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LET THE COUNTDOWN COMMENCE

Telenor Satellite Broadcasting looks forward to launching, THOR 7, its first high performance satellite, delivering seamless coverage throughout Europe.

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Commencing countdown

THOR 7 to be ready for commercial service in 2015.
Follow our progress at **www.telenorsat.com/thor7**

telenor satellite broadcasting

SatMagazine

March 2015

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Telenor's Thor 7 On Its Way For A Spatial Sending

Space Systems/Loral (SSL) has announced that the THOR 7 satellite, designed and built for Telenor Satellite Broadcasting (TSBc), is heading for the European Spaceport in Kourou, French Guiana for launch aboard an Arianespace Ariane 5 launch vehicle.

THOR 7 is a multi-mission satellite equipped with Telenor's first high performance Ka-band payload, designed to serve the maritime market.

The HTS Ka-band payload on THOR 7, designed specifically for the mobility VSAT market, will provide cost-effective solutions and offer high powered coverage over the North Sea, the Norwegian Sea, the Red Sea, the Baltic Sea and the Mediterranean.

The satellite also has a Ku-band payload for broadcast and television services in Central and Eastern Europe. THOR 7 was designed with up to 25 simultaneously active Ka-band spot beams and a steerable beam for flexibility in meeting changing market requirements. The satellite's Ku-band payload includes 11 transponders, which will enable expanded services in the region as well as back-up to ensure uninterrupted service.

"The satellite built by SSL will deliver a very bandwidth efficient and flexible service for major shipping routes and recreational vessels," said Morten Tengs, Vice President and CEO of Telenor Satellite Broadcasting. "With the launch of THOR 7, our growth satellite, we look forward to further extending our position in the market and expanding our European coverage."

THOR 7 is based on the highly reliable SSL 1300 platform, which provides high-power and the flexibility to support a broad range of applications and technology advances. When launched, THOR 7 will be positioned at 1 degree West longitude and is designed to provide service for 15 years or more.

"SSL and Telenor Satellite Broadcasting share a commitment to providing satellites and services that improve the human experience," said John Celli, President of SSL.

Space Systems/Loral: **www.sslmda.com/**
Telenor: **www.telenorsat.com/**

SSL's built Thor 7 satellite with (l) Oddveig Tretturud, Thor 7 program director, and (r) Morten Tengs, Telenor CEO. Photo is courtesy of SSL.

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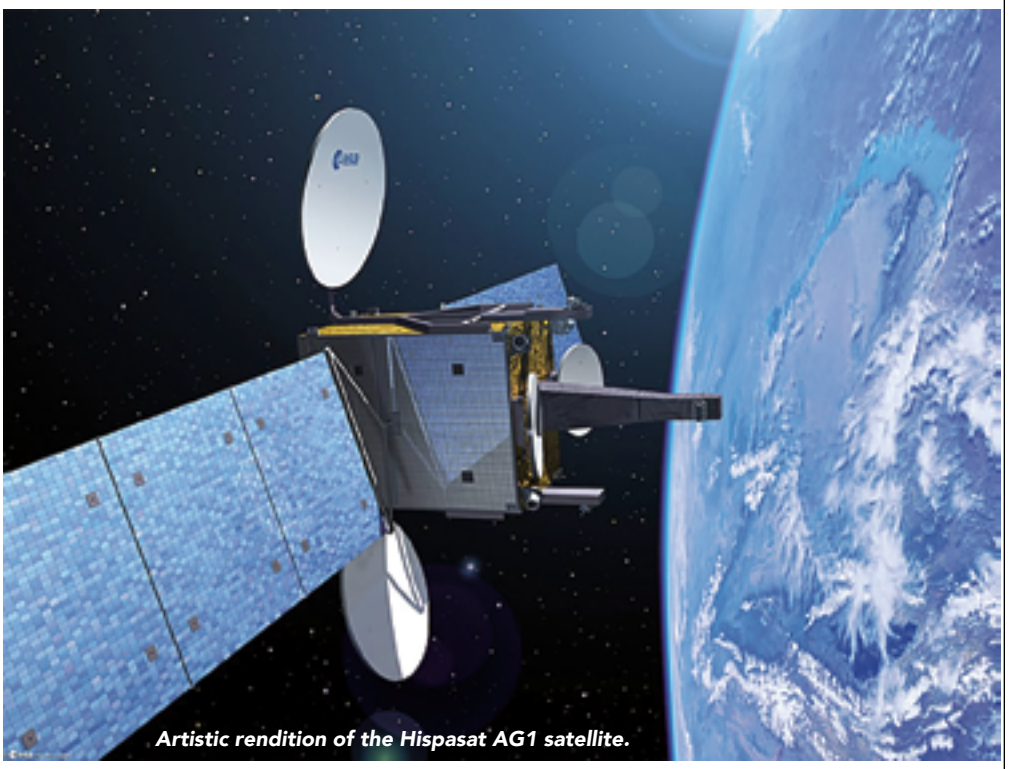
OHB System Sends HISPASAT AG1 On Its Way To Ottobrunn + OHB Sweden To Develop MATS Sat

Developed and built by OHB System, the "Hispasat Advanced Generation 1" ("Hispasat AG1") geostationary communications satellite has departed from the satellite's integration hall in Bremen, Germany.



Artistic rendition of the Hispasat AG1 satellite.

After successful system testing at the end of the integration phase in Bremen, the environmental impact testing campaign is now underway. Hispasat AG1 will undergo this testing over the next few weeks at the space center operated by IABG in Ottobrunn near Munich. During environmental impact testing, the satellite is placed in a thermal vacuum chamber, where its functions are tested under space conditions in both heat and cold and in vacuums. Further functional testing entails the simulation of mechanical and also electro-magnetic strain on the satellite.

As the principal contractor, OHB is responsible for the overall satellite system, integration of the satellite, in-orbit testing and start-up. In addition, it will provide real-time support during the satellite's entire 15-year service life. Spanish communications service provider and satellite operator Hispasat will be using HAG1 to supply Spain and Portugal, the Canary Islands and America with multimedia services. This is the first satellite to use Europe's new SmallGEO platform, developed through a public–private partnership between the European Space Agency (ESA) and OHB.

Additionally, OHB Sweden, Stockholm, and ÅAC Microtec, Uppsala, have been appointed by the Swedish National Space Board (SNSB) to deliver a highly capable small satellite platform, named InnoSat, and to accomplish the advanced scientific mission named MATS (Mesospheric Airglow/Aerosol Tomography and Spectroscopy).

OHB Sweden and ÅAC Microtec have been contracted by SNSB to develop, integrate and operate MATS, the first scientific mission based on the new innovative state-of-the-art small satellite platform. The launch of the satellite is currently planned for spring 2018. The total contract value, including launch and operations, is about 9 million euros.

Gierth Olsson, CEO of OHB Sweden, said, "As the next innovation step after satellites like Odin, SMART-1 and PRISMA, we are together with ÅAC Microtec developing a highly competitive product for the international market," said

Mikael Andersson, CEO of ÅAC Microtec, said, "There is a clear trend for smaller and more affordable satellites meeting higher performance requirements than was previously possible. The development of the small satellite market has really exploded in recent years. Driving factors are among other technological progress and budget constraints forcing a paradigm shift."

OHB Systems: ***www.ohb-system.de/***

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Better Geospatial Viewing For Windows

LizardTech®, a provider of software solutions for managing and distributing geospatial content, has released an updated GeoViewer for Windows, which is the fastest way to view MrSID and JPEG 2000 imagery and includes broad file format support.

Two options are available, GeoViewer and GeoViewer Pro. GeoViewer is available as a free application for raster imagery display, LiDAR point clouds, and vector overlays.

The ability to connect to online base maps, combine local data with web map service (WMS) and JPIP sources, export imagery, save projects, and other advanced display options are offered.

GeoViewer Pro allows access to additional functionality, including support for printing, additional projection systems and advanced area measurement tools.

The LizardTech infosite:
www.lizardtech.com/

Intelsat + Azercosmos' Strategic Agreement

Intelsat S.A. and Azercosmos OJSCo., the national satellite operator of Azerbaijan, have announced that the two companies have signed a strategic agreement at the 45 degrees East orbital position.

The two companies will closely collaborate on the design of the Azerspace-2/Intelsat 38 satellite and leverage their respective strengths and capabilities during the manufacturing and operational phases of development.

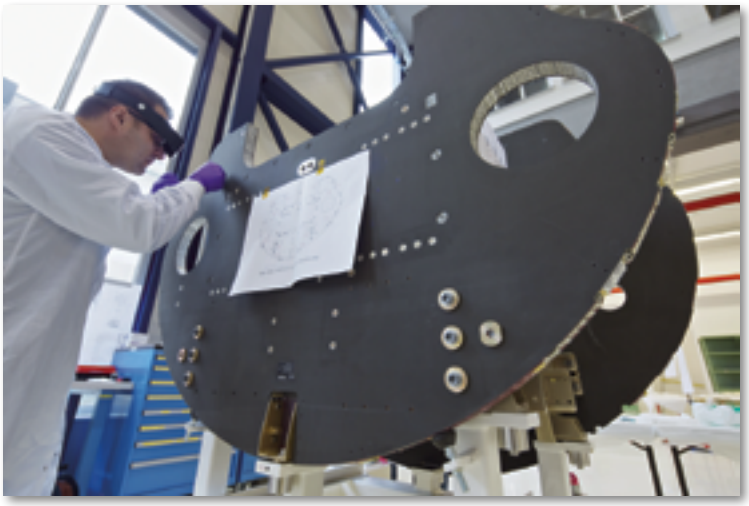
Azerspace-2/Intelsat 38 is scheduled to be launched in 2017. The new satellite will provide continuity of service for the Intelsat 12 satellite currently stationed at 45 degrees East, an orbital location which hosts Direct-to-Home (DTH) platforms and provides connectivity for corporate network services in Africa. The new Intelsat 38 satellite will also provide services across Central and Eastern Europe, Asia and Africa. For Azercosmos, the new satellite offers enhanced capacity, coverage and service offerings to support the growing demands in the region for DTH, government and network services currently supported by Azerspace-1.

Stephen Spengler, Deputy Chief Executive Officer, Intelsat, said, "Intelsat 38 will be strongly positioned to support the growth objectives of our customers at this orbital location."

Intelsat: ***www.intelsat.com/***

InfoBeam

RUAG's Automated Satellite Panel Manufacturing



At the Automated Satellite Panel Manufacturing and Insert Technology, during the JEC-Europe in Paris, RUAG Space GmbH presented to those in attendance information regarding the company's Automated Satellite Panel Manufacturing and Insert Technology.

This technology will change the way satellite panels are manufactured in the future and has the following benefits:

- ***Reduction of lead time***
- ***Reduction of manufacturing costs (all manufacturing steps are performed on one machine, trimming, cut-outs, insert hole drilling, insert placement and the measurement of the final insert location)***
- ***Increased flexibility (late freeze of insert pattern)***
- ***Increased accuracy***
- ***Reduced insert mass***

Additionally, RUAG Space has signed its first contract to supply satellite electronics to South Korea.

By the end of 2016, the company will build two electronic motor control units for satellite solar-panel positioning mechanisms and deliver these to KARI (Korea Aerospace Research Institute).

RUAG Space: ***www.ruag.com/space/***

KenCast's Fazzt® Way To Deliver Weather Datacasting For JMA's HimawariCast

Artistic rendition of the Himawari-8 + -9 satellites.

The Japan Meteorological Agency (JMA) is preparing to go live with a newer and better meteorological satellite service this year.

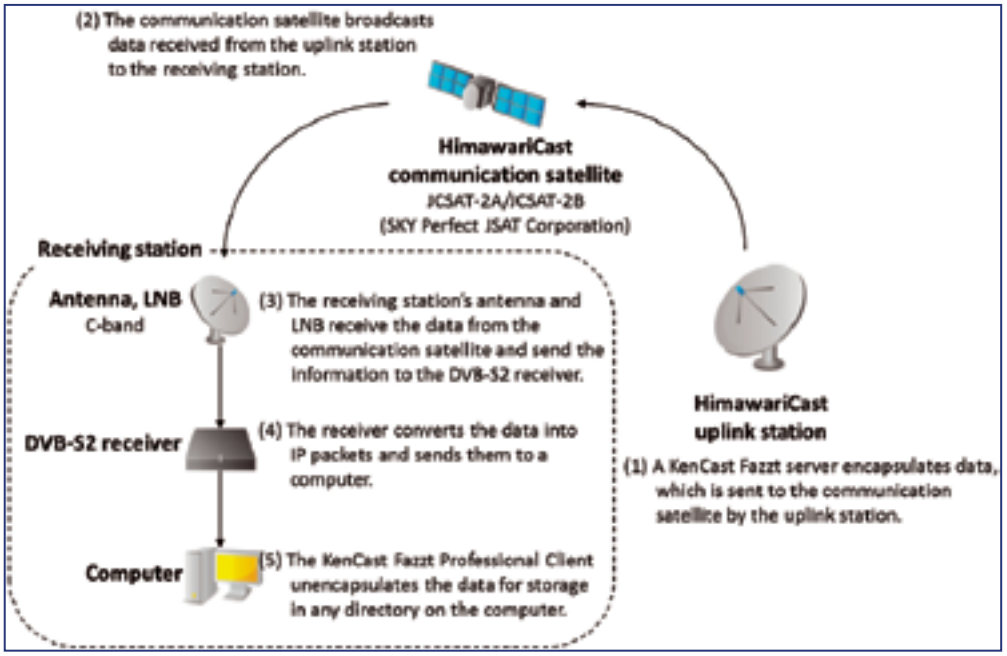
Adding management, optimization and automation is KenCast's Fazzt Enterprise Content Delivery solution, which offers the flexibility to support a transition that considers old and new data and sources as well as a proven track record in weather systems. Similar to other satellite datacasting services, such as the National Oceanic and Atmospheric Administration (NOAA) GEONETCast Americas service, Fazzt is a key component.

Since 2014, the JMA and partner Rikei Corporation have been collaborating with KenCast® on this new data delivery service, which will go live early this year.

The JMA's HimawariCast service is a transition away from existing MTSAT LRIT and HRIT services. The new service will provide more frequent and better imagery, and will do so every 10 minutes, to improve accuracy and usefulness of data.

One use of this system, among others, will be the datacasting of JMA's meteorological satellite imagery and related products. This will be a free service to users within the multicast footprint.

The JMA has produced data manipulation software, including KenCast Fazzt scripts, which will be provided through their website—once again, at no charge.



For additional details, please refer to the JMA. The Japan Meteorological Agency (JMA) is preparing to go live with a newer and better meteorological satellite service this year.

KenCast's Fazzt Dual Node Enterprise Server will provide resilience and easy maintenance through redundant design.

The Fazzt Enterprise Server™ software with Fazzt FEC® (Forward Error Correction) drives satellite multicasting and also leverages server-side Fazzt scripting to manage and automate data delivery of HimawariCast data.

Interested recipients with the correct gear and a personal computer with the Fazzt Professional Client™ can receive the data. Fazzt client-side scripts have also been created to work in concert with JMA programs to optimally manage and display the data.

"The investment in, and cooperation on, weather data satellite systems by the USA, Japan and other countries, has been impressive and improves the world's emergency preparedness, among other benefits," said KenCast CEO Bill Steele.

"The U.S.'s GEONETCast Americas and Japan's HimawariCast projects bring the global community closer together, all the while increasing safety, weather accuracy and more," he added.

GEONETCast Americas, a service managed by NOAA, is the agency's broadcast stream that covers the Americas. NOAA is the satellite data provider for GOES, POES and NOAA-NESDIS (National Environmental Satellite, Data and Information Service) atmospheric and marine data products.

The JMA's HimawariCast service will disseminate environmental data in a large footprint for the Asia Pacific (APAC) region. As with GEONETCast Americas, no registration is required and users may simply tune in to the datacast, although registration at the website is possible in order to receive updates by email.

"The JMA hopes the HimawariCast service will be widely used and contribute to disaster risk reduction in the Asia Pacific region," said KUMAGAI Yukihiro, Satellite Program Division, JMA.

Links to additional information HimawariCast, KenCast, GEONETCast Americas, and GEONETCast, are available at:

http://www.data.jma.go.jp/mscweb/en/himawari89/himawari_cast/himawari_cast.html

http://www.kencast.com/solutions/geonetcast

http://www.geonetcastamericas.noaa.gov/

Six African Flight Regions To Receive Aireon Space-Based ADS-B Support

Aireon LLC, developer and operator of the world's first space-based global air traffic surveillance system, has signed a memorandum of agreement (MOA) with the Agency for the Security of Aviation Navigation in Africa and Madagascar (ASECNA), which provides Air Traffic Control in 17 African States.

ASECNA has become the latest member of a leading group of global Air Navigation Service Providers (ANSPs) that are planning to use Aireon(SM) to improve air traffic management across the airspace under their control.

Under the MOA, ASECNA will collaborate with Aireon to assess the requirements and benefits of space-based Automatic Dependent Surveillance-Broadcast (ADS-B) services in their airspace, which covers six flight information regions (FIR) including the Dakar oceanic FIR that connects Western Africa and Europe to South America and the Caribbean.

This agreement includes evaluating the coordinated use of the service in neighboring regional airspace and demonstrating how those capabilities could help to improve aviation operations in ASECNA-managed airspace.

"Our agreement with ASECNA is yet another sign of progress in our vision to serve as a global platform for aviation surveillance and demonstrates the growing momentum of Aireon's space-based ADS-B solution," said Don Thoma, President and CEO, Aireon.

"Aireon's satellite-based surveillance will significantly improve our surveillance capabilities, while driving internal cooperation in ADS-B standards with neighboring ANSPs in the region," said Amadou Ousmane Guitteye, Director General of ASECNA.

"We're particularly interested in surveillance coverage over remote terrestrial routes within Niamey, Ndjamena and Brazzaville, as well as the oceanic routes in Dakar and Madagascar and expect that enhanced surveillance in the ASECNA FIR will not only generate efficiencies for the airlines but will also generate significant safety improvements for Africa while reducing the costs of infrastructure for ASECNA."

In partnership with leading ANSPs and investors from around the world, NAV CANADA, ENAV, IAA, and Naviair, as well as Iridium Communications Inc., Aireon plans to provide the first opportunity for global air traffic surveillance as early as 2017.

The Aireon space-based ADS-B service will complement ground-based air traffic surveillance systems currently in use, by seamlessly relaying position and status information of aircraft flying over oceans, poles and remote regions to air traffic controllers on the ground.

This new capability is a quantum leap for remote surveillance, extending air traffic surveillance to the entire planet and unlocking operational efficiencies, reducing fuel costs and enhancing safety in remote and oceanic airspace.

Additional information is available at:
aireon.com/Home

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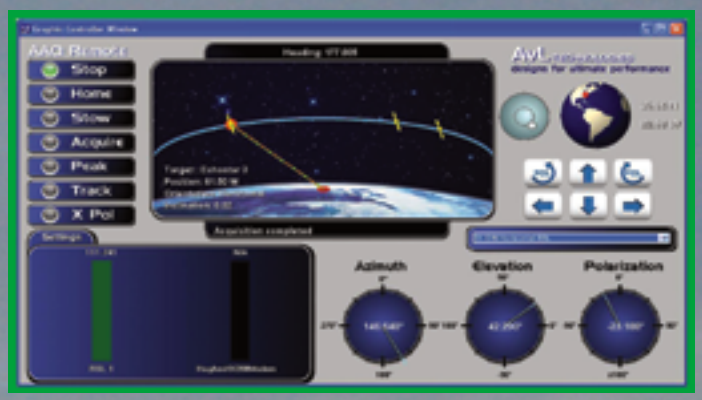

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GeoSync Microwave Is Definitely Up For Downconverters

GeoSync Microwave has introduced two new models in the company's series of Dual Conversion, Synthesized Frequency Downconverters. They are...

The DTE-800850, an outdoor, antenna mount unit covering 8.0 to 8.5 GHz in 1 kHz tunable steps. The IF is 70 MHz or an optional 140 MHz. The small, weatherproof package is only 3" high x 10.6" x 12.8" mounting area.

The DTR-800850 is a 1RU rack-mount downconverter version of the DTE-800850.

Both models are part of a series of Up and Downconverters covering L-, C-, X-, Ku- and DBS SATCOM bands using precision, low phase noise synthesizers for optimal performance. Both models come with 10/100BASE-T Ethernet interface along with RS485/RS422 serial interface.

Data Sheets GS1-SPC and GS28-SPC are available for download at the GeoSync Microwave infosite: **www.geosyncmicrowave.com**

Also, visit GeoSync at Satellite 2015, at Booth 3095 in Washington DC, from March 16th to the 19th, 2015.

The company's technical professionals will be on hand to discuss these products and project requirements.

SatLink Seas With NovelSat

NovelSat has announced that satellite services provider SatLink Communications has acquired a sizable quantity of NovelSat NS300 satellite modems to enhance the satellite communications solution offering for their maritime customers.

SatLink Communications, a global teleport, content management and HD Playout services provider, offers their maritime customers triple play solutions, broadcast and VNO services. NovelSat, a long-time SatLink partner, has delivered their NovelSat NS300 Professional Satellite Modems to replace existing KU band-based systems and for implementations with new customers.

The SatLink solution takes advantage of NovelSat DUET CeC (Channel Echo Cancellation). This technology effectively doubles channel capacity in bi-directional satellite links with no need for additional hardware. NovelSat NS300 Professional Satellite Modems are compatible with all satellite industry standards including DVB-S and DVB-S2 and offer NovelSat NS3. NovelSat NS3 is an optional software package that typically delivers more than 30 percent improvement in spectral efficiency compared with DVB-S2.

SatLink: ***www.satlink.tv/***

NovelSat: ***novelsat.com/***

Geospatial Sharing For The NGA, Thanks To Lockheed Martin + Esri

Lockheed Martin and Esri have deployed commercial software to the Amazon Web Services Commercial Cloud Services (C2S) environment for the first time with an intelligence community customer, the National Geospatial-Intelligence Agency (NGA)—the move enables government agencies to better share geospatial intelligence.

The deployment of the portal for Esri's ArcGIS geographic information system (GIS) provides a single environment for analysts to securely organize and share data throughout the intelligence community and Department of Defense. It's also the foundational step in consolidating multiple geospatial intelligence portals into the single NGA-provided portal, resulting in technology and license cost savings. This is NGA's second pioneering step in the cloud, after the agency moved its Map of the World application to the C2S environment late last year.

"Deploying Esri's Portal for ArcGIS to a commercial cloud environment securely organizes existing data and facilitates collaboration across intelligence agencies," said Jason O'Connor, vice president of Analysis and Mission Solutions for Lockheed Martin. "This cloud implementation also further shapes the government's processes for architecting and implementing enterprise class services within a cloud environment."

ArcGIS connects users to maps and geographic information. Users can create and view maps, compile geographic data, analyze mapped information and share geographic information in a range of applications.

"Working with Lockheed Martin and the NGA on this strategic implementation for national security is particularly meaningful," said Jack Dangermond, Esri president. "It recognizes the importance of consolidating geospatial intelligence information into a single portal to facilitate rapid situational awareness and response by our intelligence community."

Lockheed Martin and Esri have partnered for eight years on the Geospatial-Intelligence Visualization Services (GVS) program, which helped NGA and the Intelligence Community achieve this cloud migration milestone.

The Total Application Services for Enterprise Requirements (TASER) GVS contract vehicle, which was originally awarded in 2012, conveys geospatial visualization context and analytic capabilities to warfighters, intelligence officers and policy-makers through classified and unclassified computer networks.

Lockheed Martin: ***www.lockheedmartin.com/***

Esri: ***www.esri.com/***

Norsat International Is Pumping Up The Portables... Terminals, That Is...

Norsat International Inc. has announced that a Tier 1 Eurasian defense contractor has signed a $3.5 million agreement to purchase a range of Norsat's portable satellite terminals to provide high performance military communications for an Eurasian Ministry of Defense ("MOD").

This order highlights the broad capabilities of the company's product offerings, including the adoption of one of the company's newest innovations, the 0.9m Journey Manpack terminal. As part of this agreement, the customer will purchase multiple products from Norsat including the recently announced 0.9m Journey Manpack, the 1.2m Rover™, the 1.8m SigmaLink™ terminal, the 1.2m VSAT antenna bundle, as well as the 0.75m and 1m shipboard terminals for the Army and Navy.

This broad portfolio of satellite technology showcases Norsat's ability to deliver a full solution to its military customers. Norsat expects to ship the majority of the terminals in late 2015 with follow on deliveries throughout 2016.

The 0.9m Journey Manpack consists of an easily portable, rapidly deployable, satellite terminal that weighs less than 25 kilograms. The Rover is an ultra-lightweight fly-away satellite terminal with unsurpassed reliability, advanced assisted-acquire technology, and a flexible deployment platform. The SigmaLink is a transportable satellite terminal ideally suited to provide broadband connectivity for base camps or other prolonged missions where assignments are temporary, but deployment is protracted. Norsat's VSAT bundle is an easy to use fixed satellite terminal that provides data connectivity to remote areas for Internet connectivity.

Norsat's MarineLink shipboard terminals offer a 3-axis operating platform and a 360 degree high-speed tracking antenna that ensures a reliable link in even the most difficult sea conditions.

Dr. Amiee Chan, chief executive officer of Norsat, said, "Over the last number of years, we have made concerted efforts to invest and develop technology to further diversify our product offerings to meet the expanding needs of customers around the globe. This order is the culmination of more than two years of work and reinforces the expanding strength that we believe is capable from our military business moving forward."

The Norsat infosite: ***www.norsat.com/***

Globalstar Europe Satellite Services + FindMyAnimal Have Wandering Cow Solution

Globalstar Europe Satellite Services Ltd., a wholly owned subsidiary of Globalstar Inc., are supporting their Value Added Re-seller, FindMyAnimal.

At the Global Forum for Innovations in Agriculture (GFIA), Abu Dhabi, held from March 9-10, the company demo'd their innovative animal tracking devices. These solutions are enabled via Globalstar's low-powered STX-3 Chipset and LEO Simplex network.

Globalstar and FindMyAnimal will exhibit a variety of solutions for the farming community as they explore new ways of using satellite technology to promote sustainability and business efficiencies.

One of the highlights at the show will be FindMyAnimal's satellite tracking animal collar, which are already being used to track more than 12,000 valuable sheep and cattle in Norway, monitor cattle in Brazil and endangered species in North Africa.

FindMyAnimal's collar uses Globalstar's satellite network to geo-fence livestock, helping farmers find animals that are close to the edge of a designated area or have escaped. It also gives farmers the opportunity to take a more informed and proactive approach to herding so that they lose fewer animals to predators.
When it is apparent that a sheep has not moved in some time, the farmer is now able to send herders to the exact location of the animal, saving valuable time and resources.

Farmers deploying the collars have already experienced a significant reduction in the number of animals lost to illness or predators, which has a direct impact on their income.

Over time, the FindMyAnimal system provides a data trail based on tracking and analysis of patterns of where the animals that produced the best quality meat were grazing. The result is invaluable information and insight which can be used to determine the best grazing areas for future seasons.

Globalstar has recently partnered with Broadband Botswana Internet on the launch of a gateway in Gaborone, Botswana, which dramatically increases Globalstar's coverage across sub-Saharan Africa. With the opening up of this new market, Globalstar and its reseller partners are eager to highlight their range of business-enhancing solutions for farming and the agriculture industry in the region.

Solutions well suited for this market also include Globalstar's simplex M2M technology which can, for instance, notify farmers about levels of water and feed supply, potentially saving long journeys to remote locations, and helping livestock stay healthy, however far they roam.

At GFIA, Globalstar will be on hand at the FindMyAnimal stand to demonstrate how their portfolio of products can help keep remote farming employees and assets in contact even when they are beyond reach of the mobile phone network.

The Globalstar infosite:
www.globalstar.com/

Out & About With 5,000 Shipped By KVH For Their Mini-VSAT Broadband Offering

KVH Industries, Inc. recently shipped its 5,000th TracPhone satellite communications antenna system for the mini-VSAT Broadband network, adding more than 1,000 units in the past year and extending the company's market share lead in maritime VSAT service.

Together, the advanced TracPhone antenna systems and global mini-VSAT Broadband network constitute an end-to-end solution for maritime satellite communications, providing essential connectivity to tankers, containerships, fishing fleets, offshore supply vessels, government patrol cutters, and luxury yachts around the world. In 2012, just five years after being introduced, the mini-VSAT Broadband service became the maritime VSAT market share leader according to leading market research reports, a position that has been repeatedly re-confirmed in report updates.

