important for newsgathering as teams are often having to travel to remote areas.



If those teams are also filming in the midst of a disaster, any existing infrastructure that may have been in place may have already been disrupted. Satellite technology means these teams have an instant infrastructure ready to connect for broadcast at any time.

However, at the same time, satellite broadcasting has a variety of challenges. By their very nature, SNG trucks are constantly having to move to a new location to capture the latest footage. When a news story is breaking, this move has to be done extremely quickly to ensure the feed is captured and delivered as soon as possible during, or immediately after, the event. At each location, the antenna has to be repointed and making a satellite pointing error mistake is easy to accomplish, especially with the extreme time pressures faced by the teams.

This is especially true as the SNG teams are often not specifically trained in satellite technology, despite being required to handle and manage specialist equipment. A lack of space also means that the monitoring of those signals is generally left to the team at the broadcast headquarters location. This means the SNG team is often in the dark, not knowing until too late whether the signal has arrived in good quality.

That lack of training incurs errors all too easily. Satellite works well but simple mistakes can have drastic consequences. If the antenna is mispointed for example, the broadcaster can suffer a serious impact in service quality as well as potentially causing satellite interference for other users.

Equally, satellite broadcasters can be victim to other factors beyond their control—for example, severe weather, such as extremely heavy rain, can cause rain degradation. When there is a degradation of any description, contacting the appropriate specialists to fix the problem at the satellite operator Network Operations Center (NOC) can be problematic.

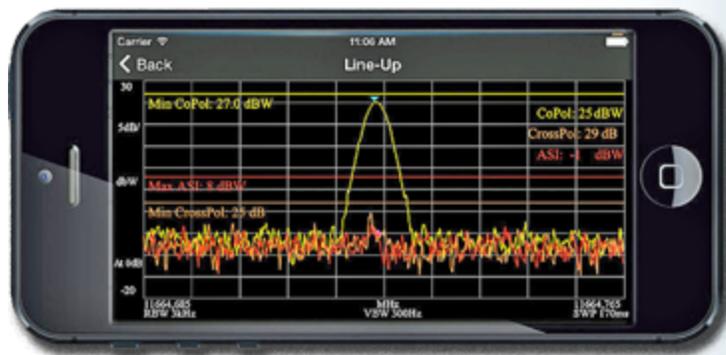
This is especially true in the case of a major breaking news or sporting event where many broadcasters may be experiencing the identical problem, especially if such is weather related, and therefore causing a bit of a bottle neck in “fix” requests that must be dealt with by the satellite operators. For many broadcasters, there may also be language barriers present when the satellite operator must be contacted directly to resolve issues—this makes resolution that much harder to correct.

### **The Correct Tools**

Prevention is the key in the satellite world to ensure the best performance and quality of any broadcast experience. As often stated by the Satellite Interference Reduction Group (IRG), one of the most effective ways to reduce errors is through better, more intelligent tools. If broadcasters have more tools in the toolbox and are able to automate more processes, the risk of human error is vastly reduced, which is by far and away the most common cause of degradation.

Through the addition of tools that alert users as soon as there is a problem, or how to take measures to automatically resolve issues with the signal, the result will be a much smoother process with a greatly reduced risk of signal loss. This is particularly significant for those events outside beyond local control. By adding in tools and processes to battle such happenings, the broadcaster can take possession of some of that control once again.

Ultimately the team in the OB truck needs as much information and support as possible to enable them to ensure that any signal leaving the site is of the best possible quality—the last element needed is further complication.



### **Satmotion SNG**

The particular and unique challenges for SNG led Integrasys to develop a special tool to assist satellite broadcasters in this environment. Satmotion SNG enables the SNG operators to regain some of that control and also simplifies the setup process for them. The antenna can be either manually or automatically aligned and the tool makes it possible for them to check the alignment is correct, whichever method is used.

Satmotion SNG also takes measurements of cross polar isolation, as well as giving the SNG operators access to measurements from the NOC. This means that the team has the appropriate tools at hand to spot if there are any problems that are likely to affect the signal.

Satmotion SNG is simple to use. As mentioned above, SNG truck operators are often not satellite specialists, nor do they have the time to deal with complicated procedures and data. Therefore, Satmotion SNG is a simple app that can be downloaded on a laptop, tablet, iPhone, or google glass. The product has a simple, easy-to-use interface and displays the required information in such a way that little training is required for use of this technology.

### **Raining In France**

This year's Tour de France was hit with some pretty horrendous weather. At the time of this writing, stage 12 was reached—this cut the race to 6 km due to high winds. Heavy rain also plagued the event—this meant a lot of soggy cyclists as well as a number of challenges broadcasters attempting to capture live event coverage.

Not surprisingly, the severe rainfall led to a certain amount of rain degradation for a number of satellite broadcasters. This meant loss of transmission and some pretty frustrated teams working hard to get their feeds back on air. Some of the broadcasters were using Satmotion SNG and that meant they were able to meet the QoS and even repoint during transmission if that was needed to keep the link up throughout the coverage with minimal effects on the actual broadcast.

### **Satellite Back On Top**

Satellite can sometimes receive bad press. Most consumers consider satellite the poor relation for broadband provision and many also have an identical view in regard to broadcast, as well.

However, with more and more tools being made available to enable users and operators to overcome some of the more interruptive challenges, that percept can be countered with seamless, good quality coverage—wherever and whenever.

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

*Juan Martínez is Technical Area Director for complex software systems at Integrasys. He leads the software engineering in the area of satellite innovation solutions. He possesses more than 20 years' experience working on Test and Measurement, Embedded Solutions, Network Management Applications and Quality Assurance Methodologies.*

# The Heyman Report: A Golden Jubilee For Russia's Soyuz

By Jos Heyman, *Tiros Space Information*

**O**n November 28, 2016, 50 years will have passed since the first precursor of the Soyuz spacecraft was launched as Kosmos-133.

By the time this golden jubilee arrives, this family of rockets will have launched 319 spacecraft.

Type	First	Last	Flights	Failures
Soyuz	23-Apr-1967	14-May-1981	41	1
Zond-1	2-Apr-1964	20-Oct-1970	7	2
Soyuz T	16-Dec-1979	13-Mar-1986	16	1
Soyuz TM	21-May-1986	25-Apr-2002	34	
Soyuz TMA	29-Oct-2002	14-Nov-2011	22	
Soyuz TMA-M	7-Oct-2010	18-Mar-2016	20	
Soyuz MS	7-Jul-2016	current	2	
Progress-1	20-Jan-1978	5-May-1990	42	
Progress M	23-Aug-1989	10-Nov-2009	69	
Progress M1	1-Feb-2000	29-Jan-2004	11	
Progress M-M	26-Nov-2008	1-Oct-2015	29	1
Progress MS	21-Dec-2015	current	3	
Various tests	28-Nov-1966	30-Aug-1985	23	5
<b>Total</b>			<b>319</b>	<b>10</b>

Table 1. Soyuz.

Over that period of time, a total of 205 cosmonauts from 30 countries will have flown in Soyuz spacecraft, some of them on multiple occasions.