KVH's advanced TracPhone antenna systems include the TracPhone V11-IP, a 1.1 meter diameter, dual-mode C/Ku-band antenna for global VSAT connectivity; the TracPhone V7-IP, a 60 cm diameter enterprise-grade antenna for Ku-band service worldwide; and the TracPhone V3-IP, a 37 cm diameter Ku-band antenna that is the world's most compact maritime VSAT antenna. All three TracPhone V-IP systems feature the Integrated CommBox Modem (ICM), a streamlined belowdecks unit that replaces the need for a rack full of components and integrates all antenna control, onboard network management, and modem functions in one small box. The compact antenna hardware makes installation faster and less expensive, and gives worldwide fleets the ability to efficiently install the KVH system with minimal idle time for their vessels.

Prior to launching the IP-MobileCast content delivery service last year, KVH developed not only the multicasting technology to make it feasible, but also acquired a company to produce, procure, and license content for the maritime market. KVH Media Group produces daily digital newspapers under the NEWSlink brand; licenses award-winning new-release Hollywood movies and TV programs under the MOVIElink and TVlink brands; provides sports highlights and video clips from around the world under the SPORTSlink brand; and develops digital music channels under the MUSIClink brand. This content is available via IP-MobileCast subscription packages.

To help fleets operate more efficiently, KVH has collaborated with leading maritime navigation and weather content providers such as Jeppesen, Transas, and AWT to deliver electronic charts and high-resolution weather data via the IP-MobileCast content delivery service.

KVH: ***http://www.kvh.com/***

SWOT's This All About? That's For Thales Alenia Space To Answer With New Satellite Build Contract

Artistic rendition of SWOT, courtesy of Thales Alenia Space.

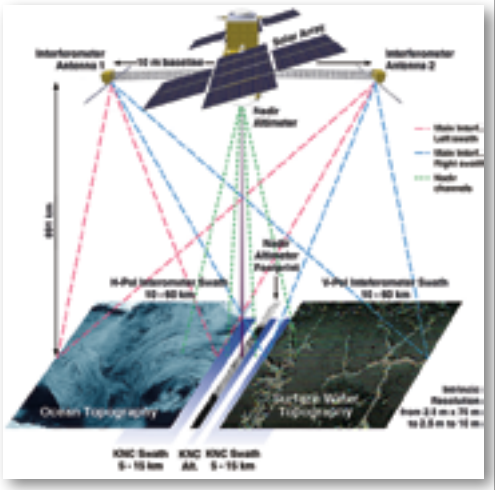

Illustration of SWOT functioning, courtesy of CNES.

Thales Alenia Space has been selected by French space agency CNES (Centre National d'Etudes Spatiales) to build the oceanography satellite SWOT (Surface Water and Ocean Topography).

Produced in collaboration with U.S. space agency NASA's Jet Propulsion Laboratory (JPL) on behalf of the French and American space agencies, SWOT is an oceanography program that will demonstrate new applications, and is a follow-on to the Jason-1, 2 and 3 operational missions. It will incorporate unprecedented technological innovations in altimetry.

As the name indicates, the satellite is designed to study ocean topography and surface water on the continents. SWOT comprises both an oceanography and a hydrology mission.

For oceanography, the satellite will provide measurements of ocean surface and wave height with higher resolution than its predecessor Jason satellites. This data will be used to analyze and understand the effects of coastal circulation on marine life, ecosystems, water quality and energy transfers, resulting in more accurate models of the interactions between oceans and the atmosphere.

The hydrology mission will evaluate continental surface water, to study changes in water storage in humid zones, lakes and reservoirs, as well as flow rates in rivers.

Thales Alenia Space will develop a new-generation platform for the SWOT satellite, offering, for the first time, a controlled atmospheric reentry of the satellite at end-of-life, in line with the French Space Operations Act.

The company will also handle satellite assembly, integration and testing (AIT), delivery to the launch center, and operations for the launch campaign.

The SWOT payload comprises two subassemblies, KaRIn and NADIR. Built by JPL, KaRIn (Ka-band Radar INterferometer) comprises two Ka-band antennas, located 10 meters apart but precisely positioned in relation to each other.

SWOT offers two-dimensional observation capability over a 120-kilometer swath, with horizontal resolution of 50-100 meters, programmable on either side.

The interferometry type altimeter will provide coverage of lakes, rivers, reservoirs and oceans, at a repeat rate of twice every 21 days. Thales Alenia Space is also offering to supply the RFU (Radio Frequency Unit), which is at the heart of this instrument.

The NADIR module comprises the same instruments as on the Jason satellites, including the Poseidon dual-frequency altimeter made by Thales Alenia Space. It also includes the Thales-built Doris system for precision orbital determination, an AMR (Advanced Microwave Radiometer), the GPSP (GPS Payload) and the LRA (Laser Retro-reflector Array) built by JPL.

Weighing about 2 metric tons at launch, SWOT will be placed into orbit at an altitude of 890 km, with an inclination of 77.6 degrees. Compatible with the Antares, Falcon 9 and Atlas V launchers, it is expected to be launched in 2020 for a demonstration mission lasting about three years.

Hervé Hamy, Vice President for Observation and Sciences at Thales Alenia Space France, said, "SWOT will be the very first satellite to offer controlled reentry, and will also incorporate new-generation avionics that perfectly match CNES's new ISIS standard. Winning this new contract paves the way for our product policy to include swath altimetry, and bolsters Thales Alenia Space's world leadership in space altimetry."

Thales Alenia Space:
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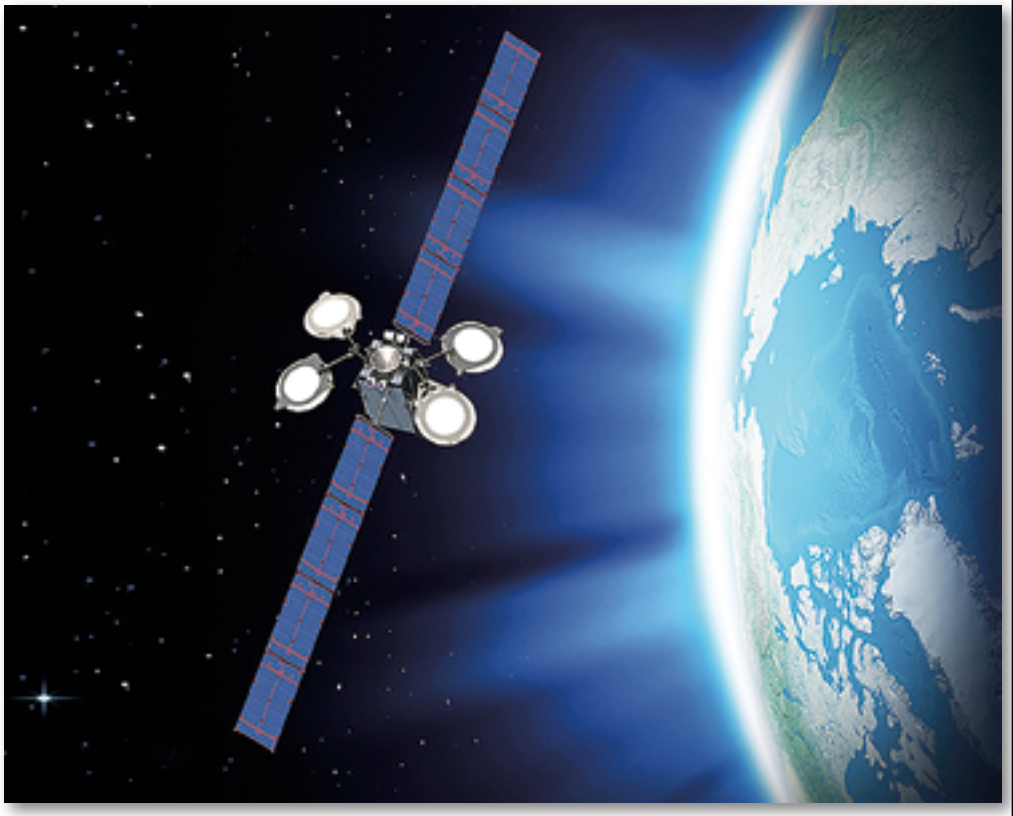
A Plethora Of New Satellites For SES—Builds By Orbital ATK, Boeing + Airbus Defence & Space

SES has announced plans to launch a dedicated satellite for governmental use in partnership with the Luxembourg Government in late 2017.

A Luxembourg-based company jointly held by SES and the Luxembourg Government is planned to own and operate the new SES-16 / GovSat spacecraft, which will be built by Orbital ATK.

The Luxembourg Government and SES would each invest 50 million euros into the new company, which, at the same time, would receive a 125 million euros bank loan from a consortium of Luxembourg banks to finance the satellite's procurement and launch.



Artistic rendition of the SES-15 (702SP platform) satellite, courtesy of Boeing.

This investment has been foreseen within SES's existing capital expenditure projections. The spacecraft would be positioned in the European arc, covering Europe, the Middle East, Africa and Asia-Pacific.

Artistic rendition of the SES-16 / GovSat, courtesy of Orbital ATK.

The capacity of the new satellite would satisfy Luxembourg's requirements for satellite communications in military frequencies. Capacity would also be made available to governmental and institutional customers for defense and governmental applications.

The multi-mission satellite will use dedicated military frequencies (known as X-band and military Ka-band), providing high-powered and fully steerable spot beams to support multiple operations.

"This new, ambitious public-private partnership demonstrates the importance of Luxembourg in the international space sector and the close and successful ties between SES and Luxembourg. SES fully acknowledges the importance of the Luxembourg Government's participation in this future enterprise," said Karim Michel Sabbagh, President and CEO of SES.

"Emerging from the national space sector, this project is not only an important contribution of Luxembourg to European defense, but it further supports the government's economic diversification policy in a key technology sector," said Etienne Schneider, Deputy Prime Minister, Minister of Defense and Minister of Economy.

Plus, SES has ordered their new SES-15 satellite to provide growth capacity in North America and capture business potential in vibrant market segments.

The new satellite is to be built by Boeing, due to be launched in Q2 2017, and will open up a new orbital location to serve North America. SES-15 will carry a hybrid payload, with additional Ku-band wide beams and Ku- as well as Ka-band High Throughput Satellite (HTS) capability. The satellite will be equipped with an electric propulsion system for orbit raising and in-orbit maneuvers.

SES-15 will solidify SES' positioning in the aeronautical mobility and government markets, providing fresh capacity and coverage over major airline routes across the continent.

SES-15 will enable SES to serve its leading aeronautical customers and serve other traffic intensive data applications such as government, VSAT networks and maritime.

Additionally, Airbus Defence and Space (Airbus D&S) has been awarded a contract by SES to design and develop the SES-14 satellite. SES-14 is the first high-power satellite in the 4-ton class and will be based on Airbus Defence and Space's ultra-reliable Eurostar platform in its E3000e variant, which exclusively uses electric propulsion for orbit raising (EOR), taking advantage of the reduction in mass that this technology enables with an exceptionally large payload.

The satellite will have a double mission. The first will be a wide-beam payload of C- and Ku-band, covering the Americas as well as a link to Europe. The other payload, called High Throughput Satellite (HTS) with numerous user beams, will combine an on-board processor with multi-beam coverage of the Americas and the North Atlantic. SES-14 will carry seven antennas. It will have a take-off weight of 4,200 kg and an electric power of 16 kW.

Artistic rendition of the SES-14 satellite.

The satellite is scheduled for launch in late 2017 nominal operational position will be 47.5/48 degrees West. It has been designed to remain in service in orbit for more than 15 years.

SES-14 is the 12th Eurostar satellite and the second all-electric satellite ordered by SES from Airbus Defence and Space. Nine of these satellites are in operational service and two are under construction.

SES infosite: ***www.ses.com/***

The European Space Agency's IXV Spaceplane Goes Up + Returns Home With A Splash

The IXV spaceplane launch by an Arianespace Vega rocket from the European Space Center in French Guiana.
Photo Credit: European Space Agency—S. Corvaja.

The IXV (Intermediate eXperimental Vehicle), the European Space Agency's atmospheric reentry demonstrator, developed by Thales Alenia Space, was successfully launched on February 11th by Arianespace on board a Vega rocket from the Guiana Space Center.

Thales Alenia Space is the prime contractor, heading a consortium of partners from European industry, research centers and universities. Italy's significant participation in the project is strongly supported by the Italian Space Agency ASI.

The IXV separated from the launcher at an altitude of 320 kilometers, continuing its ascent until reaching an altitude of 412 kilometers. It then began the reentry phase, during which experimental data was acquired via the instruments on the vehicle.

The IXV reached a speed during its atmospheric reentry of approximately 7.5 km/sec at an altitude of 120 km, typical of a reentry from Low Earth Orbit LEO), similar of those of the International Space Station. The mission lasted a total of one hour and 40 minutes and ended with a parachute descent, then a splashdown in the Pacific Ocean, where the IXV was immediately recovered by a specially equipped ship.

"The success of this mission is a source of great pride for us," said Elisio Prette, President and CEO of Thales Alenia Space Italia. "Thanks to the data collected during the flight, we are paving the way for the development of new-generation reentry vehicles in Europe, and our company, which designed and built the IXV, is now the European benchmark in this sector. Thales Alenia Space will further develop its expertise via the European program PRIDE, approved at the Ministerial Conference in December 2014, marking another significant step forward in the general understanding of enabling technologies for reentry systems."

IXV offers excellent aerodynamic properties because of the shape of its fuselage, which maximizes lift and maneuverability. The spacecraft is equipped with a high-performance guidance, navigation and control system that uses automatically controlled aerodynamic surfaces during the atmospheric reentry phase. IXV is also protected by a heat shield designed to stand up to the extremely high temperatures of an atmospheric reentry.

At the ALTEC Mission Control Center in Turin, specialized technicians followed the mission in real time, coordinating the ground stations during IXV's flight and the naval recovery operations after splashdown.

RUAG Space supplied what is known as the cold structure for IXV. Similar to the self-supporting body of an automobile, the cold structure is what actually carries the load. It gives IXV its aerodynamic shape and provides the mechanical interfaces to the launcher and to all of the spacecraft's other assemblies. At several points during the various mission phases, the cold structure must withstand considerable forces—when it takes off from Kourou on board the Vega rocket, when it re-enters the Earth's atmosphere, as the parachute opens, and finally when it lands in the Pacific.

IXV allowed the European Space Agency ESA to test out key technologies for re-entry into Earth's atmosphere and for the autonomous return of spacecraft to Earth. Particular focus was on aerodynamics and aerothermodynamics as well as the heat shield, navigation and avionics.

There are any number of applications for an autonomous spacecraft that can return to Earth undamaged. These range from research in zero-gravity conditions and exploration of the upper atmosphere, to maintenance and service missions for satellites or the International Space Station ISS. Another possibility is transporting rock samples from other planets back to Earth.

At 5 meters long, 1.5 meters high and 2.2 meters wide, the Intermediate eXperimental Vehicle is about the size of an average car and weighs almost two tons. A Vega launcher boosted the spacecraft up to around 320 kilometers.

After separation, IXV climbed to around 450 kilometers before re-entering the Earth's atmosphere around 120 kilometers above the surface, traveling at some 27,000 kilometers per hour. After re-entry, a parachute opened to slow the spacecraft down for a Pacific Ocean splashdown.

During its flight, the autonomous spacecraft will perform a whole series of precisely programmed maneuvers, which will provide engineers and scientists with the data they need to test technologies that are crucial for re-entry.

RUAG Space was responsible for supplying all IXV's instruments, which comprise some 300 temperature, pressure and position sensors and strain gauges. The sensors have to be able to deliver reliable measurements while withstanding temperatures of up to 1,600 degrees Celsius. In collaboration with ETH Zurich and Lambda-X in Belgium, RUAG Space also supplied an infrared camera, which will take high-resolution pictures of one of the two control flaps throughout re-entry. This will provide information regarding what temperatures IXV experienced at every point during re-entry and the physical effects these temperatures have.

ESA: ***www.esa.int/***

RUAG Space: ***http://www.ruag.com/***

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For GATR Technologies, making lighter inflatable SATCOM terminals has resulted in steady growth.

GATR's customers have recognized the value of lighter, more agile GATR terminals as the future of portable SATCOM.

Recent news about GATR included the following, "The inflatable satellite antenna is transforming how Special Operations forces and now airborne and other conventional forces deploy high-bandwidth SATCOM around the world," said Lt. Col. Leonard Newman, Army product manager for Satellite Communications, part of the WIN-T mission.

Amy Walker, PEO C3T, reported in Army. Mil, January 8, 2015, "Future Joint contingencies and support operations are expected to require rapid deployment of smaller sized elements to a wide variety of austere environments, with Soldiers needing to fight on arrival.

"The lightweight, easily transportable Ground Antenna Transmit & Receive, or GATR, inflatable antenna reduces size, weight and power requirements over current capability, enabling smaller units to quickly deploy anywhere in the world and achieve high-bandwidth connectivity."

WTA's Teleport Executive Of The Year—CEO Schutz Of Elara Communications

The World Teleport Association has awarded Jorge Luis Villarreal Schutz, CEO of Mexican-based Elara Comunicaciones, as the organization's 2015 Teleport Executive of the Year.

Mr. Villarreal Schutz will be honored during WTA's Teleport Awards for Excellence luncheon on March 17th during SATELLITE 2015. The Teleport Executive of the Year award is presented to an individual for demonstrated entrepreneurship, leadership and innovation in the development or operation of a teleport-based business.

A successful entrepreneur with more than 20 years of experience in the satellite industry, Villarreal Schutz is the founder of an outstanding telecommunications company that has transformed satellite connectivity.

His company has excelled in ethics, professionalism and commitment, continuously fostering the use of tailor-made satellite solutions through values such as customer service, honesty, teamwork and innovation, allowing him to

reach others and generate a positive impact by providing satellite technology in new frontiers.

"The 20th anniversary of the awards has produced a Teleport Executive of the Year from a part of the world which, two decades ago, had not yet made its mark in the industry," said WTA Director of Development, Lou Zacharilla. "Jorge is not only an excellent tactical leader focused on customer service systems and innovation, he also has enabled his company to profitably address the most pressing economic issue in Latin America, the digital divide. Under his leadership, Elara is part of a digital inclusion effort with the government of Mexico that provides coverage to more than 3,000 small villages. His teleport helps make a better world."

During the 2015 Teleport Awards for Excellence luncheon ceremony, sponsored by SES, WTA will also honor its Independent Teleport of the Year and Teleport Technology of the Year. The luncheon starts at noon on March 17th and is free to WTA members who register. Attendance is also available on a paid basis to non-members.

World Teleport Association:
www.worldteleport.org/

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Channeling Their Expertise

P&O Ferries and MTN Communications (MTN) announce the delivery of high-performance Internet connectivity and access to online content through the first WiFi hot spot on the English Channel.

This service is now live on the English Channel on ferries serving the P&O Ferries Dover-Calais route. These vessels are the first ferries in the world connected to the MTN Terrestrial Broadband Network (TBN), in addition to having back-up satellite connectivity, as many cruise ships do today.

Each P&O Ferries vessel now has a broadband antenna tracking and stabilization system, which works across the entire 22 miles (35.40 kilometers) of the English Channel. This allows the antenna to "lock" onto MTN TBN access points on shore, providing broadband service to the end user.

In addition, the shipboard data center of each vessel is equipped with the industry's most advanced processing technologies. This new service follows the launch of a satellite communications solution on the P&O Ferries Irish Sea Route in December 2013 and North Sea Route in August 2014. This initiative serves the 11 of the P&O Ferries vessels that make up Europe's largest and leading ferry fleet. P&O Ferries carries more than nine million passengers annually and provides 365x7 transport.

MTN introduced this hybrid network component of its advanced communications system, comprising satellite and terrestrial broadband connectivity, seamless switching with zero impact to users, smart computing and a comprehensive platform for eCommerce and other apps.

All this is now in place so P&O Ferries can deliver passenger and crew conveniences now required onboard their ferries.

"Ferries traditionally have relied solely on satellite bandwidth for communications services," said Ian Rabbidge, head of propositions, P&O Ferries. "With connectivity demands exponentially increasing on our ferries, it was crucial for us to find a more reliable, robust solution. We need to enable passengers to stay online while commuting to work or to stay connected while enjoying their leisure travel. Just like in the office, at home or at a land-based resort, they want to stream media; conduct eCommerce; engage in social media; access online content; watch television; call family, friends and colleagues; and more.

"MTN enables all this through its advanced communications ecosystem of hybrid connectivity, smart computing and an Internet platform designed to enable today's apps. P&O Ferries is proud to be first ferry operator in the world to showcase such an advanced communications offering to its passengers and crew."

MTN delivers more than 12 terabytes of data daily through this powerful hybrid communications network, and processes 2.8 million Internet logins per month. The company again transformed the maritime communications industry with the launch of this advanced communications ecosystem because of the transformative way it solved the demand-for-bandwidth dilemma.

MTN Communications:
www.mtnsat.com/

InfoBeam

Blending SATCOM + Terrestrial Tech

Airbus Defence and Space (Airbus D&S) has started work on the MUSTANG project for machine to machine (M2M) communications, in partnership with the SMEs SIGFOX and SYSMECA, and the CEA-Leti research center.

The project focuses on low-cost exchange of short messages in the fast-growing M2M market, with the aim to develop an innovative hybrid terrestrial/satellite access solution for the Internet of Things (IoT) for seamless and ubiquitous communications across the globe.

Supported by the French Government's General Directorate for Enterprise (DGE), the project will receive public funding through the Future Investments Program (PIA) run by the General Investment Commission (CGI) and the French ministry in charge of Digital Affairs.

The strategic target is to develop an innovative terrestrial/satellite solution to penetrate the worldwide IoT market, giving French companies a strategic foothold in this growing application domain.

The IoT will lead to people being surrounded by hundreds of connected devices that will ease and revolutionize their way of life wherever they are. However, the full potential can only be achieved by adapting networks and, in more specific terms, by offering affordable mobile communications everywhere and at all times.

Satellite links will use a dedicated communication protocol to ensure excellent coverage using a small form factor terminal, while 868 and 915 MHz ISM band will be used to communicate with the SIGFOX terrestrial network.

The dual-mode satellite/terrestrial terminal will enable automatic switching between the two communication channels in response to resource availability in the areas where connected devices are located.

The three-year project will involve the development of the terminal's modem chipset, the optimization of communication protocols and the validation of the system through an aircraft application demonstration.

Performance objectives will be achieved primarily through developments in integrated circuit technologies and in enhanced communication protocols for short messages.

Based on new terrestrial and satellite communication technologies, the solution will enable connected devices to communicate on a global scale, offering users a fully integrated and optimized low-cost short message service.

Airbus D&S: ***airbusdefenceandspace.com/***

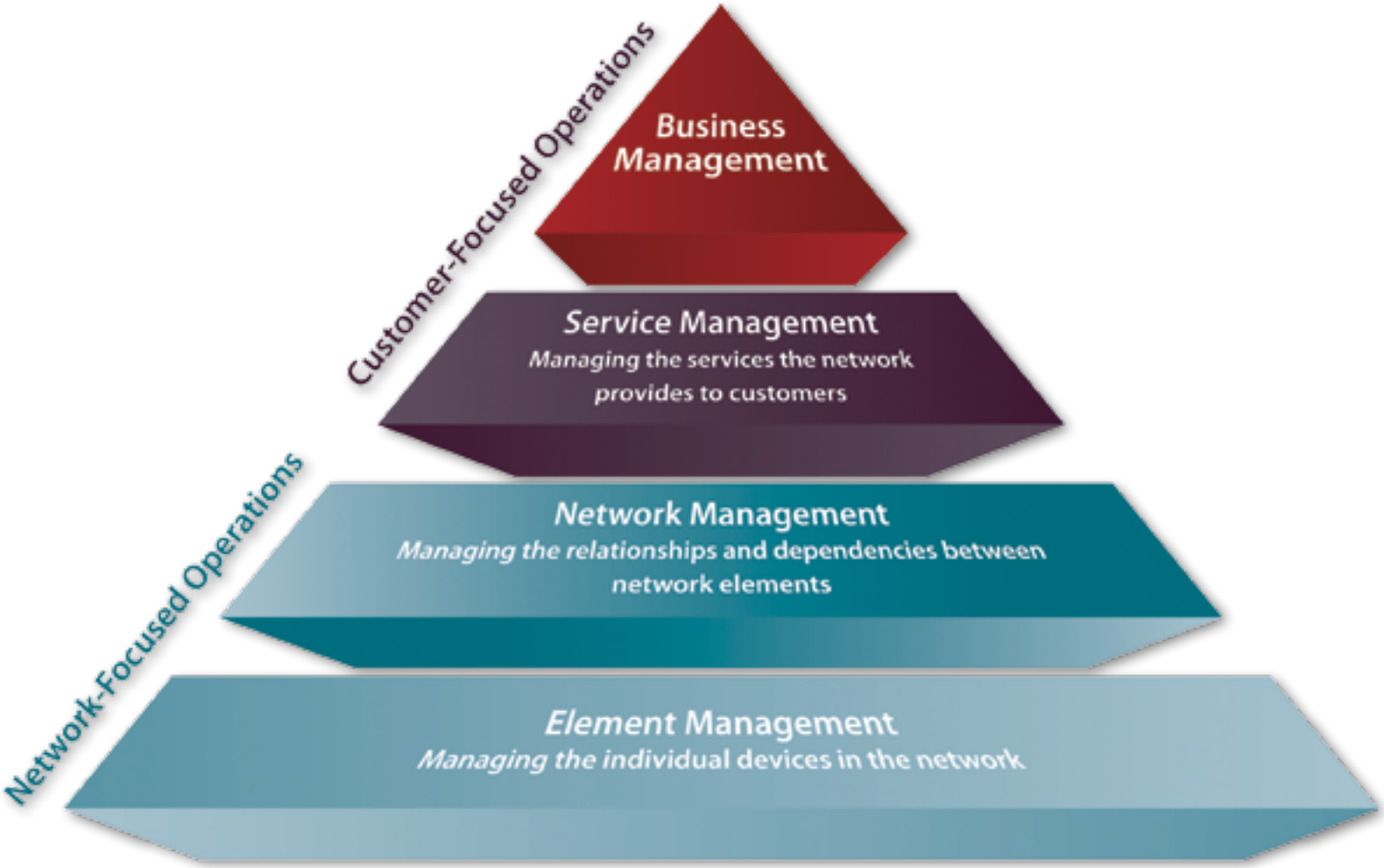
SIGFOX: ***www.sigfox.com/***

Transforming the Management Of Network Ops To Support Rapid Services Growth

Taking Operations To The Next Level By Focusing On Service Quality Management

By Don Imhoff, Vice President, Enterprise Solutions, Kratos Networks, A Division Of Kratos Defense & Security Solutions

With consumer appetites for data doubling approximately every three years, the delivery of satellite services is growing rapidly, with more quantity, different types and a range of service levels being offered to meet expectations.



An SQM approach expands beyond element and network management to track service performance and customer SLAs.

As service demands intensify, competitive pressures increase and Service Level Agreements (SLAs) become more aggressive, satellite service providers are looking for more advanced techniques to better manage network complexity, offer higher levels of service and improve the customer experience.

Just as the telecom and IT worlds have adopted Service Quality Management (SQM) techniques to manage the growth in services, satellite service providers are starting to employ these latest advances to transform their operations to keep pace with demand, better manage customer services and drive greater profitability.

SQM applications enable operators to monitor and manage the levels of service they are delivering to customers. SQM applications interface with existing tools at the element management and network management layers to provide an end-to-end view of all components on the network used to carry a particular service. Without having to replace existing systems, SQM solutions track real-time performance using Key Performance Indicators (KPIs) to ensure delivery of high-value services and prioritize the recovery of any services experiencing issues, so that customer SLAs are met.

The approach enables network operators to answer questions about service performance, such as how much capacity exists, how many customers are affected by a degradation, what SLAs are in compliance or in jeopardy of being violated and what is the potential revenue impact? Operators track revenue sources more efficiently allowing them to manage more services, maximize the returns from existing SLAs, while limiting losses due to unavoidable service outages.

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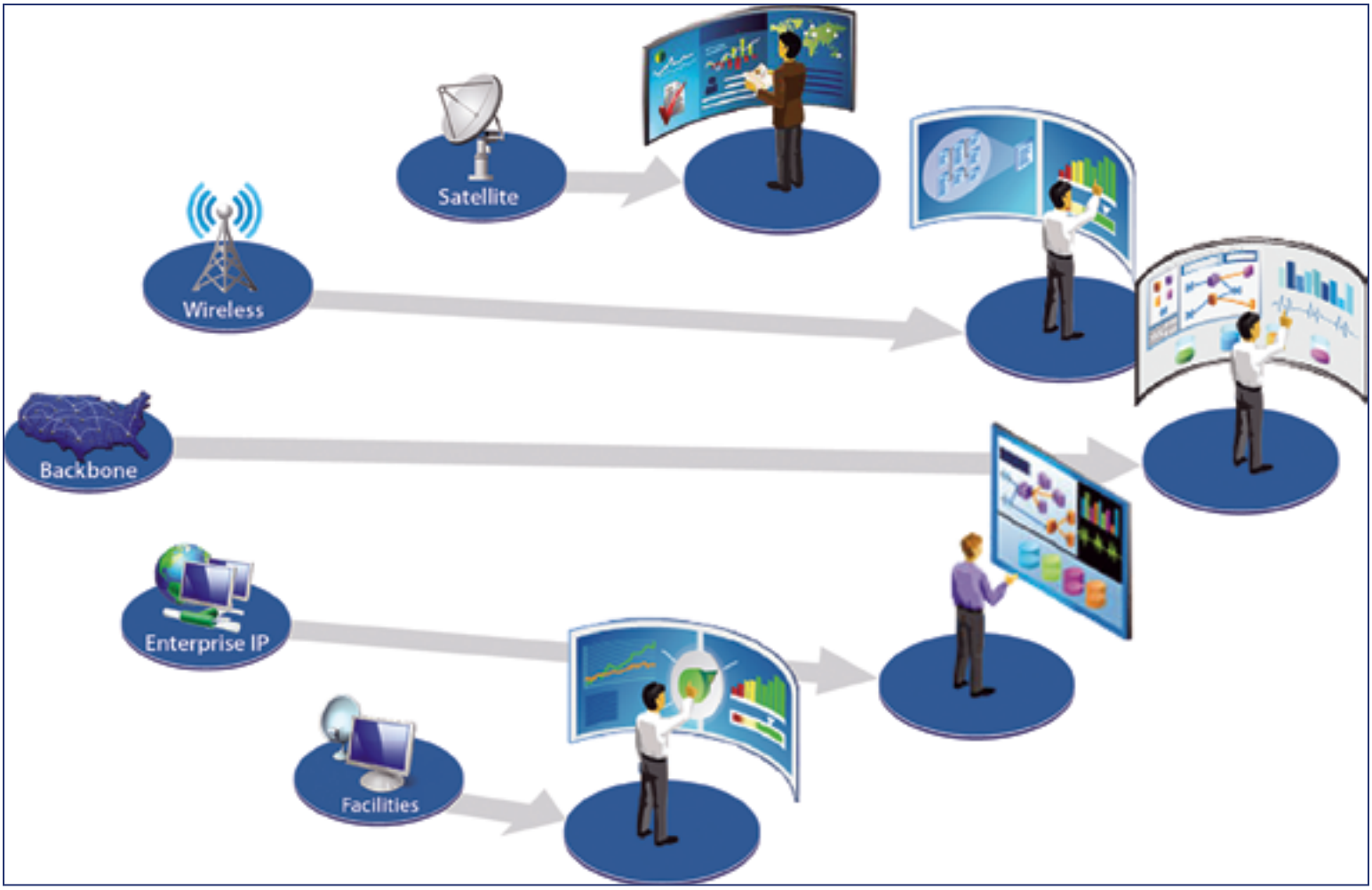

Today's siloed management tools challenge operators to gain a complete view of their environment.

Satellite providers with their range of hybrid equipment and convergence to IP technology can benefit from SQM techniques that are now an applied science in the telecom world.

As an example, when a router fails in a telecom network delivering business voice, data, and video services under a stringent SLA, the Network Operations Center (NOC) with an SQM application can rapidly identify the equipment issue and immediately see its impact on customers and revenue.

Operators determine how much time there is before an SLA is violated and view the relative value of the different services affected to enable the most cost-effective resolution. This helps operations minimize SLA violations and cost impacts of extended service outages by protecting the highest value customers.

Keeping Pace With The Growth In Demand For Services

With more services come bigger deployments, increased geographic reach and more advanced configurations that challenge the effective management of the network.

The traditional approach of adding staff and tools incrementally to manage network operations is struggling to keep pace with the rapid growth. Network teams have ended up with multiple, unconnected tool sets that do not communicate with each other and only provide insight into a limited part of the network. For example, separate tools have commonly been implemented to monitor RF equipment, individual VSAT networks, IP networks, teleport and facility infrastructures including HVAC and security systems creating gaps in visibility.

The rapid expansion of these disconnected systems is not only costly, but it is one of the biggest factors that impair a network operator's ability to optimize operations. This approach also makes it extremely time-consuming and labor intensive to track network data.

Network Operations Center (NOC) engineers often have to compile reports manually from these separate management systems to get a complete view of their operations and service performance. It becomes difficult to determine how a device failure affects a service, track the performance of top revenue producing services and guarantee SLAs for customers.

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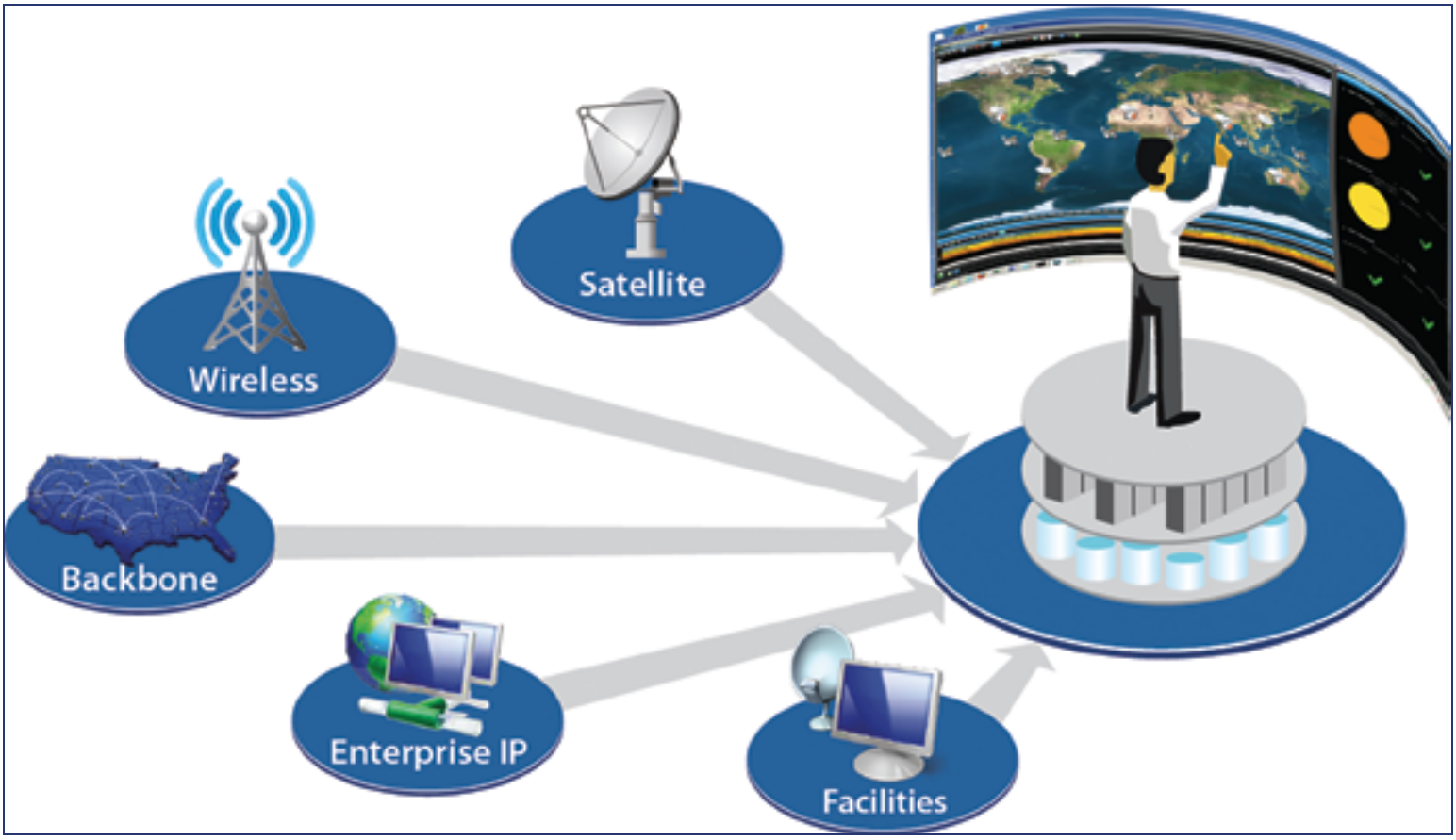

An SQM approach bridges the management silos to improve service performance and SLA management.

In this new services driven environment, the scale points change the network operational needs dramatically, and an expanded management approach is necessary to accommodate growth. When the network is only delivering a few services, a small network engineering staff can track the associated devices in the service chain individually and understand their interdependencies during troubleshooting. But, as the network scales to deliver hundreds or even thousands of diverse services from across the globe, operators need more advanced techniques to manage the environment.

Transforming Network Operations With SQM

By borrowing from the telecom and IT world, which has a head-start in managing a large quantity and range of services, satellite operators can employ the latest advances in SQM to scale, automate and optimize operations.

An SQM approach enables service providers to transform their operations by delivering improved visibility, end-to-end management of hybrid networks, enhanced troubleshooting capabilities, proactive monitoring, trend analysis, and the ability to scale seamlessly.

Improved Visibility

With dynamic service views and mapping, operators can see and understand the business implications of their technical infrastructure. They use real-time intelligence and analytics to quickly assess which customers are affected by a degradation or outage of even a single device anywhere in the network.

The specific devices such as modems, Antenna Control Units (ACUs), High Power Amplifiers (HPAs), routers and other equipment are mapped across the network to particular services and specific customers they support. This enables operators to track service performance and prioritize the highest value services with a status of "At Risk" or "Poor Quality" that need immediate corrective action to avoid any customer impact.

End-to-End Management

By bridging the management silos, SQM solutions retrieve both device and service data from monitored systems at each teleport, across the network and integrate it all into one common platform. This enables operators to gain end-to-end visibility of services from the source to destination across circuit (satellite/microwave) and packet (IP) networks.

All relevant metrics across the transport systems are consolidated into a single overall services view, so operators can act in real time to recognize and react to bottlenecks regardless of location. Comprehensive views of customers, services and circuits are provided that include IT and RF satellite layers for all types of networks including VSAT, FDMA, TDMA, DVB/RCS, SCPC, DVB broadcast, backhaul services and much more.

Enhanced Troubleshooting

The root cause identification of problems is accelerated by using a unified SQM management platform. Centralized alarm management and event correlation capabilities help identify, prioritize and recover services affected by equipment failures. Operators can drill into services and devices for more detailed troubleshooting information. For example, once a faulty modem is identified in a service chain that includes an antenna, HPA, converter, modem and VSAT hub, the SQM application accelerates the remediation process and minimizes customer impact by displaying the device's room, the room's location and the customer(s) impacted. It also provides visibility into all services or customers associated with any piece of equipment, so operations can easily identify critical components and potential impacts should it become inoperable.

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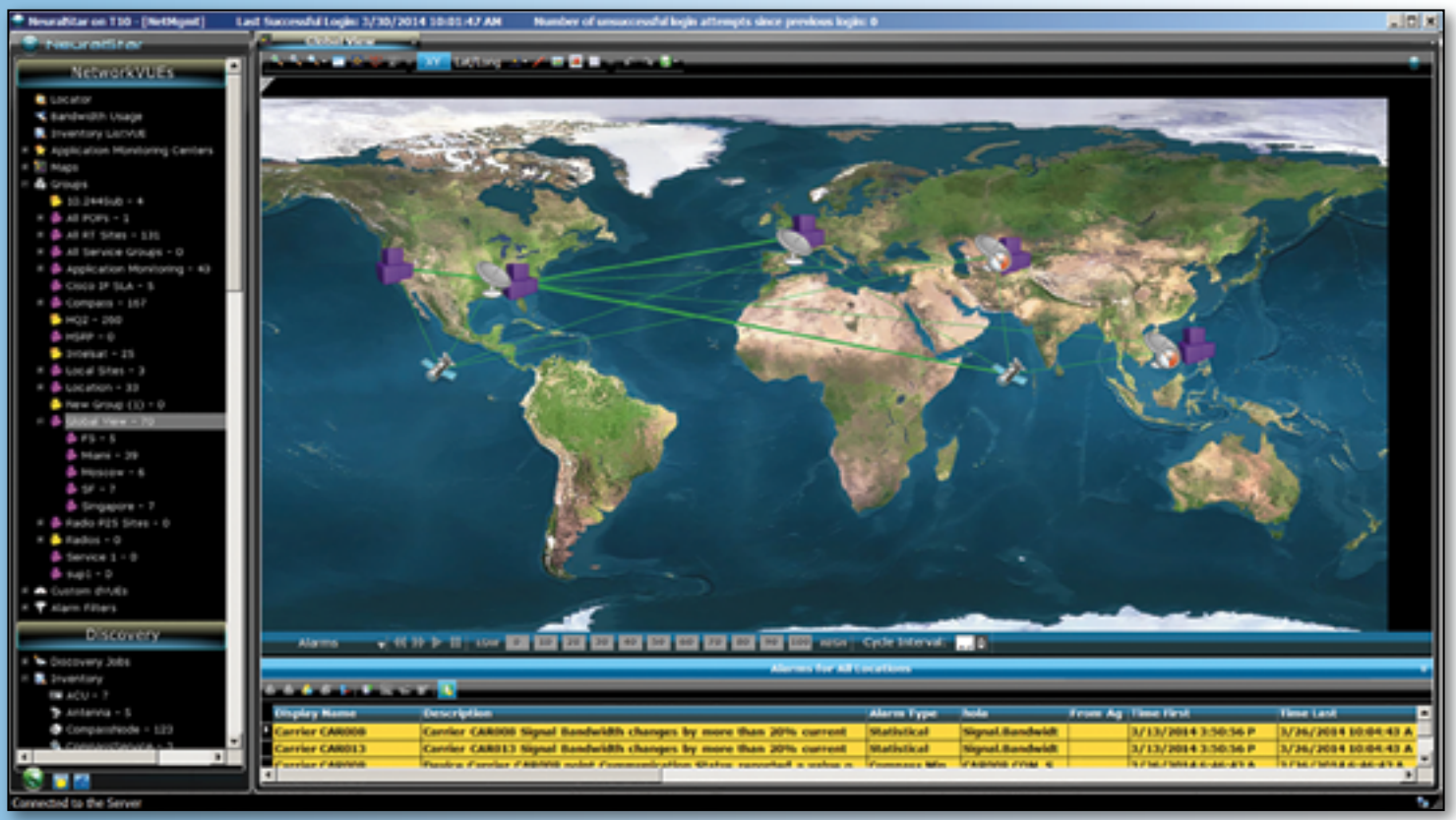

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Linearity Of GaN-Based SSPAs: An Advantech Technology Focus

By Cristi Damian, M.E.E., Vice President, Business Development, Advantech Wireless

Since the initial launch of GaN based Solid State Power Amplifiers by Advantech Wireless in early 2010, many uncertainties and unknown issues have been clarified.

We know today that GaN is the foundation of all new Power Amplifier development and design and offers unmatched performance, reliability, and efficiency. The purpose of this article is to characterize, in particular, the linearity of Advantech Based GaN SSPAS, when operated either in single carrier mode, or in multi carrier mode. A comparison with TWTs is long overdue, and here the comparison is included. Advantech's belief is that today GaN exceeds power levels that were never achieved with any technology and opens a new range of applications and opportunities for the satellite communication market.

Linearity Performance

There are now several suppliers who have accepted the challenge of designing SSPAs using GaN technology—no trivial endeavor. This article describes the performance of Advantech Wireless GaN based SSPAs and it is limited to our known measurements and observations on Advantech Wireless manufactured units. Results from other suppliers might differ, as linearizing GaN SSPAs proves to be challenging, but at the same time rewarding, if successful.

Single Carrier Mode

Traditionally, SSPAs have been characterized by two power levels:

1. *Psat or Saturated Power, it is the maximum power the SSPA will generate. No SSPA should be run at Psat, as the link will only degrade in performance.*
2. *1dB is the 1dB compression point. This is really the "Output Power Warning Level", a level that should not be exceeded. Gain is starting to compress, we only have 0.8-1 dB before saturation, and the link performance will degrade sharply. Higher order modulations will not run at P1dB power levels, as both amplitude and phase of the signal will be affected.*

In a nutshell, Psat and P1dB will not tell us how many carriers we can transmit, or which modulation type. Different measurements are needed to characterize that. Additionally, TWTs do not specify P1dB, so the confusion is even higher if a comparison is attempted with SSPAs.

What ***is*** important in single carrier mode is spectrum regrowth. Carrier spillover effect, into some other's allocated bandwidth, must be kept to a minimum. This is specified as -25 dBc at 1 Symbol offset for commercial applications, and -30 dBc for Military applications. Based on several tests performed, older generations of GaAs based SSPAs will meet the -25 dBc spec at around 4 dB below Psat. (*Please see Figure 1 at the bottom of the left-hand column.*)

GaN based SSPAs, on the other hand, are much better performing. They will meet same specifications at only 1 dB below Psat. This brings up an important issue:

1. *An older generation SSPA designed using GaAs FETs, will operate in 8PSK or 16 APSK mode for example, at 3 dB below P1Db.*
2. *New generation SSPA, using GaN, will operate in 8PSK or 16 APSK modes, at only 1 dB below Psat, or previously defined P1dB.*

The conclusion is somehow intriguing. A 250W saturated power SSPA, using older generation GaAs FETs, can be operated in single carrier mode, with higher order modulation, at only 100W. Higher than that, errors are generated that, depending on link margins, might not be permitted. The same 250W saturated SSPA, using GaN technology, can be now operated at 200W, with no degradations in link performance. This is the same as operating a GaAs based SSPA of double power, 500 W. In this context, the GaN based model is clearly a winner, doubling the amount of usable RF power, for the same Psat. GaN

Total back off	Signal to Noise Ratio (SNR)	Eb/No (dB)
6 dB	15.37	10.75
3 dB	17.26	12.05
2 dB	16.58	12.1
0 dB	15.09	10.68

Table 1. GaN based SSPA, single carrier mode, 16 APSK. SNR and Eb/No versus back off.

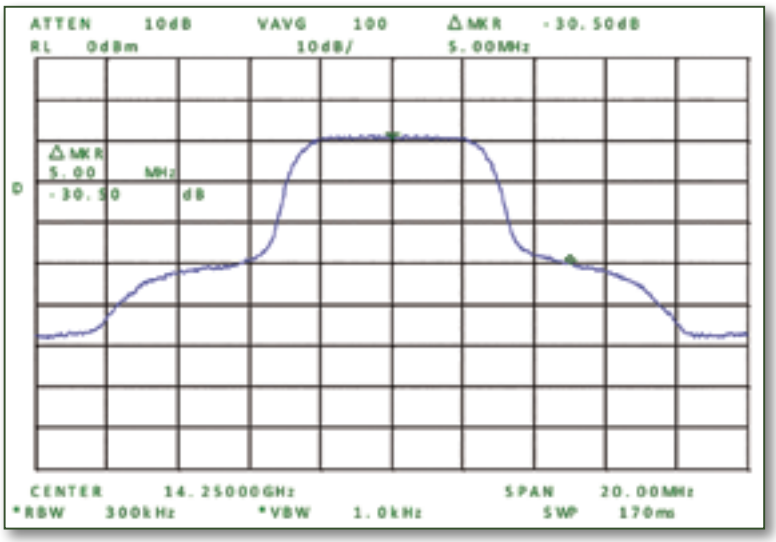

Figure 1. Spectrum Regrowth, GaN-based SSPA, 1 dB back off from Psat.

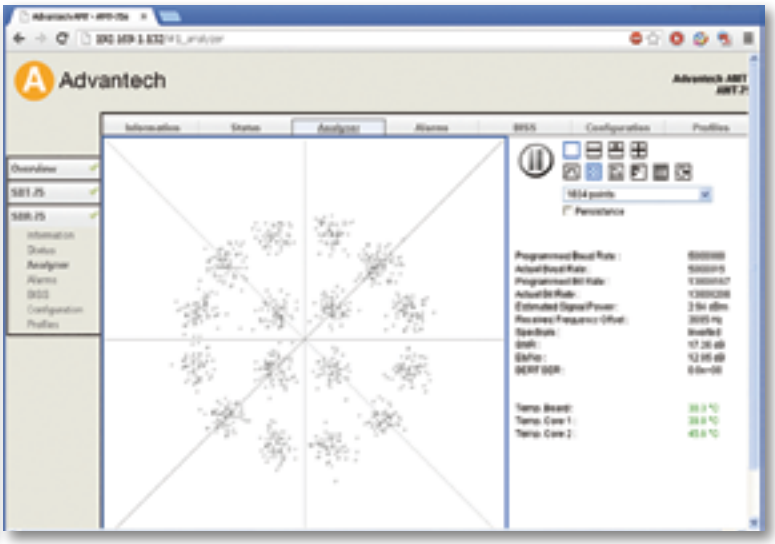

Figure 2. 16 APSK constellation at 6 dB back off.

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Dimension	89cm(D) × 100cm(H)	103cm(D) × 89cm(H)	115cm(D) × 108cm(H)	125cm(D) × 30cm(H)	116cm(D) × 58cm(H)
Antenna Weight	42kg	26kg	45kg	70kg	65kg
Frequency Range	19.7~20.2GHz (Rx) 29.5~30GHz (Tx)	12.25~12.75GHz (Rx) 14~14.5GHz (Tx)	12.25~12.75GHz (Rx) 14~14.5GHz (Tx)	12.25~12.75GHz (Rx) 14~14.5GHz (Tx)	12.25~12.75GHz (Rx) 14~14.5GHz (Tx)
Antenna Gain	41.9dBi@19.95GHz (Rx) 45.3dBi @29.75GHz (Tx)	35dBi@12.5GHz (Rx) 36.2dBi@14.25GHz (Tx)	38.3dBi@12.5GHz (Rx) 39.9dBi@14.25GHz (Tx)	35.5dBi@12.5GHz (Rx) 36.5dBi@14.25GHz (Tx)	37.2dBi@12.5GHz (Rx) 38.2dBi@14.25GHz (Tx)

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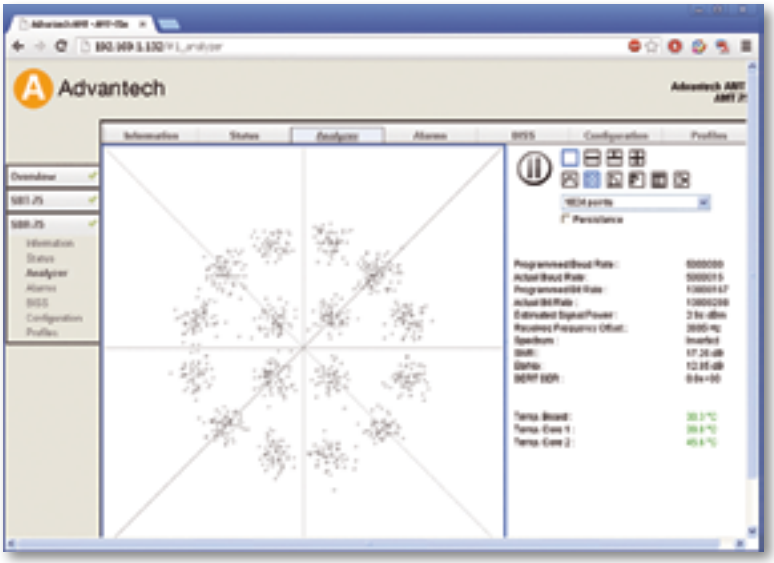

Figure 3. APSK, 3 dB back off.

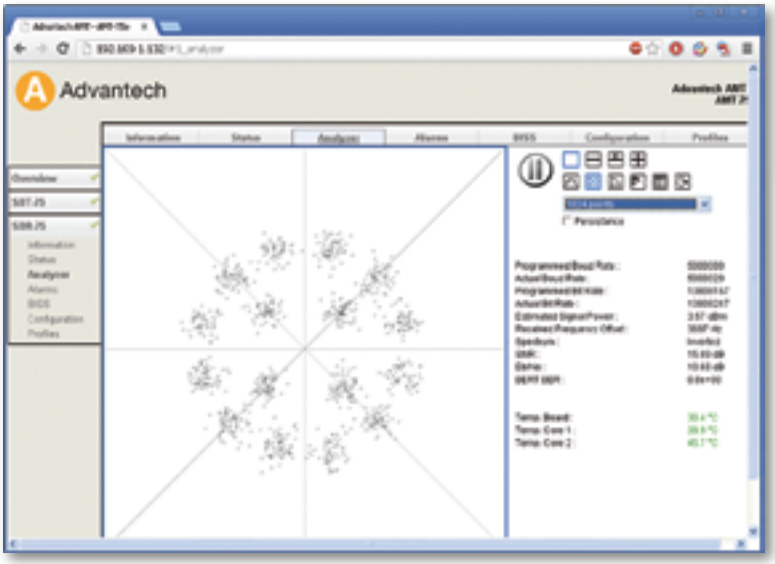

Figure 4. 16 APSK. 1 dB back off.

technology truly enables DVB-S2 advanced modulation and error correcting codes. To meet the same performance, TWTs will need at least 6 dB back off, and Klystrons 9-10 dB back off. *Table 2* on this page presents Advantech's finding when testing a GaN SSPA carrying 16APSK modulation traffic, from 6 dB back off to saturation.

Multiple Carriers Operation

In multiple carrier mode, the traditional system specification measure is Third Order Intermodulation, or IM3. Generally required is that two carriers, 5 MHz apart each, should not generate more than -25 dBc intermodulation. This was enough when all satellite modems where 70 MHz IF, and transmission was limited to one transponder. Today's modems can cover full satellite bandwidth, and all transponders can be saturated on a specific satellite, with multiple carriers. However, no specific information exists on how SSPAs behave over multiple carriers. That will be the subject of the following section.

For the purpose of this analysis, a 1.2 KW GaN based Ku-band SSPA was tested starting with 2 carriers and going up to 16 carriers, and IM3 levels were measured. In order to simulate with maximum accuracy the real-life applications, all carriers were modulated, not CW.

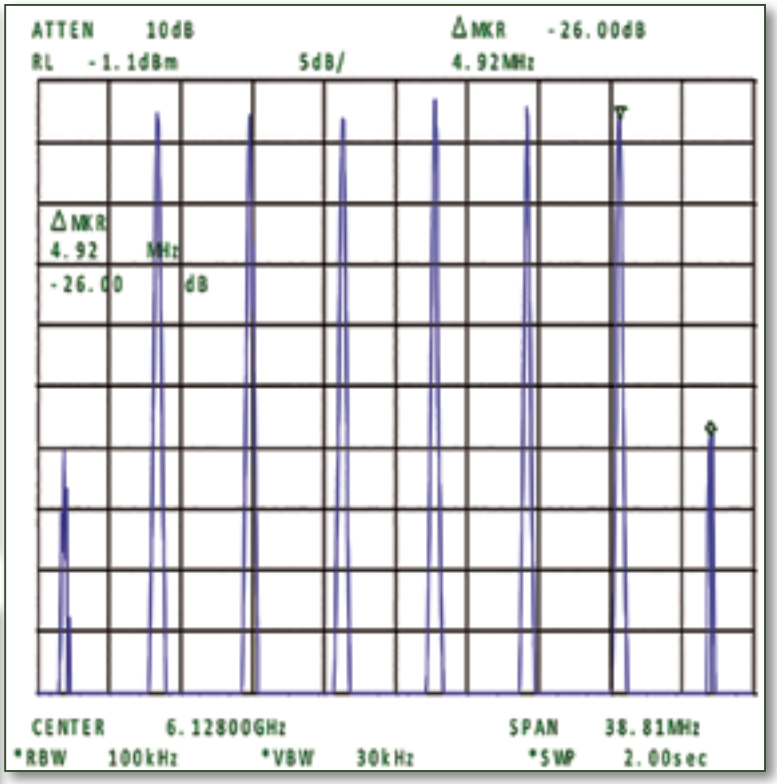

Figure 5. Typical multicarrier vs. IM3 characterization.