Over the years, the Soyuz spacecraft have been continuously developed to ensure they are up to date with modern technology, but at the same time, their basic form has been maintained. In addition, these rockets have also served as the basis for other spacecraft, in particular the Progress cargo series.

Initially developed as a crewed spacecraft for the USSR's lunar program as well as that nation's envisaged space station program, the Soyuz family have supported seven Salyut space stations, the Mir space station and Soyuz is currently the main vehicle supporting the International Space Station.

## Origins

The birth of the Soyuz spacecraft can be traced back to the late 1950s when the USSR was looking for a follow-on to the Vostok spacecraft—specific objectives included sending cosmonauts around the Moon and to eventually land them on the Moon. Simultaneously, the new spacecraft was envisaged as a ferry to travel to and from Earth orbiting space stations. Much inspiration came from the work of Konstantin Tsiolkovsky who, in the early 20th century, wrote theoretical works about spaceflight beyond Earth orbit.

As far as can be determined, work on the new spacecraft was initiated in 1958 and was undertaken by Sergei Korolyov's OKB-1 design bureau, the precursor of the current Energia corporation.

This was at a time when the United States had embarked on the military Dyna Soar program that ran from 1957 until its cancellation in 1963 and the civilian Mercury program that was started in late 1958.



This was also a period of (misinformed) hysteria about the 'Soviet lead in space' and the 'loss of the high ground' by the United States and led to efforts of inserting an American into space as quickly as possible.

These efforts were inspired by President John F. Kennedy's address to Congress on May 25, 1961, when he said, "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth."

This inspiring statement, undoubtedly strengthened by the President's assassination on November 22, 1963, triggered the race between the United States and the Union of Socialist Soviet Republics (USSR) to determine whether the words "This is one small step..." or similarly, other words that would become legend... would be spoken by an American or a Russian.

However, the USSR did not possess such a strong inspirational commitment and, apart from powerful government meddling, that nation's effort was hindered by competition within the space industry, in particular between the two major designers, Sergei Korolyov and Vladimir Chelomei.

Country	#
Russia/USSR	109
United States	43
France	7
Germany	7
Japan	7
Italy	4
Canada	3
Bulgaria	2
United Kingdom	2
Afghanistan	1
Austria	1
Belgium	1
Brazil	1
Czechoslovakia	1
Cuba	1
Denmark	1
Hungary	1
India	1
Kazakhstan	1
Korea	1
Malaysia	1
Mongolia	1
Netherlands	1
Poland	1
Romania	1
Slovakia	1
South Africa	1
Spain	1
Syria	1
Vietnam	1
<b>Total</b>	<b>205</b>

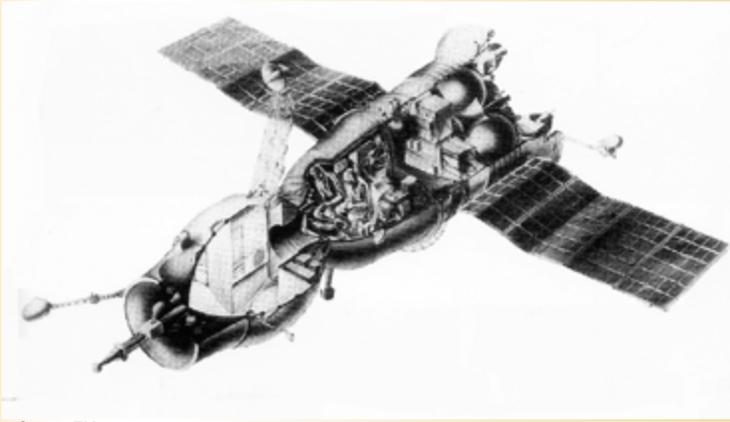
Table 2: Cosmonauts (up to Soyuz MS-02)

## Lunar Program

OKB-1 responded to the 1958 requirement for a space vehicle and by 1962 the design studies had evolved the basic Soyuz spacecraft, identified as the Soyuz 7K (K = Korabl). Soyuz 7K

The basic Soyuz 7K, as eventually flown on the flights related to the lunar program, consisted of:

1. A living compartment module, designated as *Bitovoy Otsek (BO)*, which had a diameter of 2.26 meters and a length of 2.98 meters (including the docking system). The module provided the cosmonauts with sleeping quarters, laboratory facilities as well as the cargo hold and air lock
2. The instrument and propulsion module, designated as *Priborno Agregatniy Otsek (PAO)*, was comprised of a pressurized instrumentation section and an unpressurized engine compartment.



Soyuz 7K.

The PAO had a diameter of 2.72 meters and a length of 2.60 meters. The attitude control system used 30 thrusters and the main engine was a KTDU35 with a thrust of 409 kg. There was also a limited performance backup engine to be used in case of emergencies. Two solar arrays of 3.6 x 1.9 meters could be carried, although when the Soyuz spacecraft was being used in conjunction with the Salyut space stations with a shorter flight duration, the solar panels were replaced with batteries

3. A descent module, designated as Spuskaemiy Apparat (SA), which was bell-shaped and had a length of 1.90 meters and a diameter of 2.17 meters. The bell shape provided some aerodynamic lift that allowed the spacecraft to perform 3 to 4 G reentries, although 10 to 16 G ballistic reentries would also have been possible with this craft. Although the capsule was designed for landing on land or water, the landing normally took place over land. Descent was slowed by a parachute—when a 2 mile altitude was attained, small landing rockets would fire to lessen the impact with the landing site.

For the circumlunar mission, this was part of the 7K-9K-11K complex wherein 9K referred to a module that would be placed into a Low Earth Orbit (LEO) with a Proton launch vehicle. Three to four 11K tankers would be launched as follow-ons and would dock with the 9K and transfer fuel, following which the 11Ks would be discarded. This would be followed by the launching of the 7K with a crew, docking with the 9K and then a circumlunar flight. Some reference sources have identified this version of the Soyuz as 7K-OK (for 7 Korabl-Orbital'nyy Korable).

The subsequent program that foresaw a landing on the Moon and was far more ambitious than the earlier circumlunar program was dependent upon the Nosital (N)-1 launch vehicle. In September of 1963, a proposal was made that the OKB-1 match the basic Soyuz spacecraft with the N-1 launch vehicle to achieve crewed landing missions. The program consisted of five stages:

1. L1: six circumlunar flights using the 7K-9K-11K complex, in which the 7K was designated as 7K-L1
2. L2: six flights of an automatic rover vehicle designated as 13K, in combination with the 9K and 11K spacecraft
3. L3: crewed lunar landing using the 7K with a separate landing craft. It would have required one launch with a Soyuz launch vehicle and three launches with N-1
4. L4: a single lunar orbital flight with a modified 7K, to be launched with N-1
5. L5: and advanced lunar rover, launched by a single N-1.