Number of carriers	Actual Intermodulation (dBc)	Total Output Power, 1250W Ku-band GaN SSPA (dBm)	Total back off relative to Psat (dB)
1 carrier	Meets -25 dBc spectrum regrowth specifications	58.5	1
2 carriers	-27.3	57	2
3 carriers	-25.5	55.5	3.5
4 carriers	-25.17	54.8	4.2
5 carriers	-25.50	54.5	4.5
6 carriers	-26.67	54.3	4.7
7 carriers	-25.50	54.2	4.8
8 carriers	-25.16	54.0	4.9
9 carriers	-25.3	53.8	5.1
10 carriers	-25.3	53.8	5.1
11 carriers	-26.66	53.6	5.3
12 carriers	-25.5	53.5	5.5
13 carriers	-25.67	53.4	5.6
14 carriers	-25.17	53.2	5.8
15 carriers	-25.5	53.0	6.0
16 carriers	-25.0	53.0	6.0
24 carriers	-25 dBc	53.0	6.0

Table 2. Total Output Power versus number of carriers for 1.250 KW GaN based SSPA, while meeting min -25 dBc IM3.

The results were compared with similar published tests results for TWTs. The conclusions are remarkably clear. GaN technology exceeds the performance of TWTs and Klystrons and offers large linear power levels, which are simply not achievable with any other technology. *Table 2* above presents the total back off required for a 1.2 KW GaN based Advantech Wireless SSPA, when operated with 1 to 24 Carriers, in order to meet -25 dBc third order intermodulation, IM3.

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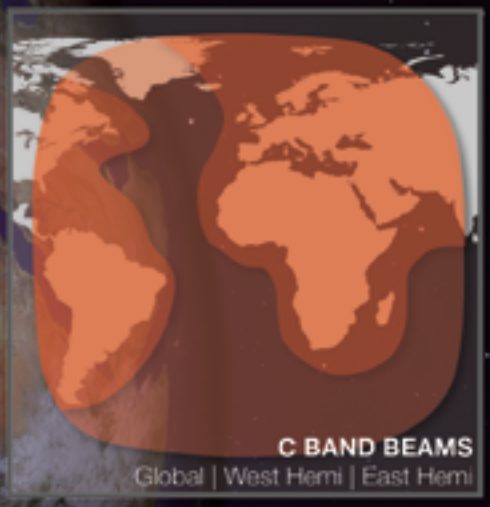

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Number of carriers	Actual Intermodulation (dBc)	Total Output Power, 1250W Ku-band linearizedTWT (dBm)	Total back off relative to Psat (dB)
1 carrier	N/A	57.3	3.6
2 carriers	< - 25 dBc	57.3	3.6
3 carriers	< - 25 dBc	55.5	4.75
4 carriers	< - 25 dBc	54.3	6.0
5 carriers	< - 25 dBc	53.4	6.84
6 carriers	< - 25 dBc	52.75	7.54
7 carriers	< - 25 dBc	52.1	8.20
8 carriers	< - 25 dBc	51.6	8.65
9 carriers	< - 25 dBc	51.3	8.95
10 carriers	< - 25 dBc	51.1	9.25
11 carriers	< - 25 dBc	50.9	9.38
12 carriers	< - 25 dBc	50.8	9.50
13 carriers	< - 25 dBc	50.7	9.60
14 carriers	< - 25 dBc	50.6	9.70
15 carriers	< - 25 dBc	50.5	9.80
16 carriers	< - 25 dBc	50.43	9.87
24 carriers	< - 25 dBc	50.4	10.20

Table 3. Total Output Power versus number of carriers for 1.250 KW Linearized TWT, while meeting min -25 dBc IM3.

Of interest is that once 6 dB back off was reached, the total number of carriers do not affect IM3 values. Actually, from 8 carriers and up to 24 carriers, all that is needed is 6 dB back of in total from Psat. *Table 3* above was built using published information about linearity of 1.2 KW TWT, in the same scenario. The two tables that follow *(Figure 2 on Page 38 and Figure 3 on Page 40)* provide some key information regarding multicarrier operations, in GaN based SSPAs/ TWT.

1. ***The GaN based SSPAs level off at 6 dB back off, which means more carriers can be added without additional back off. The TWT on another hand, requires more back off as more carriers are added.***
2. ***As many as four carriers, both units behave similar, but after that, the difference is significant.***
3. ***For example, a 1.2 KW TWT, when operated with 10 or more carriers, will only deliver half of the power level that can be achieved with the 1.2 KW Ku-band GaN SSPA.***

In other words, a 1.2 KW TWT is not the equivalent of a 1.2 KW GaN SSPA anymore, but is the equivalent of a 500W Ku-band GaN SSPA. This has a major impact on the entire system design, cost wise. Both CAPEX and OPEX will be significantly lower by using just a 500W Ku-band GaN SSPA. The following charts summarize the findings and display the differences between the two technologies. As seen in ***Figures 6*** and ***7*** upper right, GaN SSPAs require 3 to 5 dB less back off than linearized TWTs, in multicarrier operation mode, as soon as the traffic exceeds more than 6 carriers.

A Quick Selection Guide

Specifying units as per usual Psat designation is no longer good enough, which makes the job of system designer confusing. What follows is a simple guide to selecting a high power amplifier. Considering that, going forward, more and more use of high order modulation schemes will be seen, as well as higher traffic, the following suggestions will be useful in real life applications. The main assumptions considered here are as follow in the next column:

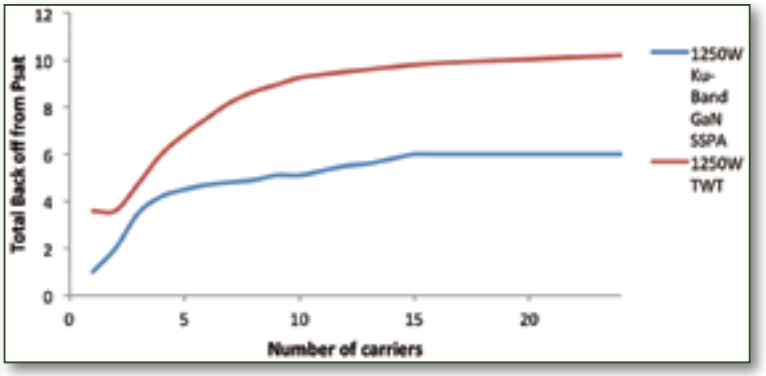

Figure 6. Total Back off from Psat versus numbers of carriers.

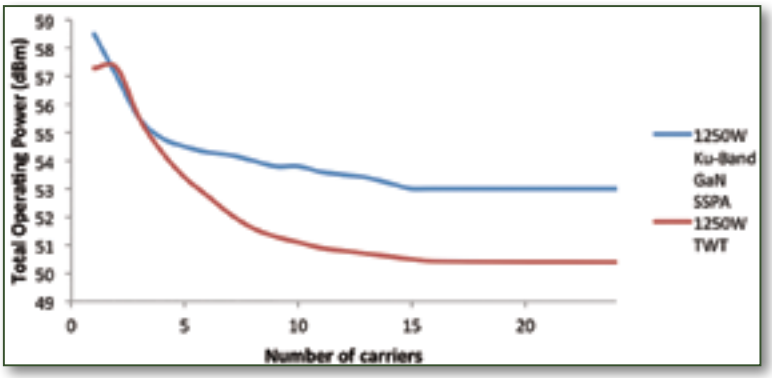

Figure 7. Total Transmit power versus numbers of carriers.

Blue: 1250W Ku-band GaN SSPA
Red: 1250W Ku-band linearized TWT

1. ***A maximum 1 deg/dB of AM/PM degradation is required. This is in line with transmitting high order modulation schemes, VAS in DVB-S2.***
2. ***A minimum -25 dBc spectrum regrowth is required, in order to eliminate interference between adjacent channels.***
3. ***The intention is to transmit multiple carriers, high data rate, high modulation schemes, and wide bandwidth, as in any typical broadcast applications.***

However, it should be noted proper link budget analysis should always be completed. Selection of power amplifiers requires knowledge of specific satellite performance, rain fade, geographical coverage, antenna sizes, and link availability specifications.

In multiple carrier mode, for example 16 carriers, a 250W Ku-band GaN based SSPA will be the equivalent of 750 W Ku-band linearized TWT. A 500W Ku-band GaN SSPA can easily replace a 1.2 KW linearized TWT. A 1.2 KW SapphireBlu™ GaN SSPA will have, in the same context, no equivalent in TWTs. From the examples, GaN based SSPAs can deliver maximum power in single carrier mode and require minimum back off in multi carrier mode. However, the difference is even higher when the new generation of modular, very high power SSPAs are introduced. These Advantech Wireless units now deliver 3 KW in Ku-band and 6 KW in C- and X-band, by phase combining multiple units. The main reason is that this approach provides built in redundancy, or soft failure modes. If one unit fails, it will cause the power to drop around 1 dB, which can be easily compensated by uplink power control systems. Replacing a defective

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No.	GaN SSPA	Previous generation GaAs SSPA	TWT technology
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1	200W	300W	400W Linearized TWT
2	350W	500W	750W Linearized TWT
X-band			
3	300W	400W	500W Superlinear TWT
4	400W	500W	750W Linearized TWT
Ku-band			
5	80W	100W	200W Linearized TWT
6	100W	150 W	250W Superlinear TWT
7	200W	300W	400W Linearized TWT
8	250W	350 W	400W Superlinear TWT
9	400W	500W	750W Linearized TWT
10	600W	700W	1250W Superlinear TWT

No.	GaN SSPA	Previous generation GaAs SSPA	TWT technology
C-band			
1	150W	200W	400W Linearized TWT
2	250W	300W	750W Linearized TWT
X-band			
3	250W	300W	500W Superlinear TWT
4	300W	400W	750W Linearized TWT
Ku-band			
5	80W	100W	200W Linearized TWT
6	80W	100 W	250W Superlinear TWT
7	200W	250W	400W Linearized TWT
8	250W	300 W	400W Superlinear TWT
9	300W	400W	750W Linearized TWT
10	600W	700W	1250W Superlinear TWT

unit is relatively fast, requiring on average 30 minutes. However, the unexpected result is that, somehow, these phase combined system perform better in terms of intermodulation than the individual SSPAs used as building blocks. There is a clear explanation for this performance.

When phase combining multiple units, transmitted power adds coherently, i.e., they have same phase and amplitude. The IM3 products do not add coherently, and in many cases, they will cancel one another. This is visible in a real operating system where multiple carriers generate visible IM3 products on a single SSPA but are not visible on a system including 8 similar units phase combined, even if the back off is the same.

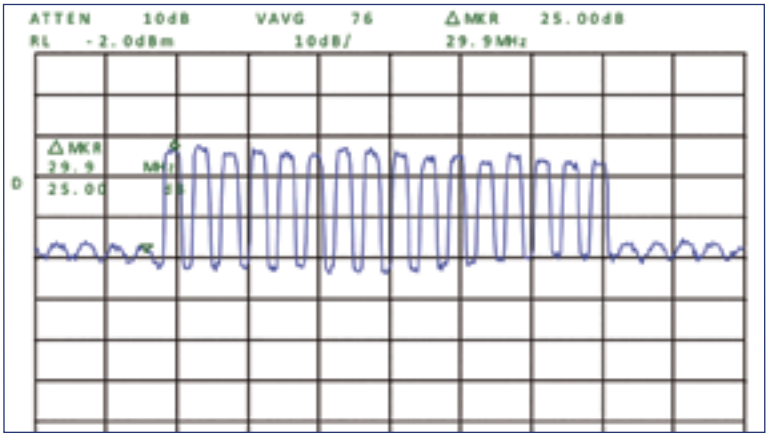

Figure 8.

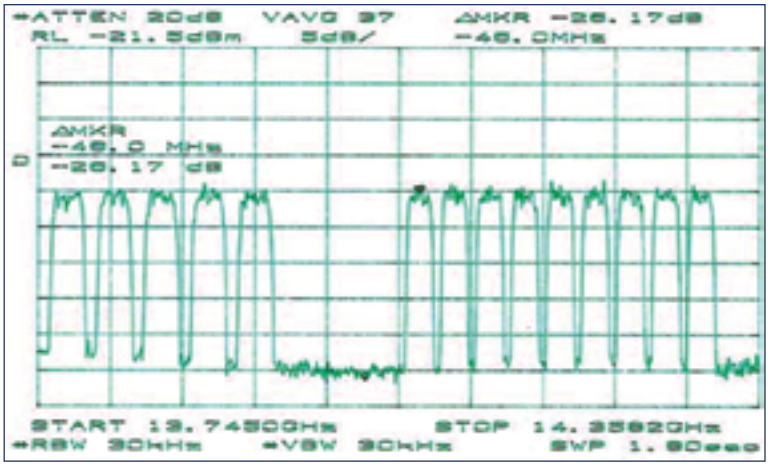

Figure 9. Real-life operating 2.4 KW Ku-band GaN SSPA, multicarrier mode, 6 dB back off

The next figure shows the performance of a 2.5 KW system in real-time operation. Although still run at 6 dB back off, the IM3 products are now cleared, or much improved, and in the noise floor.

IM3 products are better than those of single SSPA, as seen in *Figure 8*. The 3KW Ku-Band GaN system is now breaking any previous set limits and it can transmit a single carrier at 2 KW, no other TWT or Klystron is able to do that. The 50 year old debate of SSPA versus TWT is reaching a final conclusion.

Figure 10. 2.5 KW Ku-band SapphireBlu™ GaN SSPA

Today, GaN based SSPAs exceed—by far—their TWT/Klystron equivalents. They reach power levels with wide bandwidth that are not possible with any other technology. They manage that performance with higher efficiency and much greater reliability. This will be the equivalent of a 6 KW linearized TWT, if available A 6KW Klystron will not be adequate because it is bandwidth limited to 80 MHz only

To our knowledge, these TWTs are not available yet, which brings us to the final conclusion. It seems that finally now, the 50 years old debate, SSPA versus TWT, is reaching to its end. This is state of the art, superb technology and is the future for SATCOM needs, as well as being is the ground base for all new, exciting developments that are just around the corner.

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Leveraging The Latest Interference Mitigation Strategies

By Jeffrey Chu, President + Chief Executive Officer, Glowlink Communications Technology

The satellite communications industry continues to wrestle with the undesirable effects of intentional and unintentional interferences on communication signals. The latest strategies for interference mitigation involve new technologies and tools that satellite operators and their customers can use to deal with these effects.

Effective ways to deal with satellite interference largely fall into four main categories of strategy: monitoring and detection; geolocating the emitter; removing the interference; and prudent traffic planning. Individually, each of these four strategies may have limited utility against the effects of interference. Together, however, they form a powerful toolset that can minimize and even eliminate the adverse effects of interference, if not the interference itself. Details regarding these four categories follow.

Monitoring + Detection

The SATCOM provider needs to practice continuous cognizance of their carriers through rapidly updated performance and bandwidth availability in order to formulate pictures of the space resources they rely on to serve their customers. This can be accomplished by having a high quality carrier monitoring system that can automatically, or on-demand, scan the carriers/spectrum of interest.

Ideally, the monitoring system should provide as much visibility into spectrum activities as possible at any instant, while gathering specific spectrum performance parameters. To do this, the monitoring system must have a high instantaneous bandwidth (IBW). This will allow the system to rapidly capture a broad swath of spectrum (perhaps even an entire wideband Ka-band carrier). Moreover, interference can be resident adjacent to or buried deep inside a carrier, so it may not be noticed until it becomes a real problem. Imperative is that the monitoring system has high instantaneous dynamic range (typically provided by 14-bit A/D conversion). With a higher instantaneous dynamic range comes a greater capability to expose smaller but potentially troublesome interference signals—a high-quality carrier monitoring system must possess a wide IBW and a high A/D front end, preferably of at least 14-bit. Some systems on the market also have the ability to pick out Interference beneath the authorized carrier without turning off existing traffic—a helpful aid in analyzing the interference and characterizing the possible source without impacting on-going link traffic.

These systems, such as the Glowlink Model 1000 series of carrier monitoring products, possess all of these key attributes. In addition, a unique feature of the Model 1000 is that the product has the ability to assess, in real time, the state of health of a transponder without having to inject tones or measure satellite-transmit EIRP, a performance metric that can be difficult to measure accurately. This capability gives the operator the tool necessary to detect and potentially prevent a potential cause of IM type of interferences: an overloaded transponder.

Locating An Interfering Emitter

A tool able to locate a terrestrial cause of satellite interference, commonly referred to as geolocation, is a must have" element in the battle against communication intrusion. Such is of benefit whether the interference is caused by faulty equipment, unintentional bleed-over from another user, or an intentional interferer.

Traditional geolocation involves triangulation of the interference using two (or more) satellites in close proximity. However, there are two inherent limitations: (1) There may not be any suitable adjacent satellite because of incompatible frequency range or footprint coverage, etc.; (2) An existing carrier on the adjacent satellite is sufficiently strong enough to obstruct the interference's weaker replica on that satellite. Quite often, (1) and (2) are the root causes for a failed geolocation attempt.

Tools are now available on the market that can help alleviate these limitations. For example, the Glowlink Model 8000 geolocation system can be outfitted with the capability to perform geolocation using only the interfered-with satellite. This capability, marketed as SSG™, operates directly on the interference signal and does not require a second satellite to help locate the emitter. The technology also does not need reliance on databases of known interference emitters, or presumed known characteristics, such as interference Carries ID, should it have one.

Another interesting tool that can dramatically help with a successful geolocation is the Glowlink GS380L. Working in conjunction with the Model 8000, the GS380L can digitally remove the stronger carrier (without affecting the carrier itself) prior to geolocation, thereby removing the blocking signal and allowing geolocation of the interference signal to proceed.

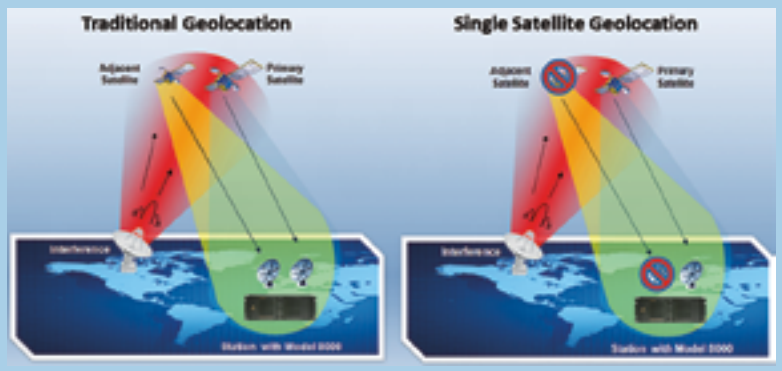
Together, these products and tools basically ensure geolocation can be run quite successfully.

Removing Interferences

While detection and location of interferences are useful strategies for situational-awareness, often the adverse effect of interferences remains, i.e., there remains interference with the customer's traffic.

In this case, the ultimate interference mitigation strategy is called for: removing the interference. This idea, while conceptually simple, can be extremely challenging to implement. Fortunately, there are now products on the market that make this strategy possible.

For example, the Glowlink Model GS380X is designed to remove the interference from a communications signal prior to that signal's demodulation.



Left: Traditional geolocation using satellite pairs to triangulate an interference emitter (e.g., using a Model 8000 Geolocation Systems). Right: Model 8000-SSG uses only the satellite being interfered with to geolocate, eliminating the problem of not having a usable adjacent satellite while performing geolocation.

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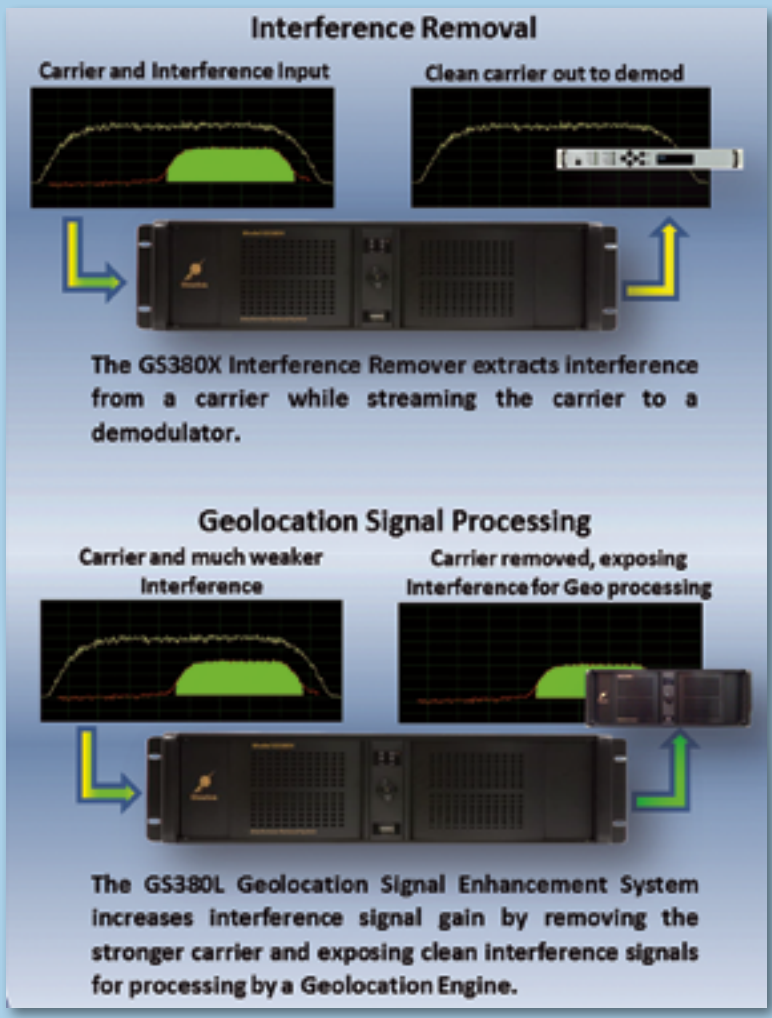


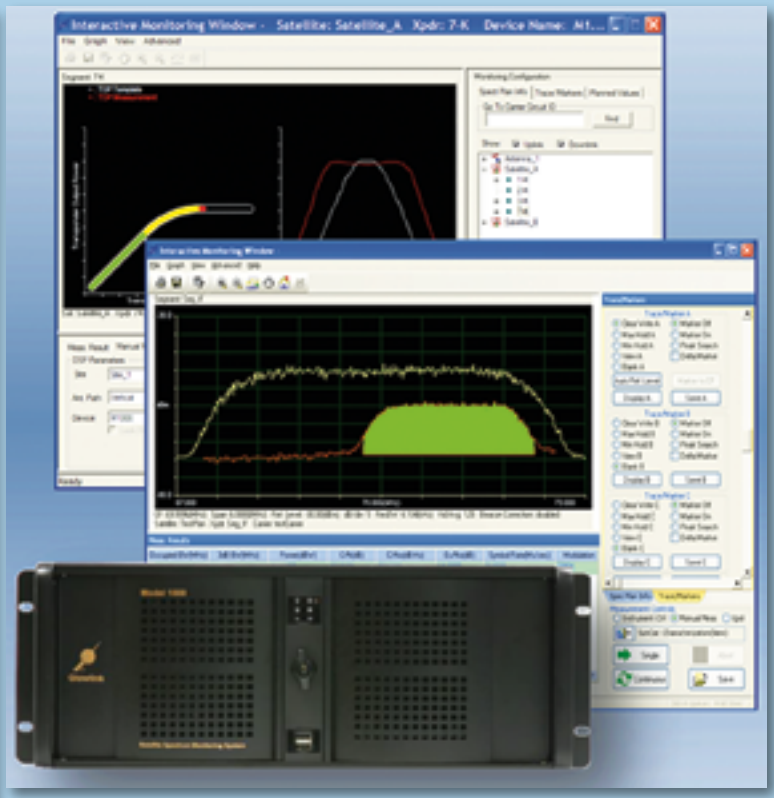
Based on the company's patented technology known as CSIR™, the GS380X is designed to remove the interference signal in a real-time streaming fashion. The original signal's quality is completely unaffected—and in many instances, actually improved slightly—prior to demodulation by the receiver.

By combining the GS380X with the previously described monitoring and geolocation tools, SATCOM providers and users can now reduce the undesirable effect of the interference on the received signal, while simultaneously carrying out the more time-consuming process of identifying and geolocating the signal.

Prudent Satellite Capacity Planning

As prevention is far more desirable than intervention, the ideal countering strategy is to avoid allowing interference to occur in the first place. One way to achieve this is—no surprise here—is through better frequency planning. Proper planning leads to more efficient use of satellite bandwidth as well as help to prevent the generation of interferences. This is especially crucial in mobile SATCOM services, such as airborne or maritime SATCOM, due to the dynamic nature of the underlying communications platforms.

A good capacity planning system can establish accurate predictions about how a bandwidth utilization plan will perform. When using it in conjunction with a high-quality carrier monitoring system, the operator can also make necessary adjustments by verifying the measured carrier operation against predicted performance. Doing this effectively requires the seamless integration of monitoring and planning tools.



Carrier monitoring systems, such as the Glowlink Model 1030, can highlight interference under carrier with 300 MHz IBW and high 14-bit A/D dynamic range. This system can also alert operators to an overloaded transponder, a potential source of IM-type interference. Image courtesy of Glowlink.

One example of such a combination is the Glowlink SAMS capacity planning product and the previously described Glowlink Model 1000 series carrier monitoring systems. SAMS is specifically designed to handle fixed as well as mobile satellite services.

As this combination of the two products ensure seamless integration, and also come from the same vendor, their users have the upper hand—avoiding the usual culpability arguments between planning tool and monitoring tool vendors, when planning predictions and monitoring results do not converge.

Removing The Vexation

While continuing to be a vexing problem for satellite communications providers and users, modern tools allow for the formulation of an overall strategy to deal with interference. The key is to be aware of important product attributes and performance drivers in order to make intelligent purchase decisions.

For additional product information regarding the above mentioned applications, please ***contact sales@glowlink.com***.

The Glowlink infosite is readily accessible at ***http://www.glowlink.com/.***

Jeffrey Chu is the co-Founder and President of Glowlink Communications Technology, Inc, a company that specializes in interference mitigation products and technologies that cover satellite and wireless communications. Jeffrey is a graduate of Harvey Mudd College and the Electrical Engineering and Computer Sciences (EECS) department at the University of California, Berkeley.

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Broadband Satellite Communications... Catching Up With 4G

By Dr. R. Gilmore, Chief Executive Officer, EM Solutions Pty Ltd.

Less than 20 years ago, broadband Internet to the home first became a reality, thanks to the introduction of DSL technologies that enabled twisted copper pair to carry traffic at speeds above 1Mb/sec.

Less than ten years ago, Internet access over a mobile phone became a relatively painless exercise. It is only today that 4G cellular networks and modern mobile phones are offering the same experience to the mobile user as is possible from wired or fiber connections in the home or office. Multimedia calls can be made to and from any country in the world, wherever appropriate 4G or WiFi infrastructure exists.

It is natural, then, to consider whether the user satellite communication (SATCOM) experience will ever be similar. Satellite "sleeves" are commercially available that transform an iPhone into a mobile satellite terminal. While these do offer true "use anywhere" experiences to a person in the two-thirds of the globe covered by the relevant satellite system, their data rates are measured in tens of kbits per second. However, broadband SATCOM requires higher frequency bands, and consequently antennas with higher directivity. This means that any sleeve would need to be repointed toward the satellite as it moves.

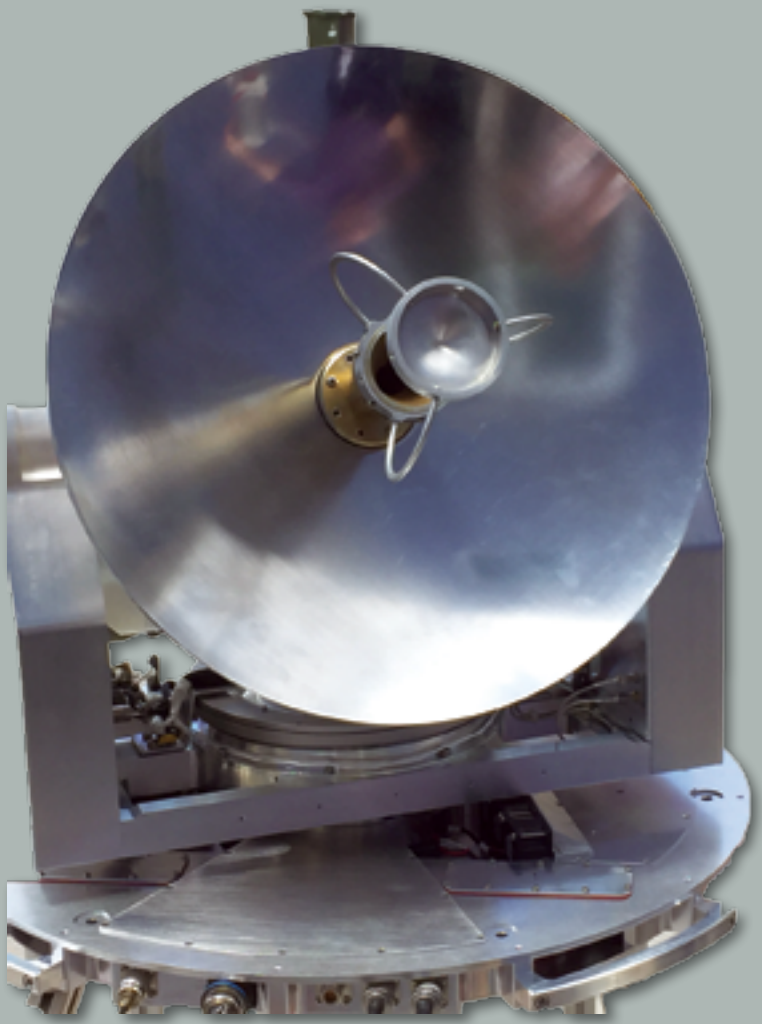

Figure 1. EM Solutions Ka-band militarized SATCOM-On-The-Move (SOTM) terminal with integrated closed-loop tracking.

For a mobile user, this requires constant adjustments to within a degree or two, either mechanically or electronically. As for automatically roaming between networks in the event of outages or lack of coverage? Not yet!

For a variety of reasons—not the least of which is the physics of limited signal/noise ratio—SATCOM can never match the multimedia experience offered to the mobile cellular user. Although SATCOM has one major advantage—fixed terrestrial infrastructure for backhaul to a central office is not required, so such services are available anywhere on Earth that the satellite beam covers—broadband roaming for a mobile satellite user still remains in the distance.

4G SATCOM Requirements: Bandwidth Anywhere On-The-Move

A core requirement for SATCOM to approach 4G in performance is to achieve robust, reliable, broadband communications under all common motion conditions, with assured availability and redundancy, even when one particular satellite is unavailable, for instance due to an outage, congestion, or weather-related fading.

The first of these requirements is to achieve a high data rate. Although this is now commonplace with a terminal in a single frequency band, this is not so easy as other requirements are added. For mission critical operation, a fixed frequency band may not always be available, due to congestion or environmental effects such as rain fade. All frequencies that support broadband requirements, such as X-, Ku-, and Ka-band, should ideally be available for use in these instances. This usually necessitates roaming between satellites and potentially different operators and requires more than a commercial consideration between different satellite operators—a multi-band terminal is also required.

A second requirement is support for mobility. In the higher frequency bands, which are most capable of supporting high data rates, antennas with reasonable gain will have narrow beamwidths and require pointing toward the satellite. Inaccurate pointing leads to loss in the link budget as well as poor performance and can result in unacceptable interference to users accessing other satellites. Off-road terrain, in particular, can be unique not only for violent motion, but also for susceptibility to path interference from overhead foliage or man-made structures. Recovery after such blocking is an important consideration.

A 4G cellphone user is rarely affected by either, as the lower frequency bands in which cellular systems operate do not require direct line of sight, and are able to achieve high data rates through clever re-use of frequency and multiple antennas that have relatively large beamwidths. Yet the same constraints pose serious challenges for SATCOM—any solution needs to acquire the correct satellite, remain pointing no mater the motion profile, and recover quickly from blockages, all with high gain, high directivity antennas. The system size, profile, and weight will also enter the design equation, given that the terminal may be used on a vehicle, plane, train, or ship.

Terminal Design

EM Solutions is making a start on its roadmap toward 4G-like SATCOM terminal performance capability. The company is currently developing a terminal capability that supports simultaneous military Ka-band and military X-band operation as well as automatic fallback to commercial Ka-band, all in a single terminal. Electronically switchable operation to Ku-band follows on the

product roadmap. This will go further to match the ability of current 4G phones to adjust their settings, including frequency, to those of the environment and available network.

The technology to electronically switch between X-, Ku-, and Ka-bands is complex in terms of antenna, feed, and electronics design, particularly to avoid a brute-force approach of just combining three parallel systems into a single system. Using a single parabolic reflector that provides high antenna gain across all frequency bands, we have developed a single X- and Ka-band feed, and a single X- and Ka-band solution for the BUC, still maintaining excellent phase noise and monopulse pointing for accuracy. The Ku-band feed that comes later on our roadmap will comprise a separate parallel structure that uses the same reflector and will be electronically switched in to the correct focal point on the reflector when that band is activated.

The terminal senses the signal to achieve the correct polarization, whatever the band, and points the terminal accurately, using closed-loop monopulse tracking of the satellite beacon to minimize the pointing error and maintain a lock on the satellite while on-the-move. Using a parabolic reflector maintains signal and also reduces the transmit sidelobe signal density to avoid interference with adjacent satellites, whatever the frequency.

We are achieving these features by modifying EM Solutions' existing Ka- and Ku-band on-the-move terminal designs (*Figures 1 + 2*) and adding the following capabilities:

Figure 2. Existing EM Solutions Ku-band SOTM terminals showing the parabolic reflector antenna and the monopulse feed.

- *A light-weight sub 1-meter antenna reflector and integrated waveguide feed capable of operating simultaneously at X-band, commercial Ka-band, and military Ka-band frequencies without physical intervention*
- *A diplexer structure to combine RF signals from a single X-band / Ka-multiband block up converter (BUC) and into multiple low noise block down-converters (LNBs) fitted to enable simultaneous transmission and instantaneous switching between any of the selected communications bands without manual intervention*

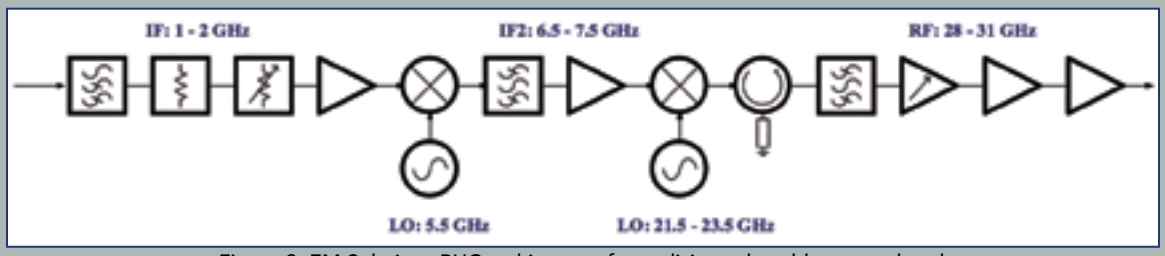

Figure 3. EM Solutions BUC architecture for realizing selectable output bands

- *Software to manage either manual or automatic fall-back to alternate bands, provide network element management functionality for plug and play capability, and to provide appropriate layer 2- and 3- functionality where necessary for self-healing*
- *Universal stabilization to the most severe motion conditions through a monopulse pointing technique, so the terminal can be used either on land or at sea*
- *Integrating all X-and Ka-band electronics within the radome, avoiding the need for expensive and lossy waveguide runs to external equipment racks*

An important design consideration is to achieve the simplest solution possible. Although three separate X-, Ku-, and Ka-band on-the-move terminals could conceivably be integrated into a single solution, this would be bulky, expensive, and prone to failure.

Creating a single X-/Ka-band feed, including monopulse pointing for closed-loop tracking of the terminal, is one example where clever design has enabled a simpler and more integrated system to be created within a single structure. A second example of innovation is in the RF transmitter (block upconverter) electronics. As a starting point, EM Solutions' current Ka-band BUC covers 28 to 31 GHz across military and commercial Ka-bands and remains small enough to qualify as an EM Solutions nanoBUC product.

Rather than being designed as a parallel combination of three traditional BUCs with heavy filtering and potentially in-band local oscillators operating at 27GHz, 28 GHz, and 29GHz respectively, the company adopted a dual conversion architecture in the design to achieve multi-band coverage. Dual up-conversion involves translating the input IF frequency from the modem to a secondary IF frequency before further up-converting the block of frequencies around the IF to the desired band.

The benefit of this approach at Ka-band is that the LO of the final mixer can be well separated in frequency from the desired RF signal, thereby allowing the output filter to operate over a 3 GHz bandwidth (at Ka-band) while still rejecting any leakage at the final LO frequency. With this architecture, there is only need for one Ka-band waveguide filter and no mechanical microwave switches, as would be required in a brute-force triple BUC combination.

There are three main concerns when implementing a dual stage up-converter: spurious signals, gain flatness and phase noise. The first of these can be overcome by careful frequency planning and filtering at appropriate stages; the second by maintaining excellent return loss throughout the various stages; and the third by careful design of the main frequency synthesizer to operate across a broad frequency range. This required the first LO to operate around 5.5 GHz and the final LO to operate around 22.5 GHz, as shown in *Figure 3* on the previous page.

Importantly in the current context, this BUC allows the X-band frequencies to be generated directly at the output of the first upconversion stage by appropriate tuning of the first LO and appropriate post-amplification. This means that a single BUC can be used to electronically switch between X- and Ka-band without adding unnecessary complexity, cost, and weight into the terminal. Coincidentally, it also parallels the approach taken in the design of current 4G mobile phones.

SATCOMs And 4G

Broadband on-the-move SATCOM terminals of the type described in this article are able to offer true mobility and high data throughputs to military users and first responders, even under the most demanding mobility requirements. Automatic switching between satellites and frequency bands is made possible by end-user equipment that can automatically detect loss of signal in the favored band, and respond by switching bands and satellites automatically and without user intervention if desired.

The system under development uses a single shaped parabolic reflector and horn with a combined waveguide feed for both transmit and receive signals at both X-band and multiple Ka-bands, to automatically switch between bands depending on prevailing conditions. Compared with the current class of existing terminals, the benefits of this terminal will include:

- *Fully transportable and operational on-the-move capability with unparalleled satellite tracking capability in three bands across all ranges and types of motion (land, sea, air)*
- *Support for broadband communications (data rates up to several Mbps) without using excessive satellite transponder resources consumed by a very small terminal, but with the option to reduce footprint and weight if necessary by changing reflector size*
- *Fall-back to a fully integrated commercial capacity (with built-in modem) in the event of failure or congestion of the primary network*
- *Network survivability with assured communications in a contested environment*
- *Rapid and automatic self-healing in the event of rain fade or other link outage*
- *Configurability for a range of platforms to suit either a small or medium vehicle or vessel, with simplified field repair and cost optimization*

Although such a system is still a long way from a hand-held 4G cellphone because of its weight and size, please recall the size and weight of the first mobile phones 30 years ago. EM Solutions and others in the industry are developing new antenna and system technologies that share many of the communications' features offered by a 4G phone and they will help pave the way for increased uptake of SATCOM.

Editor's Note: "*EM Solutions wishes to acknowledge that the research and development of the heat exchanger and EMI/EMC technology of the terminal in Figure 1 were funded through a project supported by NICT Japan.*"

Additional information regarding EM Solutions may be viewed at
http://www.emsolutions.com.au/

Rowan Gilmore is CEO of EM Solutions Pty Ltd, an Australian designer and manufacturer of advanced microwave modules and systems for satellite and wireless broadband communications networks.

He has worked extensively in the ICT industry, and was formerly based in Sydney, Atlanta, London and finally Geneva as Vice President of Network Services (Europe) for the airline IT company SITA, now France Telecom's Orange subsidiary. He was previously Manager of Advanced Global Networks in Telstra's International Business Unit. Prior roles have been with Schlumberger as both a General Field Engineer on various assignments throughout Asia, and as an R&D Manager in Houston, Texas.

He is an engineering graduate and winner of the University Medal from the University of Queensland, and earned his Doctor of Science degree from Washington University in St. Louis in the U.S. He currently holds Adjunct Professorships in both the School of Business and the School of Information Technology and Electrical Engineering at the University of Queensland, Australia.

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Hacking Satellites— The New Frontier In Security Breaches

By Conrad Smith, Chief Technical Officer, SRT Wireless

Last month, the NBC drama *State of Affairs* featured a disgruntled former U.S. government agent who hacks into a government satellite system to view video that discloses real-time information about enemy combatants.

While this was a fictional plot point in a prime-time television program, its depiction in pop culture highlights the pubic conversation surrounding the current state of satellite cybersecurity, and the growing threat of satellite breaches.

Corporate hacking went mainstream in 2013, with high-profile breaches of companies such as Target and JPMorgan Chase. 2014 also witnessed Sony getting hacked, allegedly by agents of the North Korean government. While the full economic fall-out of the Sony attack is still being felt, Sony Pictures Co-Chair Amy Pascal resigned last month in the wake of the embarrassing and insensitive emails stolen and made public following that attack.

Already in 2015, January saw the hacking of YouTube and Twitter accounts belonging to CENTCOM, which oversees U.S. military forces in the Middle East. And in February, U.S. health insurer Anthem disclosed that it was the victim of a hack that compromised the personal and medical information of as many as 80 million people, exposing them to hugely expensive identity theft and medical fraud.

This has led to a new presidential executive order regarding the sharing of cybersecurity threats and information, cementing into place the role of the Department of Homeland Security (DHS) as the government lead for information sharing with the private sector.

This unprecedented uptick in publicized attacks, over the last few years, demonstrates not only the increased number and complexity of attacks, but also the alarming vulnerability of data held by corporations and governments.

Satellite hacking of terminal devices represents the next frontier of these ever-growing and more sophisticated breaches, and the consequences of satellite hacks extend far beyond financial damage to the companies involved. Given the integral role satellites play across a range of economic sectors, successful breaches could wreak havoc in areas that range from terrestrial communications to military operations, from oil and gas pipelines, to financial markets and more.

Advances in satellite communications technology have brought us a more interconnected world—from television and radio broadcasts to GPS mapping; from more efficient stock exchanges to safer supply chains. However, cybersecurity safeguards have not kept up with cyber threats, and the ubiquity of satellite communications means increased vulnerability to potentially devastating attacks.

Known Satellite Breaches

U.S. military satellites have been subjected to hostile jamming attacks since at least 2006. In testimony that year before the House Armed Services Committee's Subcommittee on Strategic Forces, then-Lieutenant General Robert Kehler (USAF, ret.) noted that an analysis of commercial SATCOM links over a 16-month period during Operation Iraqi Freedom found 50 separate instances of interference with military communications over commercial satcom channels. Of those incidents, five (or 10 percent of the total) were attributed to hostile jamming sources.[i]

In 2007, independent rebels affiliated with the Tamil Tigers in Sri Lanka successfully accessed the communications channel of a U.S.-made Intelsat satellite and used it to distribute propaganda via international television and radio broadcasts.[ii] Also in 2007, hackers gained control of the NASA Terra EOS Earth Observation system satellite for several minutes in June and again that October. Likewise, two separate attacks resulted in hostile control of the Landsat-7 satellite for short periods of time in 2007 and 2008.[iii]

Governmental Attacks—The NOAA Satellite Hack

Among recent breaches, *The Washington Post* reported last November that hackers based in China successfully breached weather satellites belonging to the National Oceanic and Atmospheric Administration (NOAA), which includes the National Weather Service.[iv] The breach resulted in NOAA's primary forecasting satellites being off-line for 12 hours.

While the problem was quickly resolved, this hacking event demonstrated the vulnerability of U.S. government satellites not only to hacking, but to hacking by foreign agents. Far from being innocuous, the National Weather Service satellites provide information that is critical for U.S. farming and transportation interests and for natural disaster planning, to name only a few.

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Weather satellites are, therefore, a key component of critical infrastructure—they provide environmental intelligence that alerts the public about disasters such as hurricanes and tornadoes days before they occur. For example, the National Weather Service satellites provided key intelligence that led to the early warning and evacuation notices prior to landfall of Superstorm Sandy. Even with those early warnings, Sandy caused an estimated $50 billion in damage when it hit the northeast region of the U.S. in 2012. With less notice, the economic damage would have been far higher.

Cybersecurity Report Sounds The Alarm

Last spring, cybersecurity advisory firm IOActive released a report detailing multiple vulnerabilities in a wide range of commercial and military satellite communications systems.[v] These vulnerabilities include digital backdoors built into computer codes, hard-coded credentials that allow easy access to devices, insecure language protocols, and weak encryption of communications channels. The firm found that these vulnerabilities could allow hackers to intercept, manipulate, or block satellite communications.

"If one of these devices is compromised, the entire satellite communications infrastructure could be at risk," the report said. "Ships, aircraft, military personnel, emergency services, and industrial facilities, which include oil rigs, water treatment plants and gas pipelines, could be affected."[vi]

Vulnerabilities

Vulnerable Software

While kinetic dangers (i.e., being hit and/or damaged by stray objects such as meteorites or other satellites) remain rare, satellite systems are remarkably vulnerable to a range of cybersecurity issues and hostile attacks because they are hugely complex and expensive, take months to deploy, and the primary emphasis is on getting a working system that meets specification and the contract deliverables.

Most cyber exploit attacks take advantage of incomplete code that does not boundary check incoming data allowing for stack buffer overflow attacks. These are very prominent in embedded C and C++ systems and require an additional vulnerability assessment exercise, at great cost and time, in order to fully secure a system. In these cases an internal buffer may be overrun by an intentionally 'malformed' packet and code execution achieved by overwriting the area of memory where the return address resides. Once basic code execution is achieved, new threads and processes may be started and most, if not all, facilities within the system can be accessed.

Encryption

Encryption primarily ensures that the traffic through a satellite system cannot be overheard. For the most secure environments, the encryption is achieved outside of the actual satellite channels. Where encryption has been used on the satellite channels there are some examples where that encryption is so weak that it as been easily exploited.

Hard-coded Credentials And/Or Backdoors

Hard-coded credentials function as cybersecurity master keys, common back doors that allow service technicians to access multiple pieces of equipment with the same log-in credential and password.

Insecure Protocols

Weak system protocols could allow malicious actors access to satcom channels. Although, in most cases, care has been taken regarding the security of the protocol being used, there is invariable weakness that can be exploited.

Common Types Of Hacks

Further, due to their complexity, satellites and SATCOM systems are vulnerable to a range of hacks:

Denial of Service

A denial of service attack can occur in a number of ways, including 'bricking' the device, selective denial, denial based on position etc. These are the easiest hacks as most software vulnerabilities crash the device when exploited without too much trouble. In fact, it is the device crashing when 'fuzzing' a device that signals a vulnerability has been discovered.

Monitoring

Breaching a satellite's communications channels enables hackers to access transmitted data due to the lack of sufficient encryption. In fact, a number of decryption packages that facilitate this illicit access are widely available for sale commercially, coming out of countries such as Russia, Israel and countries in the E.U.

NAT Pass-Through

Satellite modems generally are IP routers providing connectivity to various IT infrastructure on the LAN side of the terminal. With the built-in firewalls and NAT, there is protection in place to stop unauthorized access to the LAN side. However, once code execution is achieved on the terminal, these protections can be turned off and the NAT can by punched-through by outsiders, giving access to the LAN.

User Specific Data

All sorts of User specific data can be collected and sent back at the attackers' convenience. This includes user logs, network credentials, connected nodes etc.

Mission-Critical Attention

SR Technologies was founded in 1999 to take advantage of the coming convergence of cellular, satellite communications and WiFi technologies foreseen by the company's founder, SRT Group chief executive Rick Lund. SR Technologies' original purpose was to deliver best-in-class satellite communications for mission-critical government applications and its products and services continue to support the most demanding government missions in the harshest environments worldwide.

Over the last 16 years, however, SR Technologies has evolved into the SRT Group of companies, with separate divisions for government, law enforcement, commercial, and aviation customers. Today, SRT Group collectively provides mission-critical satellite, WiFi and aviation technologies to major government, business, and non-governmental customers, domestic and international.

In partnership with the Thuraya Telecommunications Company, SRT Wireless developed the VIPturbo, a compact, single-board modem that operates as a software-defined radio (SDR) for advanced SATCOM. With versatile functionality across Thuraya's network and the ability to be modified to support additional waveforms, the VIPturbo's integrated WiFi enables users to connect and communicate via their own tablets and smartphones even in the most desolate and inaccessible locations.

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This year, SRT is launching a next-generation satellite modem, the Afterburner. While the VIPturbo's dimensions are equivalent to that of a paperback book, the Afterburner measures just 2 x 4-inches, the size of a business card. Furthermore, Afterburner requires 50 percent less power, enabling the modem to outperform competing products in weight, size, price and performance. Representing the latest evolution in SATCOM technologies, the new Afterburner satellite mode will inspire new inventive and affordable uses for satellite communications.

Cyber Hardening

Having discussed many of the vulnerabilities facing satellite and satcom channels today, we now turn our attention towards solutions—the steps that corporations, government agencies, satellite manufacturers and SATCOM vendors can and/or should take to protect their systems against cyber-attacks. There are various levels and barriers that can be put in place that continually raise the bar to make the system harder to exploit.

Vulnerability Testing

At SRT, cyber-hardening is incorporated into the design of product as a matter of course. Prior to deployment, VIPturbo and Afterburner modems are run through a series of vulnerability assessments and stress tests, in addition to the standard QA process. These tests identify, isolate, and resolve any software vulnerabilities or left over 'debug' mechanisms that could be exploited.

Encryption + Authentication

Operations and certain code execution cannot be performed until proper authentication and encryption and been achieved. Additionally, ensuring continued authentication and encryption goes a long way to securing the system.

Filesystem Verification

Much can be done to ensure only validated executable code is actually executed. For example, filesystems are validated on boot using dedicated hardware within the CPU. This then mitigates any permanent cyber exploit that would survive a reboot. In the latest SRT Platform, the TI OMAP secure boot and secure environment features are used to ensure the integrity of the executed code and filesystem.

SRT is confident that the safest cyber-hardened satellite communication channels available are delivered, products that can withstand cyberattacks using the latest technologies.

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Conrad Smith is the Chief Technology Officer of SRT Wireless. He joined SR Technologies, a forerunner of SRT Wireless, in 2004 and is responsible for all major architectural and design decisions as well as providing technical leadership to SRT's Wireless' engineering, software design and product development teams. He holds a Bachelor of Engineering with Honors in Electronic Engineering from the University of Hertfordshire in England.

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SatBroadcasting™: Satellite Signal Simulation Via Multichannel Signal Generation

By Peter Lampel, Product Manager, Digital Video Test Equipment, Rohde & Schwarz + Seann Hamer, Vice President, Communication Products, SED Systems

The satellite industry is undergoing a significant transition. Carrier bandwidths are increasing and signals are being placed more closely together than ever before. Most importantly, the technology used to process these signals on the receive side is changing dramatically with the use of digital sampling and Full Band Capture (FBC) techniques.

This is forcing people to rethink their product test and validation strategies. What's required to address these new requirements is a sophisticated and flexible test solution that can quickly and easily generate complete multichannel lineups with a myriad of different signal configurations and impairments.

Why Is Multichannel Signal Generation Important?

The traditional receive signal process is based on analog signal processing techniques that include single channel super heterodyne frequency conversion. In this scenario, single channel RF loading over the design dynamic range was sufficient and valid for testing.

The latest LNBF and set top box (STB) front end processors are now based on wideband digital sampling, where the entire spectrum of interest is digitized with a high sample rate analog to digital converter (ADC) and is fully processed in the digital domain. In order to fully and thoroughly assess performance with this type of technology, the units under test need to be loaded with a full spectrum of signals so that they can be tested over a much wider range of signal loading scenarios.

Until now, two different approaches have been available, each with specific technical or economic drawbacks. One approach is to use a large number of L-band satellite modulators and aggregate their output signals. Such a setup is expensive, complicated to configure and calibrate, and very infrastructure demanding (space, cabling, power and HVAC).

Alternatively, an arbitrary waveform generator with sufficient bandwidth can be used. However, it is not an easy task to generate a suitable I/Q waveform file library to cover the required test scenarios.

Furthermore, this solution is inflexible and slow, as any new configuration requires the creation and loading of a new file. Most importantly, though, it cannot support the real-time generation of an RF carrier containing pseudo random data or a specific bit stream such as an MPEG transport stream consisting of digital video.

Figure 1. R&S®SLG, the compact multichannel signal generator for satellite TV.

The new R&S®SLG satellite load generator (***Figure 1***) provides the complete solution to all of these challenges. SLG is a multichannel signal generator for satellite applications. Up to 32 DVB-S/S2 or ISDB-S/S2 carriers can be generated simultaneously with per carrier control of symbol rate, FEC, rolloff, frequency, and level (***Figure 2***).

Symbol rates from 100Ksps up to 416Msps are supported and present is the capability to generate real-time modulated signals with either internally provided PN data or external data.

SLG supports arbitrary waveform generation from files provided with the unit or waveform files generated by the end user and also offers a significant range of signal impairments, such as phase noise and Gaussian noise enabling users to accurately simulate real world conditions. SLG provides a sophisticated GUI interface complete with factory preset and user definable configuration files and set up wizards enabling users to rapidly establish and modify operational configurations.

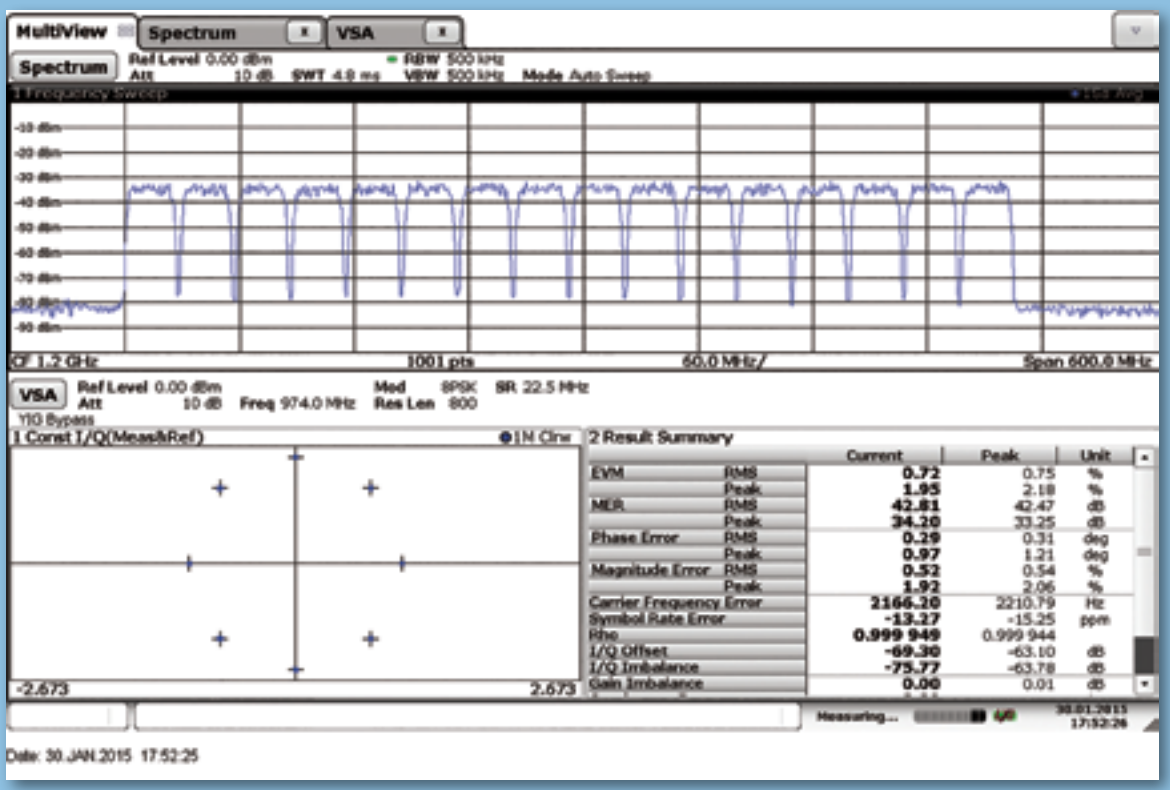

Figure 2. R&S®SLG output signal: US BSS ITU Region 2 Channel Configuration

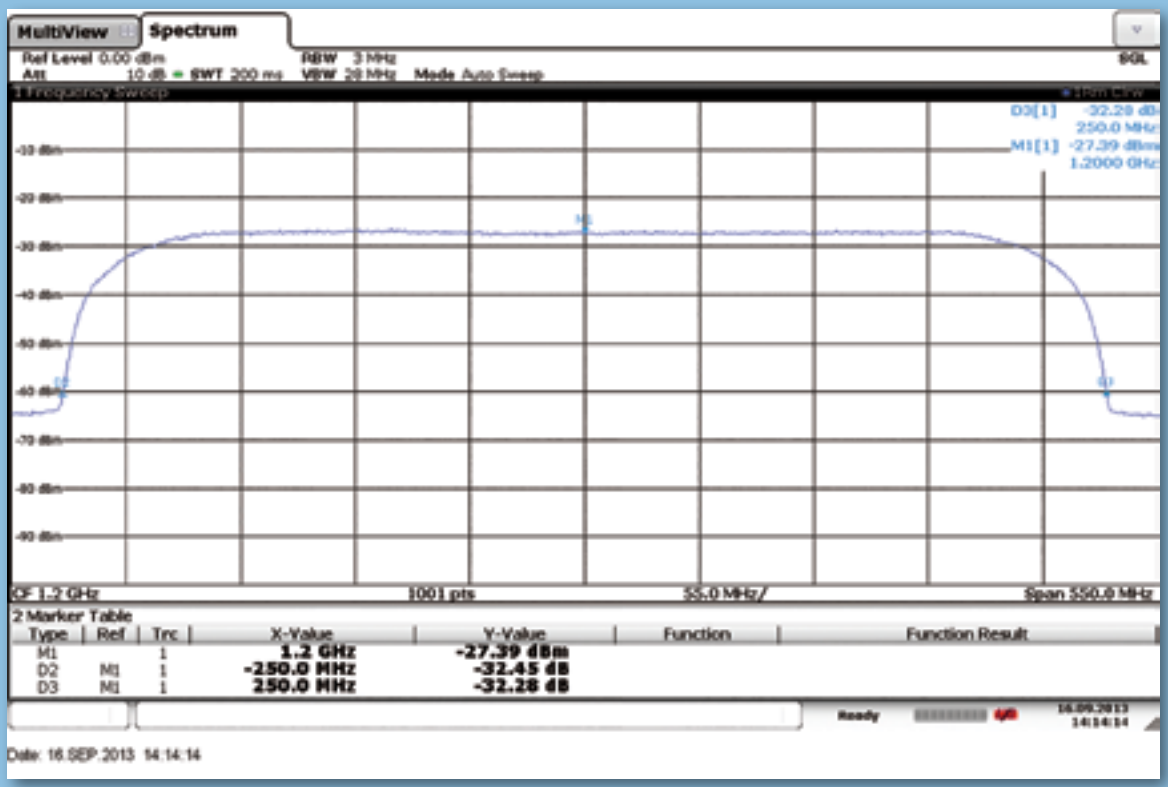

Figure 3. Transponder for DVB-S2 wideband with 416 Msymbol/s.