The other components of the program were the Soyuz Lunova Orbitlny Korably (LOK) lunar orbit cabin, and the Soyuz Lunova Korably (LK) lunar cabin. The Soyuz LOK lunar orbit cabin was to carry the crew to the Moon, remain in lunar orbit and then, after the LK had docked again, fly the crew back to Earth. The mission profile intended to launch the Soyuz LOK and LK combination with an N-1 launch vehicle. Two cosmonauts were to be carried aboard the spacecraft.

From LEO, the fourth stage of the N-1, also designated as the first stage of the Lunova Raket Kompleks (LKR), would send the spacecraft into a trans-lunar trajectory. Powered by a Kuznetsov NK-31 engine, this stage would separate after trans-lunar injection.

The fifth stage, also referred to as the second stage of the LKR, would perform the mid-course corrections as well as the lunar orbit insertion and serve as a braking motor for the lunar landing. This stage would then separate from the LK at an altitude of 2 km, following which the LK would descend on its own.

Once in lunar orbit, one cosmonaut would make a spacewalk to transfer from the Soyuz LOK to the LK. The latter would then separate and descend to the surface of the Moon, using the remaining propellant of the second stage of the LKR to take the LK out of lunar orbit and into a landing trajectory. At an altitude of 1.5 km, the LKR would separate from the LK and impact the lunar surface. An engine on board of the LK would be used for the final landing phase.

Following landing, the single cosmonaut would undertake an EVA of about 90 minutes, wearing a semi-rigid Kretchet spacesuit with a hoop structure that would allow him to regain his upright posture should he fall. After about four hours, the LK would take off from the Moon again, leaving the landing platform behind, and rendezvous with the Soyuz LOK which had remained in lunar orbit. After the transfer of the cosmonaut, the LK would be jettisoned. Using a boost engine, the Soyuz LOK would then be sent into a trans-Earth trajectory. Eventually, the re-entry capsule of the Soyuz LOK would return the two cosmonauts to the surface of the Earth.

When initiated, the program anticipated two low-Earth test flights in 1969 and 1970 to test the rendezvous and docking systems of the LOK and LK—the first of three circumlunar flights was planned for 1973. The first lunar landing would have occurred in 1974.

The program was cancelled in May of 1974 and the principal reason was, apart from the fact the United States had 'won' the race to the Moon, were technical problems encountered with the N-1 launch vehicle. Other causes cited included the lack of funds due to a conflict of interests between the military and the Academy of Sciences, on one hand, and designer groups on the other hand. Also suggested was that the OKB-1 design bureau lacked the technological expertise to support the mission.

The first orbital flight of a Soyuz spacecraft, in an uncrewed configuration, occurred on November 28, 1966, as Kosmos-133. The intention was to launch and recover the spacecraft following 33 orbital flights, but the spacecraft failed to stabilize and was destroyed in orbit on November 30, 1966, to preventive craft from crashing into Chinese territory.

In spite of the problems encountered with the Kosmos-133, Soyuz-1 was launched on April 23, 1967, with the cosmonaut Komarov on board. The intention was to have Soyuz-1 joined by Soyuz-2 to be crewed by Bykovski, Khrunov and Yeliseyev and that a crew exchange would take place in orbit.



An artistic impression of what never happened.

Also suggested was that Soyuz-1 and -2 would dock, or that a formation flight would be made.

The program was designated as Eksperimentalnaya Kosmicheseskaya Stanziya (EKS) which means Experimental Space Station). However, during the flight, which lasted 26 hours, 48 minutes, the solar panels did not properly deploy and caused the thermal system and other systems, including the attitude control system, to malfunction. Nevertheless, Komarov succeeded in putting the spacecraft into a roll for a stabilized re-entry.

A re-entry during the 16th orbit failed and the cosmonaut attempted again on the 18th orbit, on April 24, 1967. During that re-entry, the main and emergency parachutes became entangled and the spacecraft smashed into the ground, killing the cosmonaut. There is, however, also evidence which suggests that the cosmonaut had died prior to, or during, re-entry. Other suggestions include that, under political pressure to achieve the crew transfer in space, the Soyuz-1 flight was made too early for it to be safe.

Following this docking, Kosmos-186/188 and Kosmos-212/213 were tested and about one-and-a-half years later, on October 25, 1968, a crewed attempt was made. Soyuz-2 was launched without a crew, followed the next day by Soyuz-3 with one crew member. The intention was for Soyuz-3 to dock with Soyuz-2—the docking did not take place.

The process of docking was eventually achieved between Soyuz-4 and -5 on January 16, 1969, and two cosmonauts performed a 37 minute tethered spacewalk, during which they transferred from Soyuz-5 to Soyuz-4. To prove that the transfer was actually made, they carried newspapers which were dated after the Soyuz-4 launch.

The docking was attempted again in October 1969 with the Soyuz-7 and -8 flights but, although the two spacecraft came within 480 meters of each other, a failure in the manual controls prevented docking and instead a formation flight was performed.

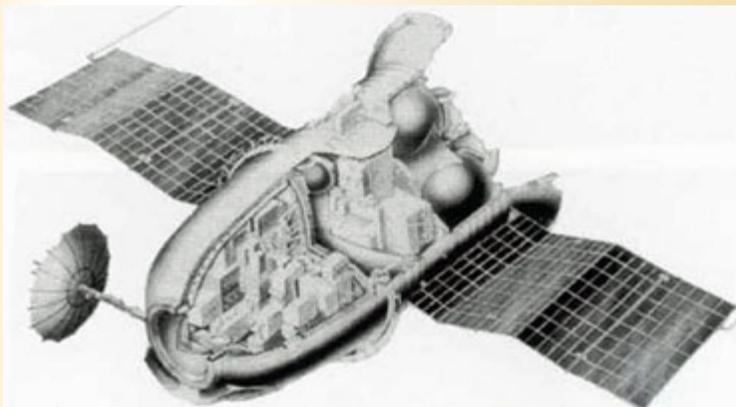
At this time, the US had achieved a crewed Moon landing and there have been suggestions that the Soyuz-8 was originally intended to dock with a test article of the Salyut space station, while likely that both Soyuz-7 and -8 were no longer connected with the lunar program. Further flights with the Soyuz spacecraft were clearly associated with space station programs.

As stated earlier, the basic Soyuz spacecraft was also used for a number of circumlunar missions in the Zond program.

### **Zond**

The configuration of the circumlunar Zond spacecraft was similar to that of the Soyuz LOK, consisting of:

1. *The Soyuz service module but with a single KTDU-53 engine*
2. *The re-entry module as for Soyuz*
3. *A docking collar*



Zond.

Zond was fitted with two solar panels. Some of the other Zond flights may have included the LK module. The program was not very successful and, out of the seven launched Zond spacecraft, only four achieved their objectives.

The first of these, Zond-5, was launched on September 15, 1968, and flew successfully around the Moon on September 18, 1968, when a minimum distance of 1950 km was achieved around the Moon. During this flight, images were also returned from the far side of the Moon.