These test configurations can be set up on the SLG in minutes, rather than the hours it would take to set up conventional test systems. SLG also supports comprehensive SNMP and SCPI interfaces enabling easy interconnection with automated test systems.

SLG is based on the latest direct digital synthesis technology ensuring RF performance suitable for satellite uplinks. This means that SLG has the RF fidelity to be used for test and validation of satellite uplink components such as block upconverters and amplifiers as well as satellite payload components themselves.

Detailed technical information on SLG can be found at:
http://www.rohde-schwarz.com/en/product/slg

Not Just About RF

While SLG provides outstanding RF performance, much more is offered than that. With the capability to provide a wide range of different signal types with real-time encoding/modulation engines and external data inputs, SLG is ideal for testing and validating conditional access software, STB middleware, and headend transcoders.

SLG can also be used to model real-world environments providing valuable information about signal performance and real-time data integrity under a wide range of conditions.

An Investment For The Future

SLG is based on the latest digital signal processing techniques and programmable firmware technologies. All software and logic can be upgraded via a simple license key or user friendly software update.

The re-programmable nature of the SLG makes it ideal for supporting custom protocols if required, adding new functionality or evolving to support new standards such as DVB-S2X. This flexibility combined with the existing support for wideband operation (DVB-S2 wideband carriers up to 500MHz), wide frequency range (250MHz to 3GHz) and, multi-protocol support (DVB-S/S2 and ISDB-S/S2) ensures that the SLG is a sound investment and one you can count on to be a key component of your test and simulation infrastructure for years to come.

Rohde & Schwarz has developed the R&S SLG Satellite Load Generator in close cooperation with SED Systems of Canada. The R&S®SLG is using SED Systems' industry leading multi-channel satellite modulator technology.

The SED Systems of Canada infosite is located at ***http://www.sedsystems.ca/***

High Power Amplifier Selection For Satellite Uplinks: A CPI Technology Focus

As significant improvements continue to be achieved in high-power amplifier design, many claims are being made regarding the capabilities of each type of amplifier technology used in satellite uplink applications.

Many companies will extol the virtues of the amplifier technology they offer, while playing down the strengths of technologies they do not offer. SSPA manufacturers historically have been the boldest practitioners of this strategy, often making lofty predictions about how their products will kill off TWTAs, KPAs, or both. For example, in 2011, one manufacturer excoriated those who "clung" to the "energy-draining tube technology of the past." In another advertisement from 2007, a manufacturer boldly announced a new line of "TWTA Killers," claiming reliability, efficiency and linearity advantages over TWTAs. Industry pundits even wrote articles in the late 1980s that claimed the end of the klystron amplifier within five years. Today, we all know these claims are far from the truth.

TWT technology continues to be a key player in the industry, on the ground and in space, primarily because the technology has evolved and improved steadily over the years. Solid state technology has also made significant improvements. Low power (i.e., up to 200 W Psat) applications have largely become the territory of solid state.

In today's market, "The Next Big Thing" is Gallium Nitride (GaN)-based solid state amplifiers which, like their Gallium Arsenide (GaAs)-based predecessors once did, present a new and interesting question in respect to their position against TWTAs and KPAs.

This article examines the relative merits of GaN versus tube technology, assesses recent claims made extolling GaN technology, compares technologies on a "like-for-like" basis, and draws conclusions about the most appropriate applications for each technology. Communications and Power Industries LLC (CPI) is uniquely qualified to provide this assessment, as we design and manufacture both solid-state and tube-based amplifiers, including GaN SSPAs, GaAs SSPAs, TWTAs and KPAs. To assist users in making an informed decision when evaluating amplifier technology, a balanced view will be provided for selecting the best amplifier technology for a specific application.

What Is GaN?

Solid State amplifiers use a series of combined Field Effect Transmitters (FETs) to amplify signals. These FETs are made of Gallium Arsenide or Gallium Nitride, which are compound semiconductors that together produce a covalent bond of eight electrons, yielding a large band-gap and high electron mobility.

GaN FETs first gained popularity in the early 2000s with the U.S. military for use in electronic warfare and radar applications. GaN technology is capable of achieving up to five times the amount of power of GaAs technology over the same bandwidth, necessitating less power less power combining and resulting in greater efficiency. GaN FETs are also capable of transmitting signals in all of the current and planned satellite frequency ranges. The result is an SSPA that is capable of more raw output power than one using GaAs FETs, which also makes more efficient use of prime power.

GaN SSPAs are inherently more reliable when they are used in exactly the same way as GaAs SSPAs. However, most GaN SSPA manufacturers have decided, instead, to produce smaller amplifier packages which typically have similar thermal margins to GaAs SSPAs. Thus, in practice, GaN SSPA reliability is approximately the same as that for GaAs versions.

What Advances Have TWTAs Made?

TWTAs have advanced considerably since they were first used for satellite communication uplinks 40 years ago. Ground-based TWTs originally used a single collector, necessitating amplifier packages that were large and relatively inefficient. The introduction of linearizers doubled the operational prime power efficiency by increasing the permissible RF operating point. Now, linearizers are relatively small and integrated into the amplifier enclosure. When multi-stage collector TWTs were introduced, this development almost tripled prime power efficiency. Today, all TWTs used in satellite communications have multi-stage collectors, resulting in more efficient and smaller amplifiers.

CPI has made notable contributions to the evolution of TWTAs in recent years. One such significant advancement is CPI's SuperLinear® TWTAs, which have nearly doubled efficiency again, keeping this class of amplifiers well ahead of other technologies. CPI also recently introduced technology called LifeExtender™ that considerably prolongs the TWT cathode life, significantly reducing maintenance costs.

When evaluating whether to use a TWTA or an SSPA, customers should exercise caution in reviewing marketing materials, as many SSPA manufacturers typically base their power-consumption, size and weight comparisons on older types of TWTAs. In doing so, they can overstate the attributes of their own products and unfairly denigrate the customer's other potential options. This trick can mislead users as it does not provide a valid like-for-like comparison of what is readily available today from all amplifier technologies.

Klystron Power Amplifiers—Who Uses Them?

KPAs are a good choice for a single transponder, dedicated uplink application where link availability is of utmost importance. Some of the most popular applications for KPAs today are fixed broadcast and Direct-To-Home (DTH) television. These applications demand the ability to transmit at high power when necessary in order to overcome temporary high-environmental RF losses, such as rain fade.

KPAs are narrow bandwidth devices (usually less than 100 MHz) with multiple channels to enhance flexibility. Today, klystrons generally utilize multi-stage collectors for maximum efficiency. They can also operate at reduced beam voltage so that prime power is conserved during lower RF power operation, but remain ready to ramp up when higher RF power is required. Klystrons are generally regarded as the "workhorse of the industry" with MTBFs in the 200,000 hour range.

Getting Started: Operational Considerations + The Link Budget

Several factors regarding amplifier selection can come into consideration during the system design phase. For example, whether the operating environment is benign or hostile; what type of bandwidth the application requires; what the cost of ownership is; what the operations and maintenance requirements are; and, most importantly, how much linear power is required to close the link.

Achieving the required radiated RF power is usually a trade off between antenna size and amplifier power capability. In most situations, more flexibility is afforded to the amplifier than the antenna, e.g., if more power is needed, it is usually cheaper to buy a more powerful amplifier than a larger antenna. If the amplifiers need to be sheltered due to a suboptimal climate or if outdoor maintenance is difficult, additional power will be required from the amplifiers to overcome inter-facility link (IFL) losses that occur between the shelter and the antenna. After these factors are considered, then customers can begin to make a comparison among suitable amplifier technologies.

Linear Power

Once the general properties of the amplifier have been established, the required linear power must be determined and compared to what is available from the various types of technologies. There are generally three possible methods for defining linear power: 1) Spectral Regrowth (SR) for single carrier operation, 2) Third-order Intermodulation Products (IM3) (for two to five carriers, typically), and, 3) Noise Power Ratio (NPR) for multi-carrier and high-order modulation operation (more than five carriers typically). These different definitions need to be further refined depending on the type of modulation used and where and how the intermodulation products are measured. Following is an example of each:

1) Spectral Regrowth

The graph in *Figure 1* illustrates a typical Spectral Regrowth test for a linearized 700 W C-Band TWTA with QPSK modulation. In this case, spectral regrowth was measured at 2 dB OBO or 55.8 dBm HPA flange (380 W) at 1 symbol rate offset. Spectral regrowth is a figure of merit when determining the amount of modulation induced distortion products. The graph indicates how the modulation affects or interferes with signals in the adjacent bands.

Spectral regrowth is the most frequently used method for specifying linear power in military communications. Some military applications will also specify IM3 two-tone intermodulation products.

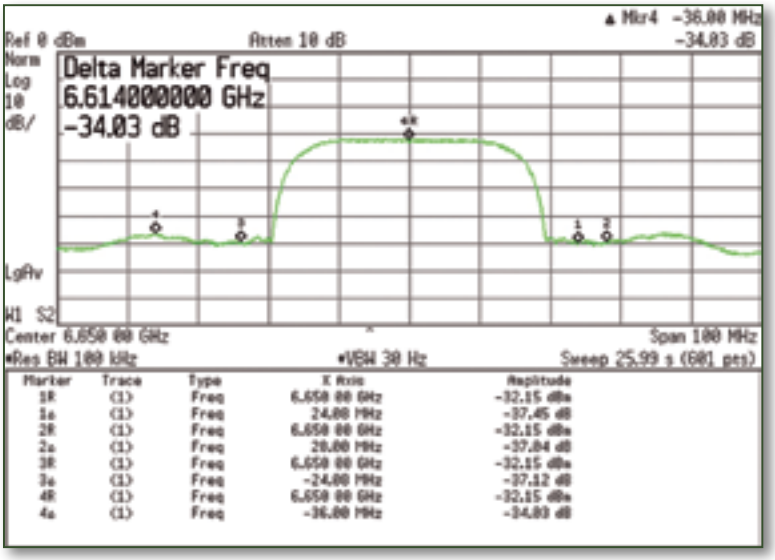

Figure 1: Spectral Regrowth

2) IM3 Two-tone Intermodulation Products

The IM3 Intermodulation Products specification is one of the most common specifications used to define an amplifier's linear power. Unfortunately, it is also quite common that amplifier data sheets are vague or misleading in providing this information. Customers should exercise extreme care to determine whether the IM3 level provided in the data sheet is for the sum of two equal carriers or for the individual single carrier level of two equal carriers. The former method is typically used in military satellite communications, while the latter is used in most commercial applications. Often the data sheet will not necessarily make this distinction. Some examples of vague or misleading IM3 specifications in data sheets are:

- ***"-25 dBc two signal 5 MHz apart at P(linear) relative to total power"***
- ***"-25 dBc two tone 5 MHz spacing at P(linear)"***
- ***"-17 dBc @4 dB total output power backoff from rated power with two equal carriers"***

None of these examples specifically state whether the specification is with regard to the sum of the two equal carriers or whether it is with regard to the single carrier level, which either improves the IM3 level by a full 3 dB, or allows for a 1.5 dB increase in linear power. In such cases it is necessary to contact the manufacturer to determine how the IM3 is specified before a like-for-like comparison of amplifiers can be made.

For the purposes of this article, IM3 has been specified with regard to the single individual carrier level of two equal carriers, spaced 5 MHz apart. Following is an example of the CPI TouchPower™ 750 W Ku-band TWTA (665 W flange power, or 58.25 dBm). The amplifier is equipped with a linearizer. At 3 dB backoff, the IM3 products are generally far lower than -25 dBc, which is the typical commercial standard of the industry.

		IM3 - two tone		
P out (dBm)	P out (watts)	@12.75 GHz (dBc)	@13.625 GHz (dBc)	@14.5 GHz (dBc)
55.25	335	-27.4	-34.3	-29.3
54.25	266	-28.8	-36.3	-32.1
53.25	211	-27.7	-35.8	-28.3
52.25	168	-27.4	-35.5	-27.7
51.25	133	-28	-32.7	-29
50.25	106	-29.3	-31.3	-31.5
49.25	84	-31.3	-31.1	-33
48.25	67	-33.5	-32	-32.8
47.25	53	-35.6	-33.9	-32.6
46.25	42	-38.1	-36	-33.5

Table 1.
IM3 When Measured at Varying Power Levels and Frequencies

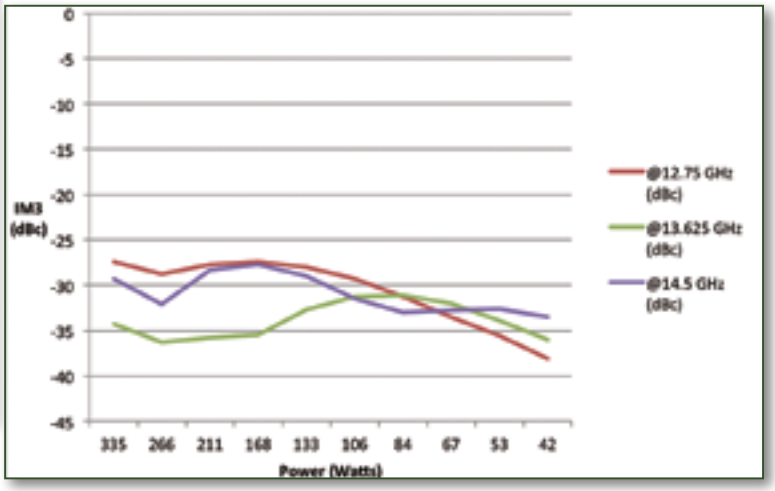

Figure 2. Comparison of IM3 at Various Frequencies

It is worth noting that the IM3 products improve when the amplifier bandwidth narrows as well as when RF output power is lowered. For example, an amplifier operating from 5.850 to 6.425 GHz will tend to have better IM3 performance than one operating from 5.850 to 7.075 GHz. This difference in performance is often not mentioned when a data sheet specifies a family of amplifiers.

3) Noise Power Ratio

Noise Power Ratio (NPR) is the figure of merit when determining the performance of an amplifier when it is transmitting many carriers (more than two), which can often be the case in satellite communications. The ratio consists of power density (signal + intermodulation distortion)/intermodulation distortion power density or (C+I)/I. In layman's terms, NPR could be considered the "quietness" of an unused channel when nearby channels are transmitting. The transmitting channels' effect on the unused channel is what is being measured.

The intricate setup and equipment to measure NPR is quite expensive, and some manufacturers may not have the ability in-house to perform this measurement.

Efficiency + Operating Costs

Once the operating parameters (including required linear power) of a customer's amplifier have been determined, a like-for-like comparison between amplifier technologies can begin to be made. Most operators will be interested in operating costs, size and weight, along with capital cost, reliability and serviceability. One of the critical elements of any amplifier is its efficiency, which always manifests itself in prime power consumption and heat generation, both of which affect the weight and size of an amplifier.

Comparisons of efficiency have always been made between KPAs, TWTAs and SSPAs. The "winner" depends on the required RF linear power level. With the advent of GaN technology, SSPAs are a good choice at higher power levels than can be practically achieved by GaAs SSPAs. However, TWTAs remain far more efficient than SSPAs at medium and higher power levels.

The following is a comparison of Ku-band amplifiers at various linear operating power levels. The more efficient amplifiers offer less weight and a smaller size, and cost less to operate. Prime power cost estimates are based on 24/7 operation annually, at $0.25 per kilowatt hour.

Ku-Band ODUs	200 W TWTA, no lin	80 W GaN SSPA	200 W TWTA w/ lin	200 W GaN SSPA	400 W SL TWTA w/lin	400 W GaN SSPA
Linear Power	35 W	36 W	70 W	80 W	160 W	160 W
Weight lbs/kg	25/11.4	15/7.2	25/11.4	48/22	32/15	119/54
Annual Prime Power Expense	$1424	$986	$1424	$2081	$1752	$5256

Table 2. Ku-Band TWTA + GaN Amplifier Comparison

When operating at 35 watts of linear power, the GaN SSPA is clearly a good choice. The TWTA costs nearly 50 percent more to operate and is significantly heavier.

In contrast, at 70 to 80 W of linear power, the results tilt significantly in favor of the TWTA. When it comes to higher power levels, the TWTA is obviously the best choice. Here the combining losses of the FETs in the SSPA, even though it is a GaN-based amplifier, are simply too much to be a rational choice for almost any user.

C-Band IDUs	400 W TWTA, no lin	200 W GaN SSPA	400 W TWTA w/ lin	400 W GaN SSPA	750 W TWTA w/lin	650 W GaN SSPA
Linear Power	90 W	80 W	175 W	160 W	325 W	325 W
Annual Prime Power Expense	$2847	$1259	$2847	$3285	$3746	$6132

Table 3:
C-Band TWTA + GaN Amplifier Comparison

For C-band amplifiers, SSPAs are a good choice at higher power levels than in Ku-band, as shown in *Table 3*, above.

In this case, GaN SSPAs appear to be a good choice under 100 W of linear power. However, when operating at a linear power greater than 100 W, the TWTA becomes the more operating-cost-efficient option. As the power level increases, the TWTA solution becomes more and more compelling.
If the amplifier is to be installed in an enclosed space, such as a room or shelter, the necessity of air conditioning also adds another factor to the cost of ownership of the amplifier.

Heat is the enemy of all electronic parts, regardless of amplifier technology. Unfortunately, amplifier data sheets often do not provide numbers for heat dissipation. Amplifiers that are more efficient will generate less heat and, thereby, require less air conditioning. Also, a system using amplifiers that consume less prime power are going to be cheaper to operate and require a smaller, lower cost UPS and generator power backup system.

Consider The Information Prior To Acquisition

Much has been said regarding the relative merits of KPAs, TWTAs, and SSPAs. It is a fact of modern life that technology evolves, including all types of amplifier technology. Before an informed decision can be made regarding which technology is best for an application, engineers and operators need to make sure they have up-to-date, accurate information about each potential technology solution.

Careful consideration of this information will help eliminate the myths and misinformation present in the marketplace so that they do not lead customers to a sub-optimal and expensive solution. As a supplier of all amplifier technologies, CPI believes there are applications suitable for all technologies, and no one technology fits all applications.

For further information regarding CPI, please visit
http://www.cpii.com/satcom

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Welcome To The Multiservice Era: Be Flexible, Be Efficient + Be Scalable

By Jo de Loor, Marketing Director, and Kerstin Roost, Public Relations Director, Newtec

It is key to understand that our industry needs futureproof solutions to meet the customer expectations: address the increasing OPEX and CAPEX challenges while remaining agile to enable new satellite services in an ever-changing world.

The era of multiservice is here—with satellite service providers, teleport operators and broadcasters facing numerous challenges, including more complex workflows, the introduction of new services, increased user expectations for always-on connectivity and pressure on efficiency in both the space and ground segments.

The importance of embracing the multiservice trend was emphasized by our recent comprehensive industry survey, which aimed to address and understand the key challenges of our satellite industry. About 270 leaders participated in the survey which took place in the second half of 2014.

The findings revealed our industry is vibrant and in a constant search for new growth and expansion, with 82 percent planning to launch additional services in the near future *(please see Figure 1 below)*.

In the past, the high CAPEX and OPEX required to roll out new services In the past, the high CAPEX and OPEX required to roll out new services on dedicated satellite capacity and network infrastructure were often inhibitors to the business cases for new service launches. This is where today's multiservice networks make the difference.

A multiservice network is a flexible, all IP-based platform that is shared to offer multiple services. Sharing satellite capacity, operational staff and ground infrastructure to deliver multiple services (like video, radio, broadband, voice, file transfers) lowers the barrier to launch new services to the market significantly, while increasing business flexibility and agility in an ever changing world.

The Three Key Capabilities Of A Multiservice Network

There are three key capabilities we see for a multiservice network that need to co-exist in one, and the same, system:

1. *A multiservice network brings service and business flexibility. Flexibility is at the core of a multiservice network, and provides piece-of-mind to service providers and customers using the network. In fact, product and service offerings can be adjusted at any time to maximize the business opportunities. Our multiservice platform, called Newtec Dialog®, (**see Figure 2 on the next page**) is a safe investment, future-proof to carry any existing or new media, voice or broadband service.*

2. *Scalability of the system (and investment) is imminent to successful incubation and launch of new service offerings. A portfolio of satellite terminals in terms of cost and performance for any frequency band, and a scalable hub, are prerequisites to scalability. The emerging market from High Throughput Satellite (HTS) networks benefits even more from scalable ground infrastructure than conventional networks do.*

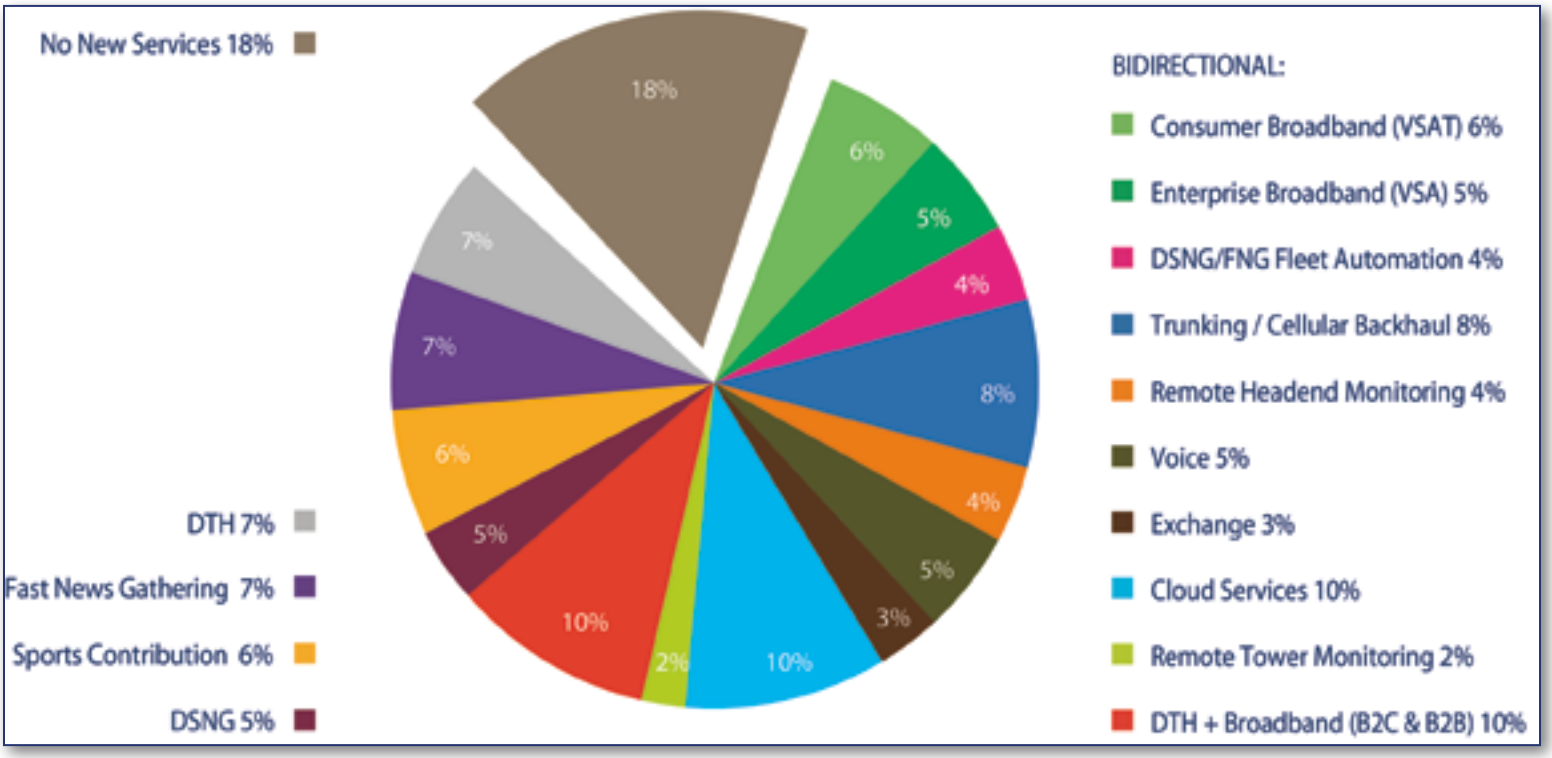

Figure 1. Newtec survey results ©: 82 percent of the participants will add new services to their network in the near future. The majority of the to-be-added services require bidirectional satellite connectivity (e.g., VSAT).

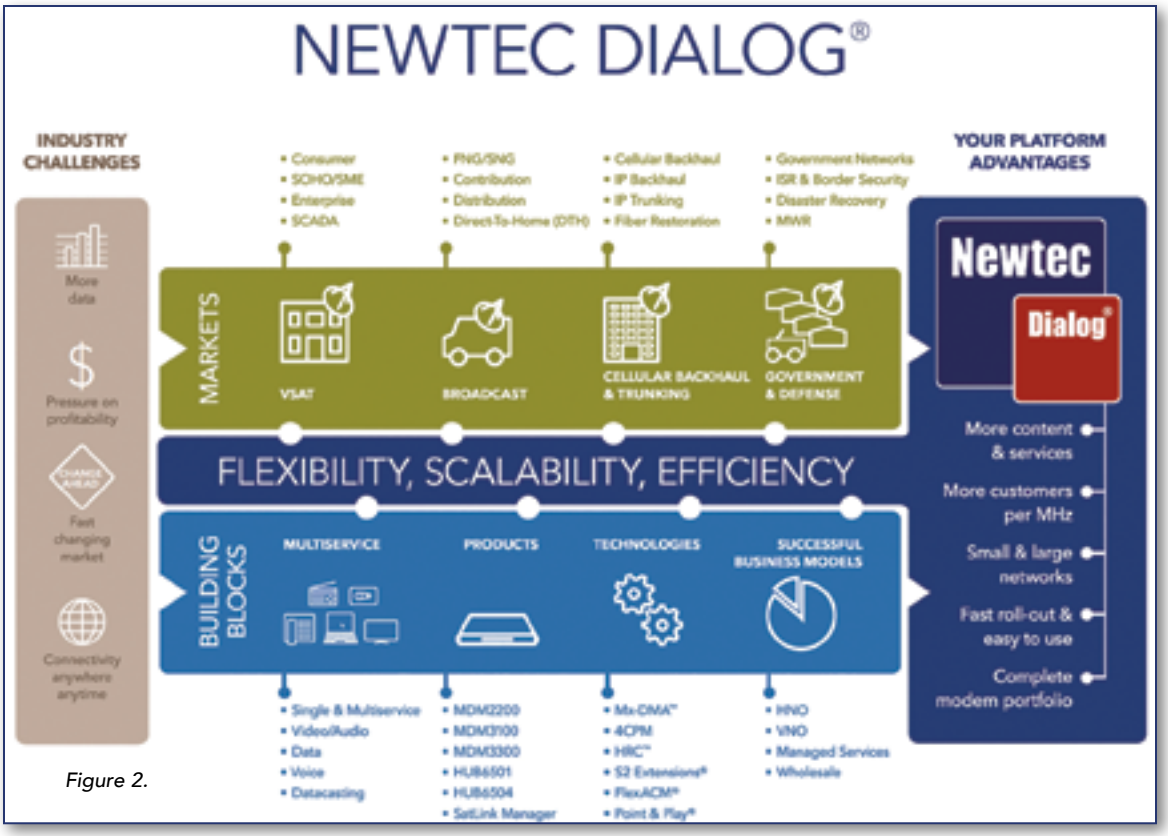

Figure 2.