Eventually the spacecraft re-entered Earth's atmosphere over the Indian Ocean and was recovered on September 21, 1968. This pattern was repeated with Zond-6 on November 10, 1968, with a new re-entry technique used for a USSR landing rather than in the Indian Ocean. Two more circumlunar flights were achieved by Zond-7 and -8, in 1969 and 1970. The Zond designation was also applied to a variety of spacecraft configurations, including Zond-1 to -3, which had nothing to do with the lunar program and were totally unrelated in design.

### **Space Station Transfer**

For use as a space station crew and cargo transfer vehicle, the solar panels and the toroidal fuel tanks were gradually deleted from the basic Soyuz spacecraft. The interior of the orbital module itself was also changed to reflect the nature of a mission. The initial intention was to fit three seats, as in Soyuz-10, which did not permit the cosmonauts to wear spacesuits. Soyuz-10 docked with the Salyut-1 space station on April 23, 1971.

The disaster with the next flight, Soyuz-11 on June 29, 1971, did cause a change in direction and, until the introduction of the Soyuz T version, all subsequent Soyuz flights were flown by two cosmonauts wearing space suits.

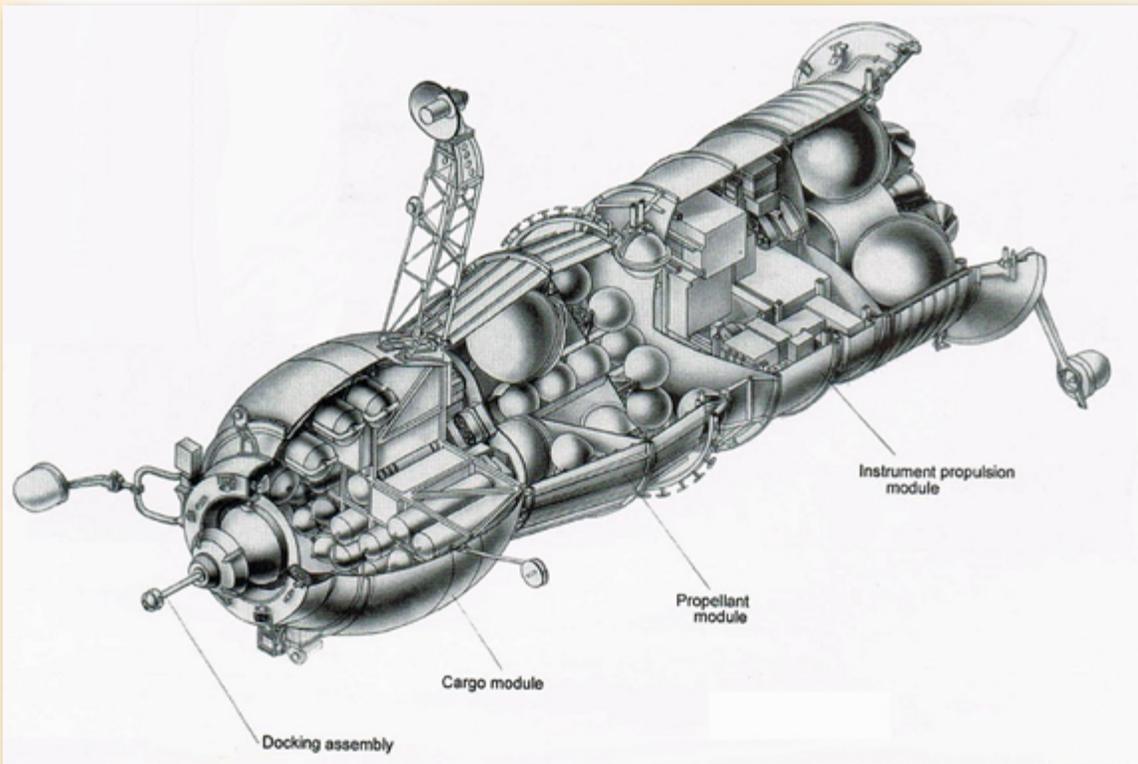
The Soyuz crew transfer spacecraft continued to serve the space station program with crew transfers to Salyut and Mir space stations before graduating to the International Space Station. Initially, the Soyuz spacecraft was not considered flight worthy after a period of 90 days in space, as propellant lines and engine valves would degrade due to exposure to the toxic propulsion chemicals. This feature dictated the comings and goings during the long duration missions which commenced with the Salyut-6 space station.

As a partner in the transfer to space stations, Energia also developed the Progress cargo transfer spacecraft, which was based on the Soyuz spacecraft, and consisted of...

1. *A cargo module which replaced the Soyuz's living compartment module and had a length of 3.15 m and diameter of 2.26 m. With a volume of 6.6 m<sup>3</sup>, it could carry up to 2480 kg of cargo*
2. *A refuelling module which replaced the Soyuz's descent module and which was 2.1 m long and had a diameter of 1.7 meters*
3. *A propellant section and an instrument module with a length of 3.1 meters and a diameter of 2.72 meters*

The entire spacecraft had a length of 7.94 meters and a diameter of 2.72 meters and had a launch mass of about 7,000 kg, but that weight varied with the amount of cargo carried by the craft.

The first Progress spacecraft was launched on January 20, 1978, and docked at the rear port of the Salyut6. Similar to the crewed Soyuz spacecraft, Progress continued to serve the Salyut-6 and -7 space stations as well as Mir and ISS, which were all equipped with facilities for fuel transfers. The propulsion module of the Progress vehicle was also used to boost the space station's orbit when required.



Progress.

**Progress**

Over time, both the Soyuz and Progress spacecraft went through a progressive modernization process, keeping the spacecraft up to date. Soyuz T was the first development and could carry a crew of three cosmonauts wearing non-EVA rated spacesuits.

In addition, two solar panels with a span of 10.60 meters were introduced. Other improvements included a redesigned fuel system and improved avionics.

**Soyuz T**

The Soyuz TM spacecraft was fitted with the new Kurs docking system. Also, through the use of new parachutes, the payload was increased and more space became available.

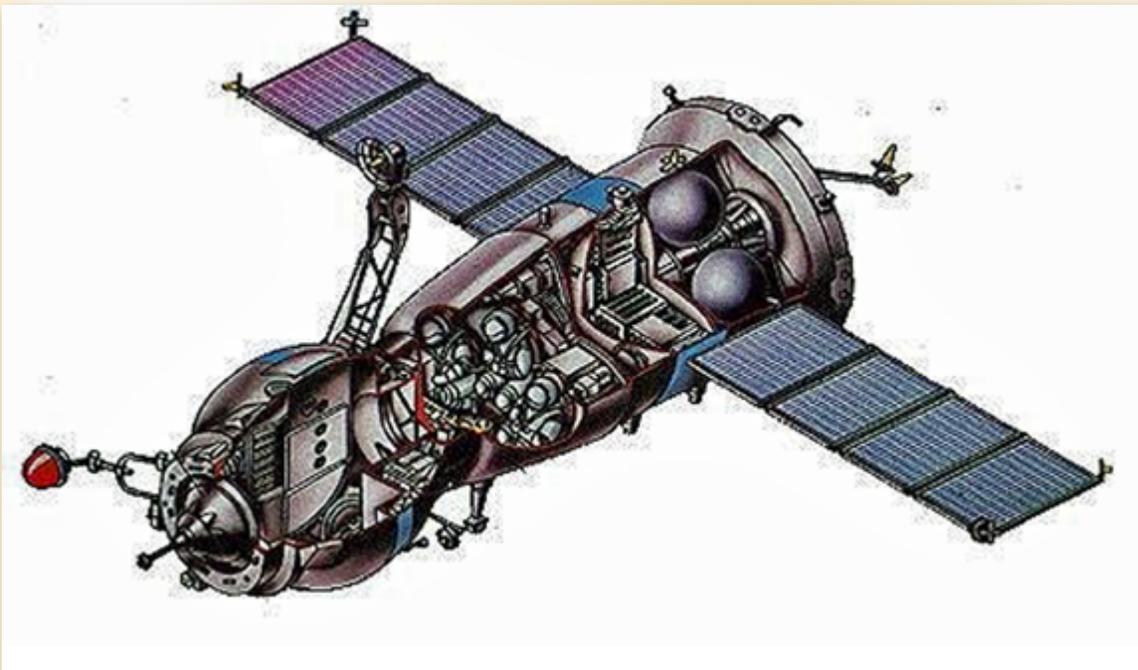
In addition, the spacecraft was fitted with the Luchs tracking system and incorporated various other improved instruments, including separate voice channels for each of the cosmonauts.

Soyuz TMA's main improvement was to accommodate seating for taller cosmonauts, hence, A = Anthropometricheski. In addition, the solar arrays were extended to a span of 10.7 meters. The subsequent Soyuz TMA-M version carried

improved avionics, data processing and cooling systems.

[tiros.zarya.info/](http://tiros.zarya.info/)

*Jos Heyman, a retired accountant, is the Managing Director of Tiros Space Information (TSI), an Australian consultancy specializing in the dissemination of information on the scientific exploration and commercial application of space for use by educational as well as commercial organizations. He has more than 40 years of experience in the historical aspects of astronautics and is the editor of the TSI News Bulletin. Jos Heyman was born in the Netherlands and has been an Australian citizen since 1969.*



Soyuz T.

# From Polar Support To A Global Ground Network A KSAT Perspective

By Stig-Are Thrana, US Sales Director, Head of the Silicon Valley Office, Kongsberg

In a little more than a decade, KSAT has moved from being a newly established station operator in Svalbard with a few antennas to support polar orbiting satellites to be one of the world's leading ground station providers.

Today, KSAT is able to provide support for any satellite and possesses an antenna network that enjoys world coverage.

## Pole-To-Pole Concept

Situated almost at the top of the world, approximately 1,300 km from the Arctic North Pole, is the commercial ground station operated by Kongsberg Satellite Services (KSAT). Even though the average citizen perhaps does not know much about KSAT, the company is well known among leading space agencies and satellite operators as the preferred ground station for all polar orbiting satellites.

The Svalbard site is uniquely positioned and is the only ground station in the world that can provide contact opportunities for satellites each time they pass over the North pole. This equates to the fact that the Svalbard site can uplink and downlink ~14 times per day, on average, or every 90 minutes or so.

The smaller and even more extremely located ground station, the Antarctic Ground Station at 72 degrees south, has similar attributes on the opposite side of the globe. Combining the two stations, Svalbard and Antarctica, is what KSAT refers to as their pole-to-pole concept.

This allows contact with a satellite nearly every 45 minutes using the two ground stations. This is a service that is only provided by KSAT and this solution has—in just over a decade—made KSAT a leader in the LEO market segment. From the position of being a company working in the extreme north and south, KSAT now operates a global ground network with 20 global ground stations, with antennas located on all of the world's continents.

## Location, People & Infrastructure

Location is one important reason why KSAT has been able to acquire a market leading position. However, as always, the people behind the company are equally as important. What started out as a close collaboration between the Norwegian and US Government originating as a temporary ground station and trailer at the Svalbard location to support NASA sounding rockets has now resulted in the largest polar ground station in the world.

In this trailer in 1996, working as the Station Manager, was Reidar Nordheim who, 20 years later, continues to work at KSAT, now as the Head of Infrastructure—he has been instrumental in building up the Svalbard and Antarctic Troll stations. Many of his original team members continue to contribute to the rapid expansion of the KSAT network.

Reidar Nordheim said, *"The knowledge and the people in Tromsø and Svalbard is really paramount for KSAT, as they offer a "can do" attitude and a highly positive approach toward our customers."*

The market leading position KSAT has acquired is the result of an intensive effort to reliably operate under adverse conditions. Nordheim explained that the company has spent a significant amount of time on the overall infrastructure design of their sites, which includes diverse fiber communication, dual sets of power generators, data halls with HVAC and more. He added that when building in the Arctic, several important considerations must be made, including how to build in permafrost terrain. Additionally, extreme weather conditions are "business as usual" in locations such as Svalbard and Antarctica.

Nordheim also highlighted the fact that KSAT's team has the proven know-how on logistics handling, as working in Antarctica places operators in a positions where they are, quite literally, on their own—the adverse conditions do not allow for the delivery of personnel and equipment as often as one might wish could be managed.



## **Technology & Solutions**

*"Implementing new technology and SW solutions has always been important for KSAT. But to combine it with the best customer-centric models, providing the customer with optimized solutions, and optimizing their success, that is when we succeed," explained KSAT COO and the Vice President of Ground Station Services, Arnulf Kjeldsen. "Rather than selling traditional services per pass or per hour of support, over the past six to seven years, we have been providing network services, that integrate global networks for our clients, similar to a one-stop-shop, to deliver world class services."*

Arne Nylund is responsible for the evolution and development of KSAT's global network as the Director of the Ground Network division. He elaborated more on KSAT's value proposition, *"Creating multi-mission solutions and offering to the customer the full value chain as a service, our bread and butter is to provide to the customer hassle free and high proficiency operation, and allowing them to focus on their core business—turning their satellite data into valuable information for their customers."*

He continued, *"We primarily buy our software and baseband equipment, but much of the brainpower in our Tromsø Network Operations Centre (TNOC), is designed in house. This includes scheduling functionality, which allows us to operate closely to 100 satellites and to provide 24,500 passes on a monthly basis. This TNOC functionality is part of our secret sauce. We have also developed a web presence that offers a human-to-machine based interface. And there is more functionality on the way, functionality which we expect will help our customers obtain easier and more rapid access to their satellites."*

## **NewSpace**

Maintaining a lead position in the market is important to KSAT and the company believes strongly in continuous innovation. KSAT built and launched a NewSpace Ground Network called KSAT lite, and is already supporting several companies with typical NewSpace needs and requirements.

In spite of many other companies having already launched satellites with lower inclinations due to their ability to then offer less expensive ride shares, the NewSpace market is heading toward more polar Sun-Synchronous Orbit (SSO). One reason for these actions is that satellite operators note the operational cost can be significantly improved for the same contact time for SSO access.

NewSpace operators have realized they need many more antennas and globally distributed locations to be able to obtain identical contact time and the same amount of data that was obtained in lower inclinations—KSAT is able to support any type of orbit.