3. *Efficiency, which means two things. On the one hand, it implies effective use of assets and resources, workflows and time-scheduled transmissions that share satellite space segment and satellite modems in a reliable manner, avoiding any conflicts during transmission sessions. This implies a solid session and resource manager as well as trustful Quality of Service (QoS) and Service Level Agreement (SLA) management at the heart of the system. On the other hand, efficiency also alludes to efficient transmission.*

Multiservice + High Throughput Satellites

In the last five years we have seen a steady growth in HTS capacity. While initially HTS was introduced for specific markets, mostly for broadband applications, most satellite operators are now entering the arena as well, resulting in HTS capacity becoming available in all regions.

We expect that the increased HTS capacity will boost applications and opportunities, which have been challenging to deliver over traditional satellite. As a result, service providers will be able to buy capacity on HTS beams that are of interest to their business offerings.

As the business environment becomes more complex, the pitfall for many service providers is to build their services on equally complex infrastructures that have organically grown over time along with their business. These platforms become difficult to manage and operate and have a heavy impact on operational and capital expenses.

Small changes to improve operational efficiency, or to satisfy the customer, prove difficult when having different technologies, topologies and platforms on top of each other. Consequently, a flexible HTS platform will be needed to achieve this simplification of operations.

New and optimized business models will also be needed as the traditional value chain for satellite operators, teleport operators and service providers continues to transform. A multiservice platform which allows operators to invest as the business grows, and scale up the hub flexibly will be absolutely vital to enable low up-front CAPEX requirements.

Bridging The Digital Divide: Mobile Backhaul

Another key area that satellite operators should be including in their business plans is satellite backhaul. Mobile operators in emerging markets are under pressure to extend their services in rural areas: Because either their markets are becoming mature, or governments are now willing to bridge the digital divide and ready to enforce Universal Service Obligation (USO) programs. Satellite backhaul is often the only mobile transport available in these remote regions, providing reliability and quick service roll-out, but also bringing increased latency and operational costs which must be mitigated with the right solutions.

Technology and usage have a direct impact on the evolution of the mobile backhaul solution and if significant optimization has been achieved on the forward satellite channel, the return channel has been somehow overlooked. This has led to the industry being entangled in the choice between SCPC and TDMA technology.

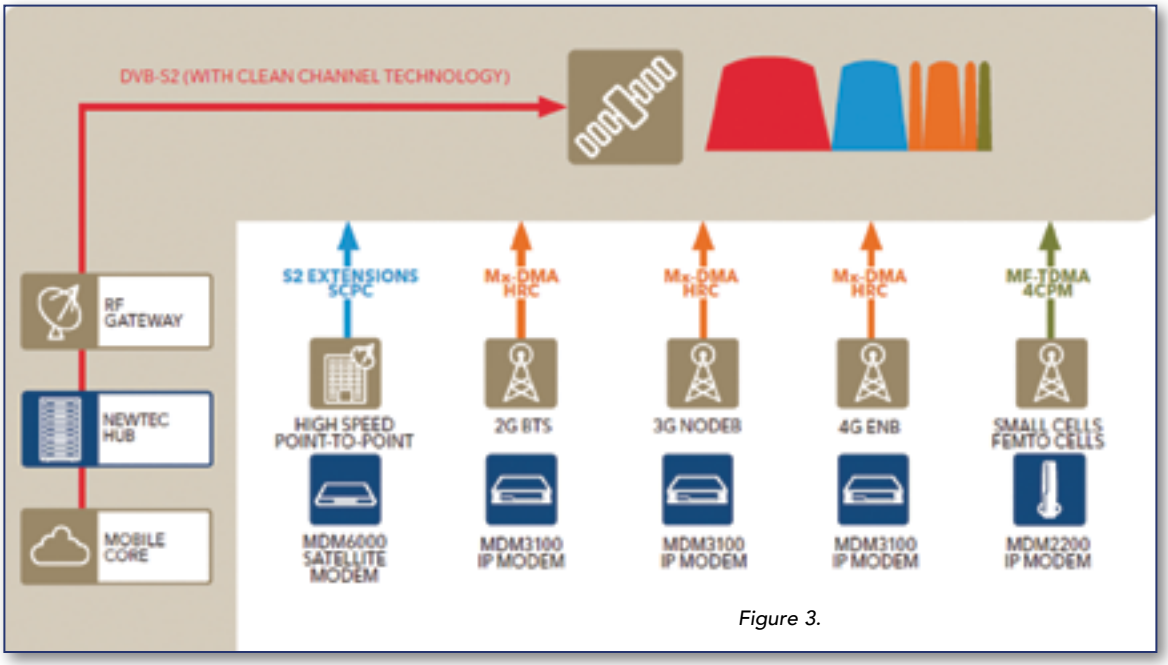

Figure 3.

While SCPC provides efficient and dedicated capacity with lower jitter (ideal for 2G voice) it can be expensive for low traffic requirements. TDMA allows sharing the bandwidth between the base stations and maximizing usage, but it cannot guarantee that voice calls will not be dropped during peak traffic conditions.

Mobile operators want to protect their voice traffic under any circumstances and they do not want to be in a situation where there has not been sufficient provision to guarantee it. They also want to reduce their OPEX and ensure that a sound utilization of capacity is performed since newer types of data traffic are bandwidth hungry. Both SCPC with its service guarantee and efficiency, and TDMA with its flexibility could help, but they would have to operate almost simultaneously!

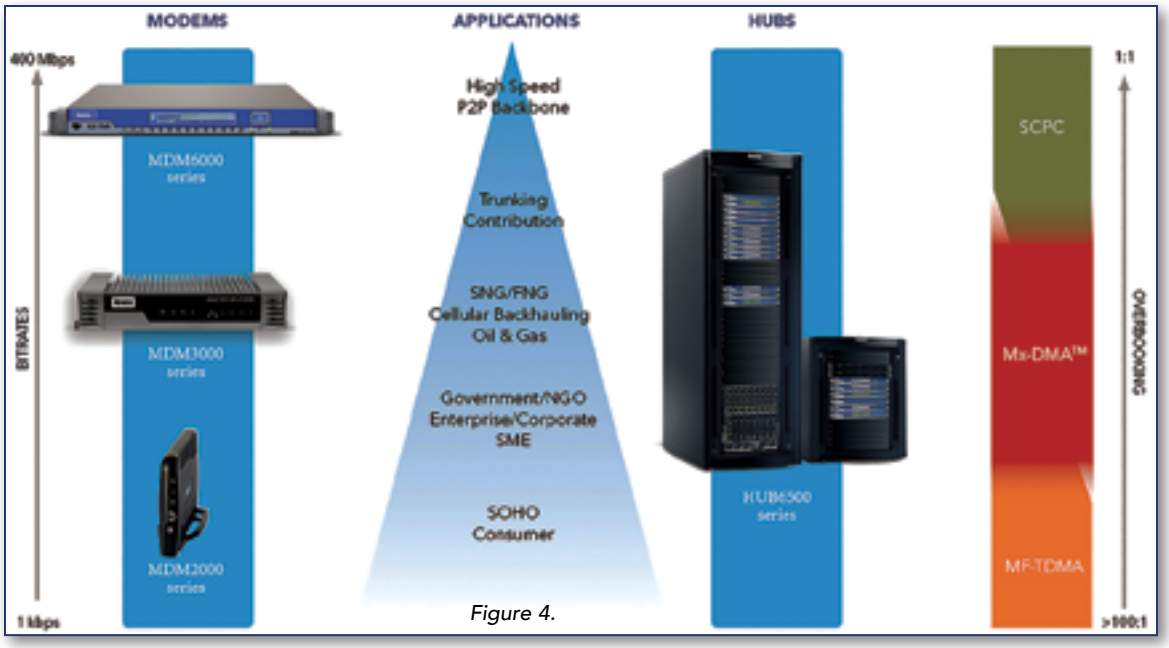

Figure 4.

Deciding Between SCPC and MF-TDMA: Have You Heard About Mx-DMA™?

In traditional systems, customers have to choose between SCPC and MF-TDMA during the network build, making this a one-time choice. Newtec has three different technologies available that can be dynamically selected to offer optimal performance for a given service and user profile. In addition to SCPC links and MF-TDMA, a third and innovative technology is part of Newtec Dialog. At the heart of this platform lies the patented return link technology called Cross-Dimensional Multiple Access or, in short, Mx-DMA™.

The innovation of Mx-DMA combines the best of SCPC and MF-TDMA, resulting in a network that offers both the flexibility of MF-TDMA and the efficiency of SCPC. The Mx-DMA access technology also includes a new low latency and highly efficient waveform called HighResCoding™ (HRC).

This HRC refers to the fact that there is a very high granularity in MODCODs so that the highest transmission efficiency and link availability is achieved at any moment in time. As a result, Newtec Dialog customers no longer have to make the difficult choice between SCPC high-efficiency or MF-TDMA bandwidth allocation flexibility at the time they design their system. In fact, the platform can always select the best-fit return technology—today or any time in the future.

When providing cellular backhaul, for example, Newtec Dialog leverages the technologies according to traffic conditions. It provides the disruptive Mx-DMA technology, combining the benefits of SCPC and TDMA which ensures that all the traffic is accommodated at each remote base station while multiplexing the bandwidth very efficiently between these remotes to decrease the backhaul operating costs.

With the advent of this game changer, the technology for satellite backhaul has to be repositioned for maximized efficiency. SCPC is then focused on very high services (trunking) or point-to-point, with MF-TDMA providing the lower end and Mx-DMA covering the largest range of dynamic services (***see Figure 4 above***). Additionally, Mx-DMA implements a smart management of link margins which is particularly useful with HTS that typically leverage Ku- or Ka-bands which are more sensitive to rain fade. Furthermore, Mx-DMA guarantees maximum throughput while constantly adapting to the rain effect.

And, Speaking of Newtec Dialog...

If service provider, broadcasters and teleport operators are finding it difficult to predict where and which satellite services will remain relevant over time, particularly versus terrestrial services, they are not alone. With a rapid roll-out of fiber in many regions and terrestrial services getting cheaper, there is most certainly a threat to the traditional satellite business model.

Newtec Dialog is the answer as this technology provides a flexible, scalable and efficient solution to face some of the challenges associated with today's markets as well as to turn those challenges into opportunities.

Dialog is a multiservice satellite platform; multiservice points to the fact that a single satellite network and space segment can be operated to support a variety of telecommunication services. All of this is applied with the highest bandwidth efficiency (OPEX) and scalability (CAPEX) to the service provider.

Welcome in the new multiservice. Let's talk about your projects:
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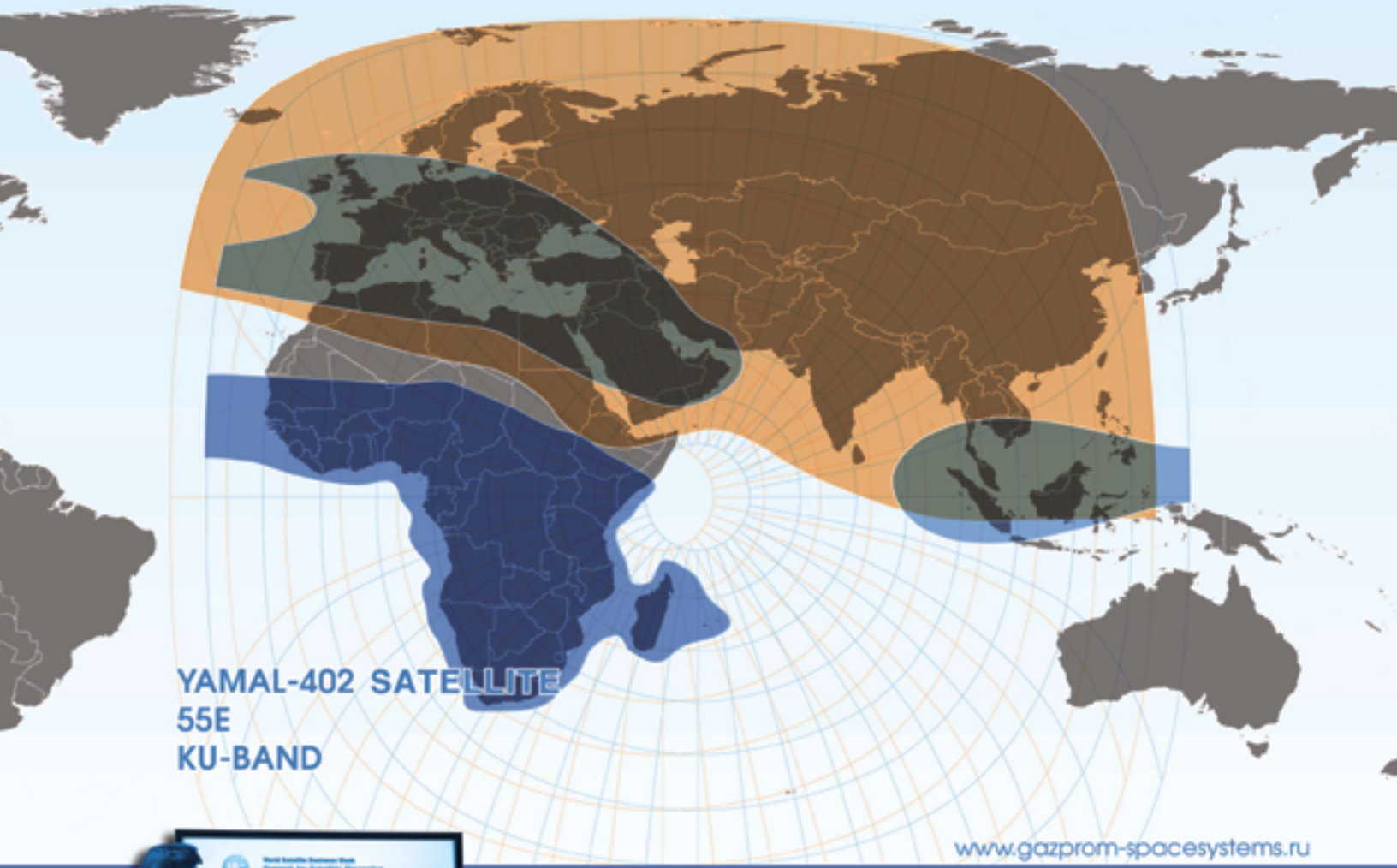

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Keeping Point-To-Point Satellite Networks Simple: Teledyne Paradise Datacom Q-MultiFlex™ Focus

By Tony Radford, Vice President, Teledyne Paradise Datacom

In today's climate of vapid economies and tight budgets, it's no surprise that consumers are searching for any opportunity to get maximum benefit from the lowest possible investment.

They're looking for the best trade off between capital and operational costs, and in essence—to get a really good deal. But on the surface, some deals may appear better than they really are.

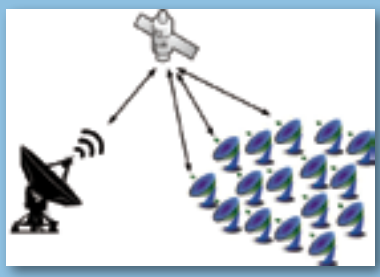
Years ago, I was on an installation down in Mexico where one of our guys fell in love with a leather coat that was on display at a local shop. The price was already suspiciously low and after an hour of brutal negotiation, he was able to drive it even lower. He was really beaming when the deal was finally done. It was a nice looking coat and he wore it proudly—always quick to point out the fact that he'd gotten such a great deal.

But after a week or so, we noticed an unusually high accumulation of flies that would follow Harvey around whenever he chose to don his imported integument. I'm not talking about regular houseflies. I'm talking about those big ones that always seem to show up right after something dies.

At the same time, we began to notice a rancid odor that was clearly emanating from that coat. When the smell finally became unbearable, he broke down and took it to a tailor who opened one of the seams only to discover that the backside of the leather was still covered with meat—rotten meat.

What Harvey thought was a great deal was in fact a complete rip-off. There was no way to fix it, so following a brief ceremony, we gave it a proper burial and tossed the experience to the annals of Hallmark moments. The moral here is that great deals aren't always great when you have all the facts—facts that you might not get until the purchase is already done.

Take satellite networks as an example. Let's say that you want to build a STAR network consisting of a hub and... let's say 16 remotes. All you want to do is to link the hub and remotes with the least amount of grief and at a bargain price. You don't want to get hit with any annual subscription fees for product features and you don't want to pay a fortune to the satellite provider.



Q-MultiFlex™ STAR Network.

You want to be able to keep tabs on things remotely, but you don't want to be buried under layers of network management complexity. You might not require high throughput, at least not initially, but you want plenty of expansion headroom to accommodate future growth—you just don't want to pay for it up front.

Your network isn't big enough to justify the cost of a VSAT hub, but you don't want to purchase a big pile of SCPC modems either. So how do you get what you want without having to do an inordinate amount of analysis to ensure that you're getting what you need without any surprises—no hidden meat? Well, I may have the perfect solution for you.

Let's talk about Q-MultiFlex™—Paradise Datacom's new multi-demodulator that's built upon the Q-Flex satellite modem platform. In addition to a full-featured modulator, Q-MultiFlex™ contains either one or two 8-demodulator arrays that transform a Q-Flex™ modem into a powerful hub controller—all in a single rack unit.

Reducing the hub modem-count by 16:1 is just where the savings begins. The embedded features of Q-MultiFlex™ can provide a host of additional benefits. Just like Q-Flex™, the most sophisticated cache of network management tools, test instruments and traffic graphing tools in the industry are already embedded in every Q-MultiFlex™ modem. Traffic multiplexing, TCP/IP Link Acceleration, PCMA carrier cancellation, interference-detection and our proprietary XStream™ IP link-optimization feature-set are all contained within the modem's architecture.

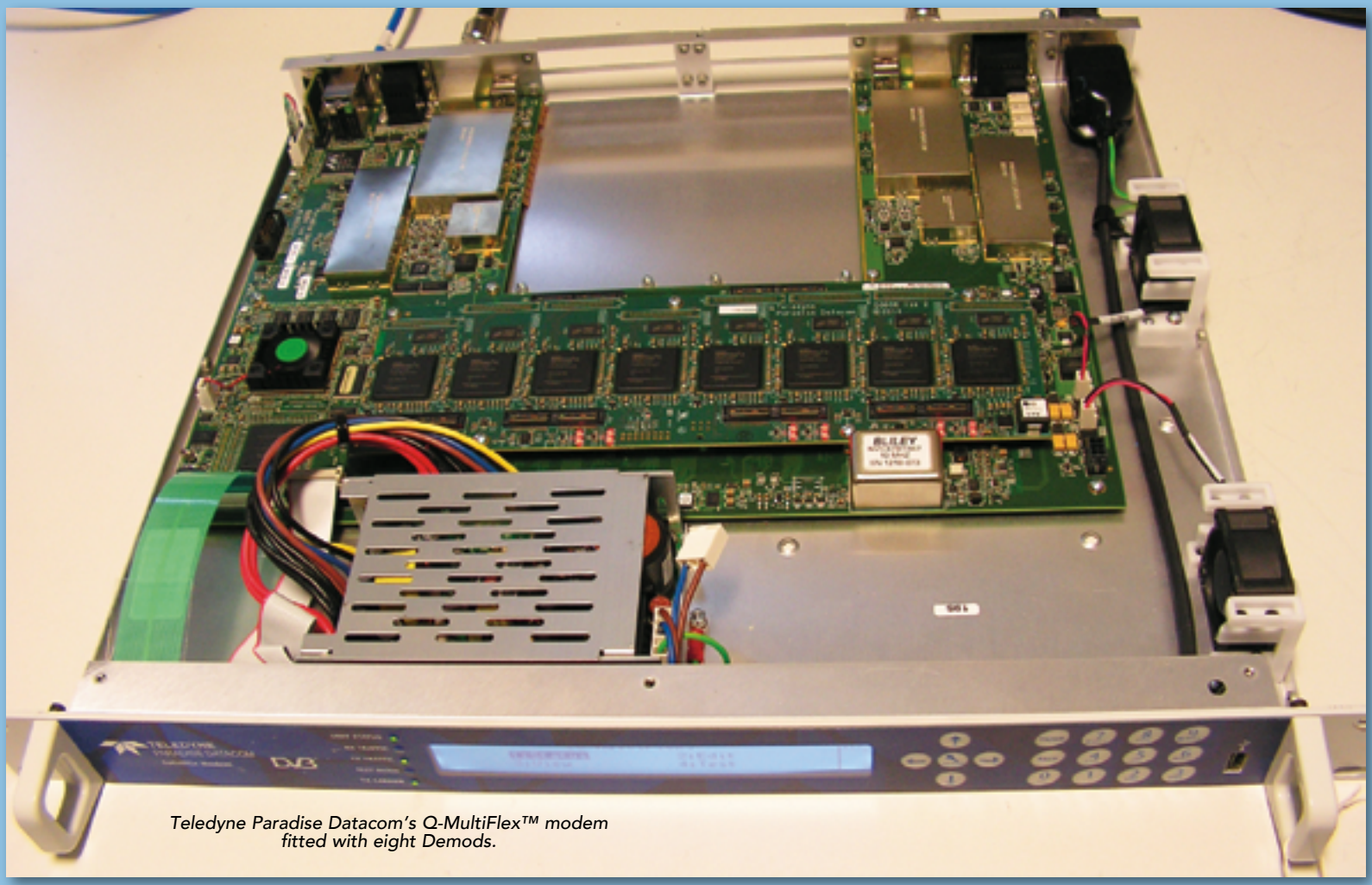
Just think, with everything contained in a single box, there's a lot less to integrate. A reduced box count means fewer interconnects and no incompatibilities. There's no need for an external IP processor, router, constellation monitor, spectrum monitor or BERT—and everything is remotely accessible through a standard Ethernet connection.

Teledyne Paradise Datacom's Q-MultiFlex™ Demodulator

Q-MultiFlex™ allows operators at the hub location to configure the modems at the remote stations directly from the front panel keypad. But let's suppose that during the process of remotely configuring one of the distant modems, an accidental input causes the link to drop. If the remote station is unmanned, there's little choice but to send someone to the site to manually restore the link.

But thanks to Reversionary Control—the remote modem will revert to a previously stored configuration so that the link will automatically be reestablished without the need for a site visit. This feature alone can save an operation thousands of dollars per year in travel expenses, particularly when the remotes are in difficult to reach locations.

A satellite network based on Q-MultiFlex™ is perfectly suited for thin-route applications, but it's the high-data rate applications that take maximum advantage of Q-MultiFlex™. A Q-MultiFlex™/Q-Flex™ network can facilitate 160Mbps of duplex traffic, and thanks to DVB-S2X, FastLink LDPC and 5 percent roll-off filtering—a minimum amount of space segment is required to get there. And if antennas and HPAs are sized sufficiently, our embedded PCMA feature can generate an even higher level of savings by enabling the return carriers to reside in the shadow of the outbound carrier.



Teledyne Paradise Datacom's Q-MultiFlex™ modem fitted with eight Demods.

The bottom line—with Q-MultiFlex™ at the hub and Q-Flex™ modems at the remotes, users are able to achieve cutting edge efficiencies when it comes to transponder utilization and reduced latency with a minimal investment.

For further information, please visit:

http://www.paradisedata.com/collateral/datasheets/213622_Rev-.pdf

*Tony Radford is the Vice President of Sales and Marketing for Teledyne Paradise Datacom. Mr. Radford's tenure in the satellite communications industry spans more than 30 years, and his book, **Satcom Guide for the Technically Challenged**, is used by companies around the world as a primer for their new employees.*

Under The Hood Of The Q-Flex™ Satellite Modem

The new Q-Flex™ satellite modem is a software-defined modem running on a new universal hardware platform. The design makes it capable of doing whatever you need, now and in the future.

Q-Flex™ is a new, from the ground-up, design that incorporates current and new Evolution Series modem features that include an optimized spectral roll-off that can provide as much as 20 percent in bandwidth savings. When combined with other bandwidth-saving features, such as Paired Carrier and FastLink-LDPC, Q-Flex™ it provides an excellent value proposition for customers who want to squeeze everything they can from a transponder.

Using the latest chips, the total FPGA count has been reduced by half from the previous platform, all the while increasing the number of functions that can be performed directly on the motherboard. Lower parts-count means less current draw and, consequently, less heat.

Q-Flex™ is a true "one-size-fits-all" modem. What the modem can't do out of the box can be accomplished with a simple flash-upgrade of additional features such as higher data rates, carrier-cancellation, higher modulation and FEC.

This future-proofed design ensures that your capital investment is fully protected by allowing functionality upgrades throughout a projected lifetime of 10+ years. Unit features include...

- *10X More Powerful Main Processor*
- *New Internet Protocol (IP) Engine*
- *Fully-provisioned IP Quality of Service (QoS)*
- *Capable of processing 150,000 IP packets per second*
- *Adaptive Coding & Modulation (ACM)*
- *XStream IP™— high-efficiency IP bandwidth-optimization and traffic-management*
- *Complete Network Diagnostics —any of which can be employed while carrying live traffic*
- *Wide-band Spectrum Monitor with Peak-hold*
- *Bit Error-Rate Tester with Fireberd-emulation*
- *Constellation Oscilloscope to 32APSK*
- *IP Packet-throughput Monitor interfering-signal detector*

SatBroadcasting™: HDR + 4K Are Changing The Way We "View"

By Simen Frostad, Chairman, Bridge Technologies

Sometimes glibly dismissed as another ruse manufacturers have introduced to get consumers to dip into their pockets again is 4K technology for broadcasting.

3DTV came and went, the cynics say, and 4K is just the next revenue-generating gimmick. Undoubtedly many consumers feel a compulsion to own the latest technology almost for its own sake. However, 4K is actually a far more momentous development than 3D, HD, the introduction of color—more important perhaps than any other innovation that has debuted since the birth of broadcasting.

Anyone who has viewed 4K at its best has probably felt that this technology offers more of a cinematic experience than a televisual one. The resolution alone means that top-quality content appears lifelike, rather than an image of life composed of pixels.

Resolution is only part of what 4K can deliver. HDR (High Dynamic Range) is the really exciting thing for the creative end of the industry. More pixels is good, but the difference is not that much of an incentive to make a change. What makes for a compelling reason to move to 4K is the combination of greater resolution with HDR and the technology's ability to show colors and dynamic range that have previously been impossible.

Content originators and consumers 'get it' when they see 4K. At the extremes of the range (dark and bright) detail is rendered with much greater fidelity—shadows and highlights that used to wash out now appear with all of the subtle nuances that the eye would see in the real world. The color gamut in between is also vastly expanded. Colors are rendered more accurately, and banding is no longer a problem.

In combination with far greater contrast, these differences in the appearance of the image add up to a more significant impact on the viewer's perception than increased resolution would manage alone. This creates a problem for consumers in that the resolution of 4K sets is standardized and easily understandable on paper, while HDR is not—at least, not for the time being. The only way to discover how well one 'HDR enabled' set performs against another is to A/B test them by eye.

Dolby's HDR transmission format can deliver highlights up to 100 times the current contrast and brightness standards, although consumer sets won't handle those values for some time. Some consumer sets announced by Sharp and others have incorporated Dolby's technology, but it's not clear whether this will become a standard: Technicolor proposes a different approach. One or other—or neither—may be included in the HEVC specification.

Although there may be muddy waters for television buyers, the ability to deliver to the viewer the full gamut of color and contrast that the DP and director captured makes 4K with HDR a fact of life for the industry: studios are re-grading features for HDR, and providers such as Netflix have announced their intention to convert their libraries.

As is usually the case in a rapidly developing field where standards have yet to be defined, the important aspect for providers is to keep their options open as they make provisions for offering 4K/HDR content to the public. As there is not yet a reliable digital media crystal ball, wise providers will want to implement infrastructure that is capable of supporting whichever future standard, or standards, becomes dominant.