KSAT will continue to deliver services to assure that all clients and end users obtain their required data, no matter if that is AIS, weather, navigation signals, maritime monitoring or other Earth Observation (EO) services. The KSAT network will continue to grow as satellite owners realize they can obtain access to their satellites—anywhere, and at anytime.

*Stig-Are Thrana is US Sales Director and the Head of Kongsberg Silicon Valley Office. He holds a Bachelors degree in Entrepreneurship and Innovation and has been working with professional radio and satellite communication for more than ten years. Stig has been one of the entrepreneurs and pioneers of the KSAT lite network, the world largest NewSpace network. Kongsberg Satellite Services—KSAT—is a world-leading provider of ground station services for LEO satellites, thanks to the company's uniquely positioned global ground network.*

# A New Satellite Is En Route & Preparing For Greater Growth A Spacecom Perspective

By Jacob Keret, Senior VP, Marketing and Sales, North America, Europe, Middle East

**A**s IBC2016 draws ever closer, Spacecom and the AMOS brand is generating praise in the Central and Eastern European, African, the Middle Eastern and Asian markets.

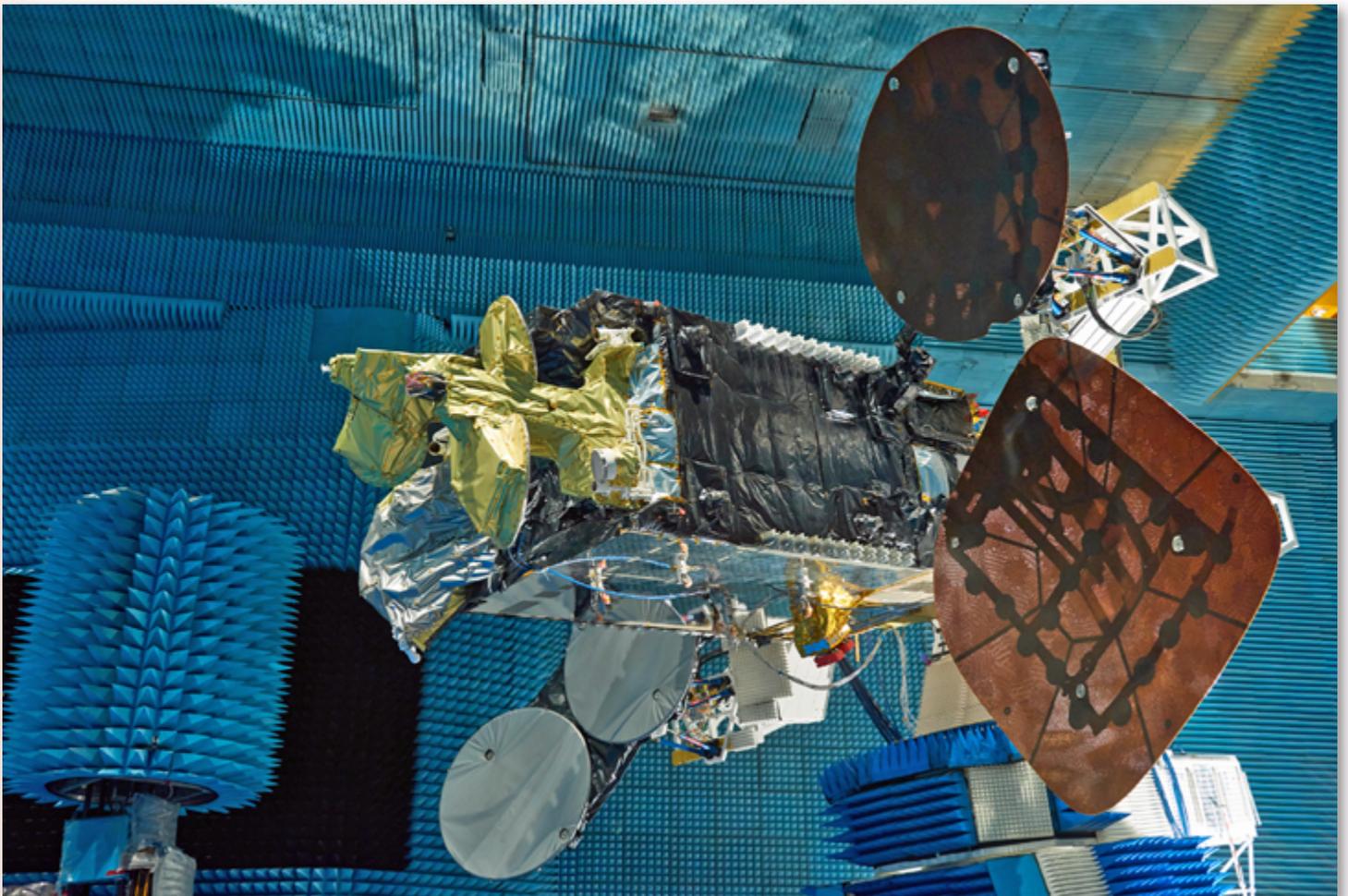
Spacecom is serving DTH providers, working with cellular companies, providing governments and their agencies with services and adding more broadband capabilities for ISPs and telecom companies. The AMOS brand is a key element in fueling growth in these markets.

Throughout these markets, the company is engaging customers with solutions that enable them to provide additional services or grow current ones to generate increased revenues and increase their client base, no matter if engaged in broadcast, broadband, data communications and telecom service provisioning by offering a wide range of communication services.

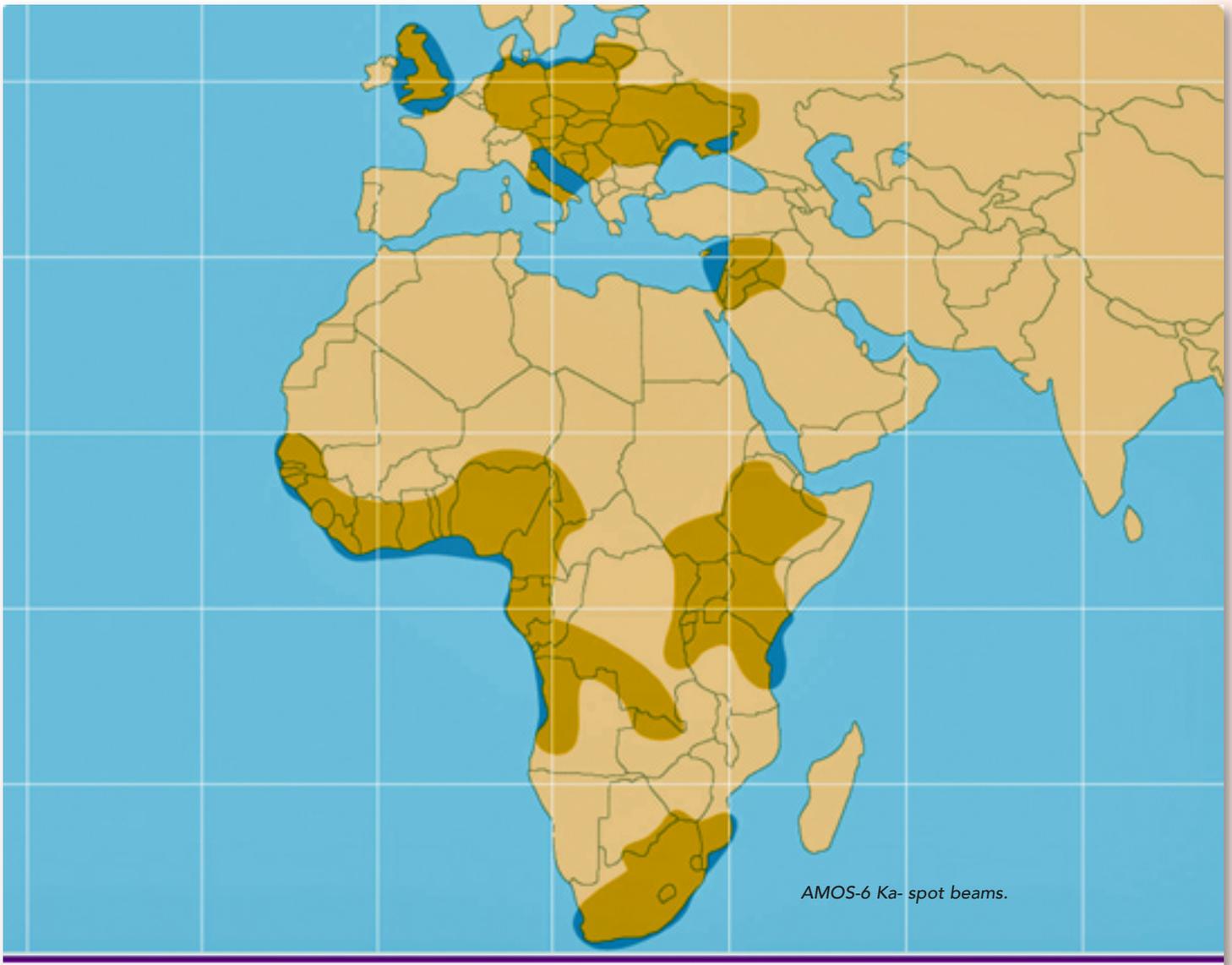
Currently, Spacecom is focused on molding the AMOS brand's future and the start of AMOS-6's commercial satellite services later in 2016 that will foster growth of new business development programs. To be co-located at the 4 degrees West orbital position with AMOS-3 (where the satellite will replace AMOS-2), AMOS-6 will be larger than both of those satellites, combined.

Incorporating advanced technologies such as High Throughput Ka-band spot beams (known as HTS), the satellite will enable operators to bring improved broadband Internet access to customers. In fact, AMOS-6's Ka-band HTS beams have been selected by Facebook and Eutelsat to anchor Facebook's African Broadband Initiative. Spacecom is at the forefront of a new communications evolution in Africa that will add to the continent's continued economic advancement—Spacecom's HTS beams will cover large swaths of Africa as well as significant areas of Europe.

AMOS-6 will also offer 39 Ku-band segments for operators throughout Europe. This Pan European beam will enable customers in the Central and Eastern Europe (CEE) markets to leverage their businesses into Western Europe, and will enable Western European operators to expand into CEE, as well. With cross-beam and cross-services capabilities, the satellite will serve an important role as a communications carrier between Europe, the Middle East and Africa (MENA).



Final testing of the AMOS-6 satellite. Photo is courtesy of Israel Aerospace Industries.



The new satellite's position, together with the onboard transmission capabilities, will meet many of the needs of the European communication markets. With novel applications such as UltraHD content or new cellular technologies continually entering the market, AMOS-6 offers the correct technologies to enable service providers to maintain or enhance their competitive advantages.

At the end of the day, Spacecom's job is to enable clients to increase their business and, by doing so, their revenue base. Superior team and management skills, as well as the flexibility of the AMOS fleet, ensure the company is always providing a welcome environment for customers and to then help them to move forward to register a positive mark in their markets.

A new 'hybrid' service will combine the best of the company's satellite services alongside fast Internet data providers to strengthen high speed Internet DSL operations. Spacecom's 'DSL Booster' service provides a satellite supported segment that will bring reliable, high quality broadband Internet to users who may suffer from slow or lower quality Internet access. Working with local providers, operators will be enabled to offer more video sharing services and to allow their customers to use more data heavy applications.

The Spacecom fleet also consists of AMOS-4 at 65 degrees East, which covers Africa, Asia and the Middle East, which make Spacecom a multi-regional satellite provider who can offer high-quality broadcast and communication services to Europe, the Middle East, Africa, and Asia via direct-to-home (DTH) and direct broadcast satellite (DBS) operators, Internet service providers (ISPs), telecom operators, network integrators and government agencies.

Looking toward the future, the company is ready for the next generation of satellites, such as AMOS-7 and AMOS-8, with a business focus on how best to realize these spatial assets. Management sees options for organic growth and growth from the outside via joint ventures, partnerships and other deals.

Spacecom will improve their position in Africa and in other, long term and high demand markets. Needed communication capabilities are being brought forward to enable clients to grow and expand their markets with advanced services that will help them maintain their competitive advantages.

[www.amos-spacecom.com](http://www.amos-spacecom.com)

# How Satellites Put A Better Wine In Your Glass

By Robert Bell, Executive Director, SSPI & WTA

**W**ine is nature's magical accident," wrote former champion jockey and mystery writer Dick Francis. We enjoy wine today because naturally occurring yeast on grapes turns the sugar within them into alcohol.

## The Correct Amount Of Vigor

Growing grapes for wine depends on a deep and intimate knowledge of what the French call the terroir (ter-WAH): how the region's soil, climate and terrain affect the taste of the grapes grown there and the quality of the wine.

Traditionally, knowledge of the terroir was gained by endless walking of the rows of vines, inspecting and pruning the plants, irrigating the dry spots and draining the wet ones. Pruning sets the stage for what they call vigor: the amount of leaf that vines grow. Vines need to be vigorous—but not too much so—to produce a good-quality grape.

Such methods work well for small, family-owned vineyards. They are an increasingly poor fit, however, for the global business that wine has become. More than one million wine producers around the world bottle and ship close to 3 billion cases per year.

The "new world" vineyards of the US, South America, South Africa and Australia are in a hurry to build understanding of their terroir—and have turned to a combination of satellite and information technology called "precision viticulture" to accomplish their goal.





### **Eyes In The Sky**

Two space-based technologies underlie precision viticulture: satellite imaging and global positioning by satellite, better known as GPS.

Winemakers take photographs captured and transmitted by satellites on orbit and enter them into geographic information system (GIS) software to generate detailed vineyard maps. The images are sharp enough to allow the entire vineyard to be divided into 2-meter square blocks and the software is capable of recording elevation, slope, soil condition and water retention ability for each block.

Walking the vineyard is still required to gather that information, but the result is a digital asset of enormous value in coaxing the most from the land. Using this information, winegrowers can determine the best grape, the spacing for plants, the arrangement of rows as well as the irrigation or drainage for each 2 meter block.

However, photographs in visible light are just the start. Infrared detection from space can reveal much more. Specialized satellites beam infrared light at the ground and receive reflections. These can be analyzed to produce something called a normalized difference vegetation index (NDVI), which accurately measures the amount of leaf area in each 2-meter block.

By taking repeated scans through the growing season, winegrowers can obtain a detailed block-by-block analysis of the all-important vigor. They can then focus their attention on blocks where there is too much or too little and apply the time-honored practices of winegrowing to reduce or increase vigor. The result is lower labor cost, higher productivity and grapes of a more consistent quality, year in and year out.

### **Pinned To The Ground**

This level of detailed understanding requires more than pictures from space—GPS is also required. The GPS coordinates pin the satellite images to specific locations on Earth, block by 2 meter block, making what would otherwise be scenic pictures into useful information. For larger vineyards, GPS and GIS systems are also used to steer mechanized pruning, watering and harvesting machines.

The world now faces a major undersupply of wine production, according to a 2013 report by Morgan Stanley. In the past ten years, satellite and information technology have allowed growers to reduce costs and make their operations more competitive. With the market turning up across much of the world, the future looks bright for those growing and making wine, as well as for those who enjoy the results of nature's magical accident.

**[www.sspi.org/cpages/how-satellites-make-a-better-world](http://www.sspi.org/cpages/how-satellites-make-a-better-world)**

*This article was produced for SatMagazine by the Society of Satellite Professionals International—[www.bettersatelliteworld.com](http://www.bettersatelliteworld.com). Additionally, there is a "Better Wine" video available for viewing at [www.sspi.org/cpages/how-satellites-put-a-better-wine-in-your-glass](http://www.sspi.org/cpages/how-satellites-put-a-better-wine-in-your-glass).*

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# Satisfying High Power Uplink Amplifier Demands A Spacepath Communications Perspective

By Terry Hall, Engineering Department Manager, Spacepath Communications Ltd.

**T**he world of satellite communications continues to evolve, demanding ever increasing diverse solutions for uplink amplifiers; new frequency bands, higher powers, smaller size, improved connectivity—providing products to satisfy this demand is the business focus of Spacepath Communications.

In April of 2014, the company was found upon the acquisition of the Stellar satellite uplink products from e2v Technologies, who had initially introduced their family of outdoor amplifier products in the mid-90s to service burgeoning demand. Spacepath has since embarked on a number of initiatives to enlarge their product range to cater to new market opportunities that include building on the proven performance of their Stellar products and strategic partnerships

One such Spacepath development is the new range of indoor, rack-mounted, uplink amplifiers. The Stellar products acquired from e2v include a range of outdoor products focused on the transportable market. The new rack mount amplifiers provide high power RF solutions for the fixed Earth Station market and cover C-, X-, Ku-Band and DBS. Power options for these offerings include 400W and 750W output power options [add image of rack mount amp].

These amplifiers use the established and reliable power supply technology of the outdoor units freshly packaged into a 19 inch rack mount format that is combined with the latest touch screen user interface. The design of the amplifier takes into account years of experience of understanding exactly what a customer needs—extreme care has been taken in the design of the layout to ensure ease of build as well as ease of maintenance, in order that key assemblies and components such as the power supply, TWT and cooling fan can all be removed and independently replaced, when required.

The front panel control is also designed to enhance the customer experience by combining a touch screen and a multi-function wheel selector with a highlight, click and confirm process. The front panel provides the user with full control of the amplifier, operational status, constant power mode and a selection of configuration settings—single thread, 1:1 and 1:2 redundancy, graphic displays of trend analysis and event logs. This functionality is extended via the Ethernet port and is available through a web browser that mimics the front panel.

Improving user friendliness is also a theme for the popular StellarCool™ 400W and 750W with the units being upgraded to incorporate front panel controls and indicators as well as an Ethernet port that offers SNMP and the web browser.

The new SAT-BUC was developed to address the increasing interest and demand from the transportable DSNG market for small, lightweight, high efficiency, high power amplifiers. The SAT-BUC operates in the Ku-band and delivers 150W rated power and more than 100W of linear power over the band 13.75 GHz to 14.5 GHz and guarantees

- Third order intermodulation products of better than -25 dBc
- Spectral Regrowth of better than -30 dBc

at 1dB back off from rated power.

The SAT-BUC is housed in a 183x348x132.5 mm package, weighs less than 9 kg and consumes less than 850VA at rated power. The SAT-BUC also offers L-band input and a 10 MHz auto-sense internal reference as standard. When compared to other leading products, the SAT-BUC is the smallest, lightest device in its class. (12.75-14.50 bands optional.)

The STA1341 series is a new generation of Ku-band 'UltraLinear' outdoor amplifiers that are capable of providing more than a 175W linear power in a package that measures 217x220x400 mm and weighs less than 13.6 kg The amplifiers offer Ethernet connectivity as standard and options include L-band BUC.

There is also a range of new Ka-band amplifiers that include the smallest 500W TWTA currently available on the market, measuring 457x216x229 mm and weighing around 14.5 kg.

The STA3252 can operate over the frequency range 27.5 GHz to 31 GHz or selected sub-bands and deliver more than 240W of linear power. Again, Ethernet connectivity is standard and a range of L-band BUCs are available that offer 1 GHz instantaneous bandwidth. The 500W Ka- is also available in a water cooled version (STA3253) for hub mount installations.

The 'traditional' Stellar TWTA amplifier product base has been complimented by an extensive range of solid state amplifiers and BUCs. The solid state offering covers C-, X-, Ku-, Ka-band and DBS with output power ranging from 10W to more than 600W. The SSPA range underpins Spacepath's objective to be able to offer the best high power amplifier solution for the required application, regardless of the technology base.

Earlier this year, Spacepath announced the opening of their US entity, Stellar Satcom. With the acquisition of the Stellar business from e2v, a large established customer base in the US was also realized, primarily within the mobile DSNG markets. Since launching the new company, existing customers are now able to access local support and new customers have direct access to the comprehensive range of new products. However, the company's efforts certainly don't stop there... Spacepath is continually tracking market trends and opportunities, such as HTS and competing technologies, 4G bonding and fiber infrastructure, to name but a few. On the horizon, the plans include:

- 100W DBS amplifier based on the successful StellarMini™.
- Higher power C, Ku & DBS 1250W Peak, UltraLinear amplifiers in both outdoor and rack mount formats

[www.space-path.com](http://www.space-path.com)

Terry Hall is the Engineering Development Manager for Spacepath Communications Ltd. Terry has more than 35 years of experience in the design and development of high power amplifiers for SATCOM, ECM and radar applications. Terry joined Spacepath in November of 2015, having previously been with e2v technologies Ltd.



Top left, 500W Ka- Liquid Cooled amplifier  
Top right, STA 3318 BUC  
Bottom: Rack amplifier