As if 4K did not already place enormous new demands on the distribution and delivery chains, HDR increases this demand even further. The pressure on bandwidth for HDR 4K content is intense. The eventual HEVC standard will seek to alleviate some of this pressure and manufacturers will respond with systems capable of greater throughput. However, there are limits as to the number of packets that can be handled—the frame rates remain unchanged, but the data-per-frame is vastly increased, and the consequences will be that tolerances for latency will become smaller.

As the IP revolution has overtaken the media industry, it's been more and more important for technical staff to have highly effective tools for tracking and understanding how and where problems arise in the digital media chain. The interaction between broadcast and IP technologies produces some new and sometimes elusive errors. The increased infrastructure pressure created by the advent of 4K will mean that it becomes even more crucial for operators to understand in minute detail what is happening to their streams and packets. Whereas for HD,the tolerances were greater, and operators could get away with a certain level of errors and some lack of precision in their fault tracking and analysis. No longer—the extra data volumes of HDR 4K will push everything to the limit. That will make super-precise forensic analysis really important for ironing out issues that will cause major service problems if uncorrected.

The ability to detect microbursting is one example of a technology that will become center-stage in the 4K era. In fast packet-switched networks, rapid bursts of data packets are sent in quick succession. The resulting periods of full line-rate transmission can overflow packet buffers of the network stack, both in network endpoints and routers and switches inside the network. While many digital media monitoring systems do not currently have the ability to detect and analyze micro-bursting, this kind of forensic capability is essential for 4K.

Because the amount and complexity of the data will be an order greater than that of today's HD services, the analysis tools will need to be easier and quicker to use, as well, in order for operators to unpick the tightest knots in their delivery chain. Advanced data visualization tools will be necessary for engineers to find a path through so much data. An open-ended ability to correlate between different data sets and to contextualize it against data from external sources will allow technical staff to find patterns and trends that point to the cause of errors, or indicate where stresses are likely to lead to failure even if such hasn't happened yet. Advanced monitoring systems will give engineers the kind of visual analysis capability that scientists have used for many years.

The widespread introduction of 4K will push providers towards the most powerful and well-integrated monitoring systems available—anything less will be inadequate for the task of maintaining service levels and efficient operation. That's the nature of a development as big as Ultra-High Definition Television (UHDTV): it exposes the fault-lines in existing systems and infrastructures and asks questions that need carefully considered answers.

Be that as it may, a few minutes watching high quality HDR 4K content will convince most people in the industry that the effort will be more than worthwhile.

More information: ***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 Aboard: How SATCOM Can Win The Train Connectivity Challenge

By Doreet Oren, Director of Product Marketing, Gilat Satellite Networks.

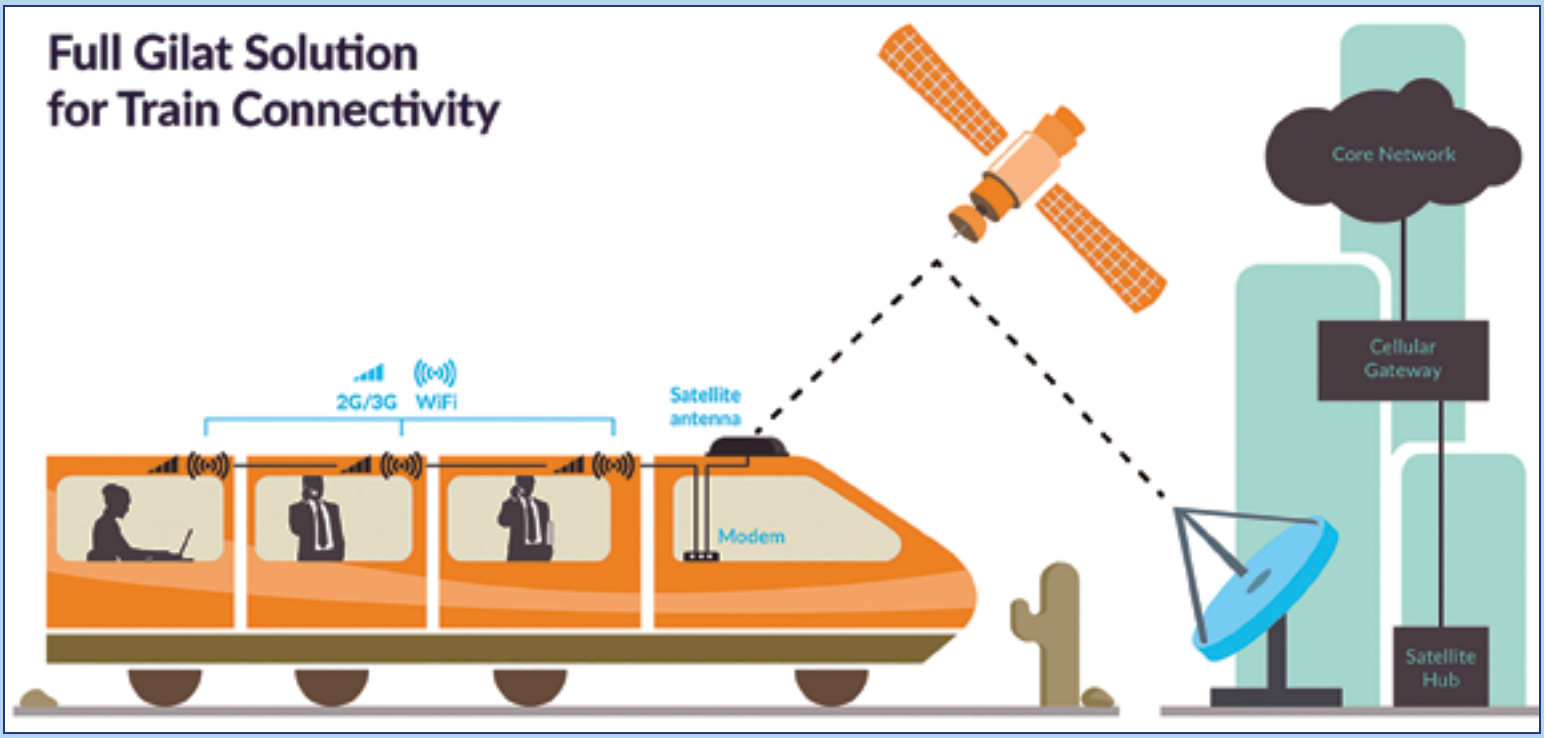
The latest satellite technology, integrated with one of the oldest mass transportation methods, produces a premium travel experience—and opens an attractive market for ISPs.

Sleek, spacious, and increasingly capable of high-speed, trains are as popular as ever. In busy urban corridors, trains are increasingly in competition with airways for passengers. This is particularly true for short hops between urban areas—a train ride is comparable in time and cost to a plane ride. In these cases, deciding between these means of transport can hinge on passenger comfort. Always-on connectivity becomes an expectation rather than a luxury and the ability to provide this service becomes a key differentiator. Studies show that mobile and Internet connectivity is a factor for travelers considering which method of transport to take. In train travel, there are two areas where traditional cellular connectivity solutions fall short: rural routes that lack network coverage and high-speed rail (HSR) trains that move between cellular base stations faster than a cellular network can handle the location transitions.

Changing The Price Equation

Intercity train routes often pass through remote, uninhabited areas where laying out a cellular network is not practical. The high cost of installing cellular towers every few kilometers along the entire track, as well as the lengthy implementation schedule, makes this option unfeasible. What does work, however, is a satellite solution, which is impervious to these limitations. A low-profile train antenna continually points to the satellite, enabling a highly reliable, high-speed Internet connection. This solution is also ideal for serving high-speed trains, which cannot offer cellular connectivity. The speed of these trains prevents reliable handover between cellular base stations. Here, too, the only alternative is to rely on satellite connectivity.

While the price of satellite deployment may have served as a barrier to entry in the past, new high throughput satellite (HTS) technologies are lowering the cost of satellite links by an order of magnitude, making such cost-competitive



with other technologies. The main reasons are the availability of additional bandwidth at a lower price and higher frequency space segments that reduce the antenna size, which, in turn, drive lower CAPEX costs. According to industry analysts, this trend is expected to continue well into the future.

The Market For High-Speed Trains: How Soon, How Real?

Today, HSR is primarily present in Europe and Asia Pacific, and while other regions are constructing or planning HSR, Europe and Asia Pacific remain the leaders in current capacity and in future usage. According to a Frost and Sullivan report, the amount of operative HSR track is expected to grow from 14,000 km in 2010 to 50,000 km by 2020. This represents a growth market for Internet connectivity, one which satellite communications is uniquely positioned to leverage.

Governments are interested in using HSR to dramatically reduce travel time. For example, a recently announced Russian HSR project will connect Moscow with Kazan, Russia's eighth-most populous city, in 3.5 hours, instead of the current 13 hours. In Turkey, HSR initiatives are in varying stages of completion. In Brazil, a planned HSR between Rio de Janeiro and Sao Paulo (511 km) will provide service in 80 minutes, as opposed to a six hour bus ride that is currently the only ground alternative. In short, this emerging market represents an enticing opportunity for Internet service providers to increase revenue.

Access From Every Train Car

The pending rollout of HSR lines has train operators looking ahead for an on-the-move connectivity solution that meets the unique requirements and constraints of high-speed train travel. Gilat Satellite Networks offers a comprehensive solution for all passenger communication needs.

Each car within the train is equipped with a femto cell and offers one access node for WiFi and a second node for a cellular connection. All access nodes are interconnected between the cabins and aggregate to the modem located within the locomotive car. From this point, a Ka- or Ku-band antenna establishes an Internet connection between the train and the satellite hub, which also connects to an MNO's cellular gateway.

An obstacle inherent in SATCOM is the inevitable delay that limits throughput and performance. However, Gilat's patent-pending embedded acceleration techniques compensate for that delay, maintaining a user experience that is indistinguishable from terrestrial solutions, offering full capacity throughput on handheld devices.

Gilat provides an end-to-end solution, from planning through implementation. From installing access nodes and satellite terminals, to equipment installation at ISP or cell operator premises, Gilat takes full responsibility for the network, freeing satellite ISPs from working outside their sphere of expertise and the worry as to whether or not their satellite link is optimized. With 24x7 NOC service, Gilat tends to every aspect of network management. With low-profile antennas, market-leading VSATs and extensive industry experience, Gilat is ideally suited to lead ISPs into the exciting and emerging train connectivity market.

All Aboard

For satellite ISPs, the selling proposition is clear: a chance to offer mobile network operators a complementary solution that expands their network to any destination a train can reach. For this market, timing is crucial. The broadband connectivity train is just about to leave the station. For more information about Gilat's mobility solutions, please visit ***http://www.gilat.com/mobility***

*Doreet Oren (**doreeto@gilat.com**) is Director of Product Marketing for Gilat Satellite Networks. In this role Oren is responsible for defining product positioning, messaging and go-to-market strategies and is responsible for market research and analyst relations.*

A SmallSat, Cost Effective Approach To X/Y Antenna Ground Terminals

By Alex Nichols, Technical Director, Ground Systems Group, TeleCommunication Systems Inc.

With the insurgence of the small satellite market the demand for cost effective ground terminals has never been greater.

Many of these small satellite manufacturers are startup companies that must first rely on demonstration flights to gain technical momentum and future investments. In the beginning, the most economical approach was to contract ground station services for data reception of their Low-Earth Orbit (LEO) or Medium-Earth Orbit (MEO) satellites. However, once the constellation starts to grow and the number of passes increases, this becomes no longer economically viable.

With the advancements made in ground terminal technologies, the cost to own dedicated terminals has been reduced, making it possible for small satellite startup companies and universities to own dedicated ground terminals. One of the most efficient cost effective antenna configurations in support of LEO and MEO missions has proven to be the X/Y antenna configuration over other pedestal geometries.

Advantages Of X/Y Antenna Configuration

One advantage of an X/Y configuration is the ability to eliminate the keyhole as the satellite approaches Zenith. Only the fastest and most expense elevation/azimuth pedestals can overcome this problem to provide uninterrupted LEO/MEO tracking. For example, a LEO pass with a 780 km orbit utilizing an elevation/azimuth pedestal with a maximum velocity of 6 degrees per second would start to lose reception at 85 degrees elevation and would remain off track for about 25 seconds as it ran full speed to catch up to the satellite during descent.

This would result in 25 seconds of lost data during a period where the signal-to-noise ratio would be at its best. The cost to obtain a higher performance elevation/azimuth system capable of out running the keyhole becomes a cost challenge for most small satellite operators. Another cost draw back resulting in this high dynamic operation is the increased wear and tear on the system. This may result in increased maintenance such as more frequent motor and gear box changes.

The elevation/azimuth-tilt pedestals, also known as a 3-axis pedestal, is another configuration used for LEO/MEO tracking. This design eliminates the keyhole by titling back on its third axis on those satellite passes that approach Zenith. This decreasing the elevation angle which provides ample time for the azimuth axis to rotate and stay on target. Disadvantages of this configuration is that there are more moving and costly parts to procure.

There is sometimes debate whether or not an X/Y configuration has its own keyhole at the East (90 degrees) and West (270 degrees) at an elevation of less than 2 degrees. In reality, at this low elevation angle, there is no practical reason to track any spacecraft as the data quality would be quite poor.

X/Y Pedestal Cost Savings Advantage

The X/Y configuration basically has two orthogonal axes. The best way to describe this is to imagine two rolling pins stacked on each other, with the upper roller rotated 90 degrees from the lower roller. This configuration has several advantages related to cost and operation.

1. ***The keyhole is eliminated because the lower axis just simply rotates as the satellite approaches Zenith. This allows the antenna to move at velocity of less than 1 degree per second during any satellite pass regardless of its trajectory. This low dynamic and elimination of the keyhole has several cost advantages.***
   a. *Lower power consumption could provide a significant savings over a long period of time.*
   b. *Less wear and tear on the components equate to maintenance cost savings. Motors should last 5 to 8 years depending on the number of passes the terminal is performing each day. The lower dynamic also allows the system to point more accurately during a pass.*
   c. *With the elimination of the keyhole more obtainable data becomes available during those high signal-to-noise ratio portions of the track.*

2. ***The X/Y configuration is less costly to manufacture over other pedestal configurations.***
   a. *The upper and lower axes essentially use the same parts, which means less spares need to be procured.*
   b. *The use of less-parts than other types of positioners increases the Mean-Time-Between-Failures (MTBF).*
   c. *The X/Y housing and related castings are less costly to the manufacturer because the upper and lower units are cast in a single housing.*
   d. *The X/Y movement eliminates cable wrap that eliminates the need for costly slip rings or rotary joints.*

Each of the antenna configurations has their place in aerospace. The Elevation/Azimuth is the best configuration for range operations in the development of aircraft and missile technologies. The 3-axis system has the ability to cross between range applications and satellite tracking applications but comes at a cost. The X/Y configuration is truly the one positioner technology designed specifically for LEO and MEO satellite tracking applications. It can be produced at a lower cost, has less moving parts and has proven itself to be very reliable because it operates at a low tracking dynamic. This makes the system more affordable, providing the opportunity for small satellite operators and universities to procure their own dedicated terminals.

More info: ***http://www.telecomsys.com*** and ***http://www.trackmysat.com***

Alex Nichols is a Technical Director for Telecommunication Systems Inc. (TCS), Ground Systems Group based in Torrance, California, Alex has more than 35 years experience in the design, installation, operations and maintenance of satellite and rocket ground tracking stations located world wide. His current primary focus is the deployment of high performance, reliable cost effective X/Y antenna satellite tracking systems. TCS is a world leader in highly reliable communication technology, including E9-1-1, text messaging, commercial location and deployable wireless communications.

Where can you find the satellite industry under one roof?

sspi gala

March 17, 2015
Walter E. Washington Convention Center
Washington, DC

The annual Gala Benefit Dinner, which takes place on the first night of SATELLITE, is SSPI's biggest fundraiser. The money we raise supports our membership, chapter and industry-support programs throughout the year. It is also the number-one place in our industry to see and be seen, and there are many ways to take advantage of that opportunity.

SSPI Gala Benefit Dinner 2015 marks the formal launch of SSPI's campaign to change the global conversation about satellite. It's a campaign called "How Satellites Make a Better World." Join us at SSPI Gala 2015 as we kick off our campaign and tell our industry how it can help to drive the change we need. Learn more at www.BetterSatelliteWorld.com

For more information and to get tickets, visit www.SSPIGala.com

Think global, party local at SATELLITE 2015

The Future Is Hybrid

By Paul Scardino, Senior Vice President, Sales-Engineering-Operations-Marketing, Globecomm

From the 1960s into the 1990s, satellite, microwave and coaxial cables were the hot transmission technologies. Innovators in technology, in business and in content worked miracles in overcoming distance, spreading knowledge and entertainment and creating the biggest mass markets ever known.

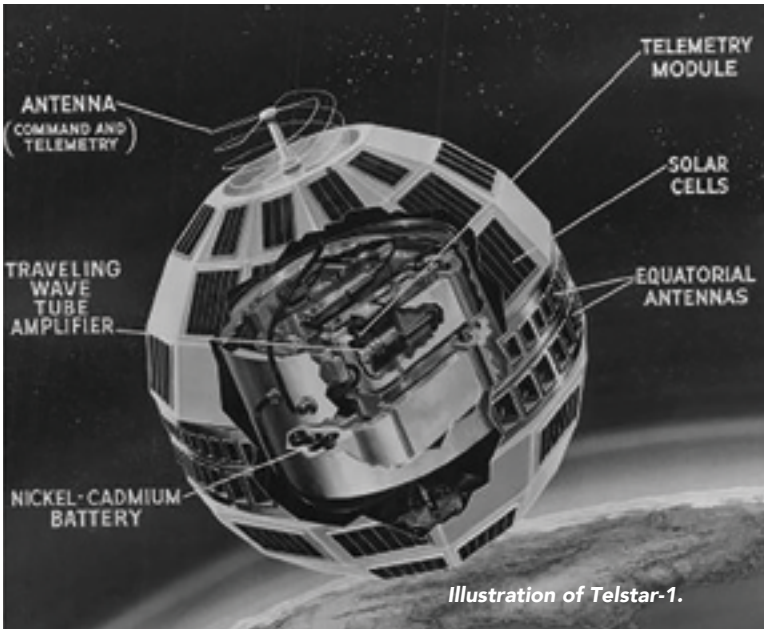


Illustration of Telstar-1.

People with acute memories will recall the Andover and Goonhilly satellite Earth stations, the Telestar-1 satellite, the Thrilla From Manilla and many other firsts. For a long time, the architecture of televised media and entertainment was unchanging. Take news, for example—there was an anchor sitting in a broadcast center who received breaking news by wire and videotape. The nightly news was transmitted via satellite to Earth stations at broadcast affiliates across the United States and beamed Free-To-Air (FTA) to households. By the time cable TV began its headlong growth in the 1980s, there were new wrinkles: SNG trucks appeared and provided content contribution by satellite or microwave for distribution to headends for transmission via cable systems as well as through an affiliate network.

A Whole New Cloud

Fast-forward to 2015—that traditional landscape is now almost unrecognizable. The TV newsroom has evolved into an all-digital content engine, as have the playout centers that feed most other programming. However, the digital revolution inside the news operation is nothing when compared to the broadband revolution that has occurred beyond those studios. From YouTube and Netflix, to the Huffington Post and Fox News or CNN online, distribution is a whole new world—or, perhaps, maybe a whole new cloud.

The Hybrid Contribution Network

A project my company implemented for a major American broadcast network drove the aforementioned home to me. The network wanted to achieve goals that appeared to be incompatible: enhance the quality and flexibility of the contribution network, which links affiliates and the network, while sharply reducing cost. And, if possible, ensure that the result was easy-to-use, requiring fewer trained personnel to operate the network.

A survey of the available technologies and transmission platforms was conducted and our engineers made a most viable case: We told the broadcaster to forget about a traditional MLPS network and private cloud (meaning, internal to the network) to store digital assets—although robust and effective, was also expensive. Plus, there is nothing simple about managing MPLS over fiber. Continuing to buy the large volumes of satellite capacity to support contribution was also not an option, as most of the time too much of that capacity went underused.

Instead, we outlined a Next-Generation Contribution Network—a hybrid IP-based platform combining satellite, the public Internet and a cloud platform hosted by one of the big providers. The network would connect the broadcast

hub with nearly 200 member/affiliate stations for the delivery of linear, real-time and file-based, non real-time, media content.

Making The Complex Look Simple

The challenge of the design was to make the most efficient use of satellite and terrestrial bandwidth, all the while providing a single software platform capable of managing all, including media assets, the scheduling of feeds, invoicing and dynamic bandwidth allocation.

We designed a unified platform that dynamically mixes Internet and satellite transmission to provide three kinds of content streams: small file transfer for low-resolution files and short clips; large file transfers and video streaming (off-air return, bonded cellular, tower or helicopter cameras); and live broadcast-quality video (news, Q&A). The unique ability to open the satellite spectrum for IP news contribution during idle periods provides the most efficient use of space segment.

Making all work together was a software platform that automated the most common workflows for ease-of-use and reduction of operating expenses. At the affiliates side of the equation, we installed all-IP advanced VSAT terminals using dynamic SCPC technology and an advanced bandwidth management system, which automated carrier switching and spectrum management.

As is true with any new system, there are adoption worries. Will the network engineering team be comfortable relying on the system? Will the affiliates actually use the system? I held my breath through the initial installation and testing—fortunately for me, I started breathing again when the network told us the affiliates loved the system, as it turned a series of complex processes into just a few mouse-clicks.

Problem solved? Well, not quite. Public Internet and public cloud storage are delivering on the promises of adequate reliability (for specific sorts of content) and lower cost. However, they also open a Pandora's box of security issues that broadcast networks and satellite operators have previously seldom had to face.

Cybersecurity is suddenly a serious issue and requires a serious regimen to handle it—vigilance is required, a network-wide assessment of risks, the ability to fixing the gaps and take frequent, holistic views of the network architecture to increase security over time—all are required actions. That's how the big boys of the Internet do it and hybrid networks need the same treatment.

With change comes complexity, but also greater efficiency and cost-effectiveness. The commercial web turned 25 last year and the Internet is not done upending traditional ways of doing business. Technology will continue to improve, as will the methods of moving voice, video and data. Within 10 years, the term "hybrid" will probably be an amusing description of this transition period into what will simply be a technology infrastructure, a fluid and dynamic portfolio of internal and external services, all cost- and performance-optimized for the moment.

For additional information, please visit
http://www.globecomm.com/

Paul Scardino is Senior Vice President of Globecomm's Sales Engineering, Operations and Marketing. He is responsible for the overall recruitment, leadership and development of the sales and marketing personnel including the global sales executives, corporate technical subject matter experts and the marketing team. He oversees the sales, marketing and strategic direction of Globecomm's new and emerging products and services. He has been involved in the telecommunications field since 1988 and has been a key to Globecomm Systems' success since February 1997.

Interference: The Importance Of Training

By Martin Coleman, Executive Director, Satellite Interference Reduction Group (IRG)

With recent discussion about the importance of training to reduce errors, and therefore, satellite interference, this theme has become a hot topic for the IRG's End Users Initiative Advisory Committee.

The IRG Team paired up with the Global VSAT forum (GVF) to build a bespoke training courses and certification programs for the broadcast community. This course was featured strongly at our workshop at the close of last year where lengthy discussions about how to ensure users are aware of the subject's importance and role within the industry, the training programs available and making training an inherent part of operations.

But how much difference does this really make? To answer that question, we asked the major satellite operators and the answer is, an awful lot, it's at the top of the initiative list.

According to Eutelsat 's Andreas Voigt, Communications System Manager, this isn't all about peaking antennas or easy to teach technical questions, "it goes much further in many different areas: lack of knowledge and awareness of good practice, security aspects, and ignorance of health issues."

Lack Of Understanding

For many users, there is, quite simply, a total lack of understanding about the technology they are using, the potential for interference, and the correct procedures to follow to negate such conditions. They are often lacking even the most basic understanding and, without any formal training, they are placed in their positions and start pressing buttons and pointing antennas with no clue about the potential impact on other services.

With such a lack of knowledge, pointing to the incorrect satellite is rather easy to accomplish, without even realizing what has been done and what has transpired to cause significant interference to other users. There are numerous examples of this happening. For example: A journalist recently destroyed a contribution link when using an auto-pointing antenna. When he was questioned about the issue, he literally had no idea there had even been an issue!

Operating The Equipment

All right, so we get past the total lack of understanding, then the problem is that people who are not trained properly are now operating technical equipment. Again, and recently, a customer transmitted to the wrong satellite as he didn't know how to operate a spectrum analyzer and consequently took out a live OU feed. Sadly this is just one of many such disastrous examples.

Operators are also experiencing numerous Adjacent Satellite Interference (ASI) cases caused by customers not knowing how to properly operate an MF-TDMA VSAT return channel system. There is a serious lack of knowledge concerning Network Management System (NMS) settings, how the system actually works and in different layers, and the correct antenna installation of peak and pol settings. This is undoubtedly due to either knowledge transfer from the VSAT Network Manufacturers not getting through to the user, or within the user's organization where training programs have not been established.

Knowledge Transfer

Indeed, there is a considerable breakdown in knowledge transfer in several areas. For example, those leasing space capacity often don't forward, agreed operational restrictions or procedures to sub-lessees, and often they don't seem to understand the need for that knowledge transfer. However, without such recognition, mistakes happen because procedures are not followed.

One operator recently received an issue from a customer that accessed their own leased capacity without coordination with the Operations Center. The customer transmitted without adjusting the isolation and consequently caused Cross-Pol interference to live sports coverage. The operator reacted promptly, but the affected customer was, of course, not happy to have had interruption to the live feed—ultimately this interference cost the operator the revenue from that disrupted feed.

There seems to be a consensus that a large proportion of interference cases are caused by a total lack of knowledge, understanding, or experience. Therefore, if we were to train every single person responsible for operating satellite equipment, the amount of interference would be dramatically reduced. Of course, in practical terms, that is no mean feat. In order for us to make that happen, training needs to be more accessible to everyone, and we need to ensure that users are aware of the importance of training. Or, dare I suggest, there should be mandated training for the operation of all satellite equipment.

That said, there are good training courses available today. GVF already has a large portfolio of training products and they have worked with our EUI advisory committee to develop a broadcaster-centric training and certification programs. There are also other providers who specialize in different industries. By working together, they bring more training development and ideas to the table.

Throughout this year, one of the IRG's biggest remits is to educate the user about satellite interference and what can be done to mitigate this problem—training will, of course, be a big part of this global effort.

Please note: At Satellite 2015, the IRG will be hosting their next workshop at the Intelsat Headquarters on Thursday, March 19, in the afternoon and all day on Friday, March 20.

For additional information or to register, please visit ***http://www.satirg.org***

Martin Coleman started his company, Colem, as an engineering services and design consultancy. Using his experience in management systems, Colem now supplies a unique satellite and broadcast control system design based on the industry standard GE Proficy iFIX Process Control platforms.

Martin has worked with numerous broadcasters and satellite operators, improving their process control, including BSkyB, Reuters and YLE. Prior to establishing Colem, Martin was involved in the engineering and operations of various BT satellite projects for Madley and Goonhilly ground stations in the U.K. His background is in satellite and international telecommunications.

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SatBroadcasting™: A Case In Point—ETL Systems + SIS Live... Betting On The Farm In The U.K.

The baseline—the SIS brand incorporates SIS Betting, one of the world's leading suppliers of content, programming, facilities and technology to the betting industries, and SIS Live, Europe's largest satellite uplink supplier, provide broadcast connectivity solutions via satellite and media fiber.

Supplying the live racing that bookmakers' customers see, the audio commentaries they hear and the betting information on the screens upon which they rely, SIS Betting aims to make the betting process fast, accurate and seamless. From horse racing and greyhound racing in the U.K. and Ireland, to international racing and football in South Africa, France and UAE, more than 45,000 betting opportunities are available through the SIS Betting system.

Meanwhile, SIS Live is the only company to design, build, operate and support uplink and production vehicles in-house, providing a complete bespoke service. The company holds Satellite News Gathering (SNG) contracts with leading broadcasters that include the BBC, ITN and SKY. The company delivers 80 percent of the U.K.'s live news contribution feeds and offers service levels in excess of 99.8 percent uplink availability. During the latest project, SIS Live was tasked to provide a fleet of 18 HD vehicles to ITV, with delivery of the Ka-band vehicles completed earlier this year.

"After 10 years of working with ETL Systems, I would choose their equipment time and time again. With ETL the broadcast is high quality, it's quiet, it's clean and you don't get any unwanted noise. Furthermore, the equipment is extremely well-built, hard-wearing and durable."—Martin Bartram, RF Systems Specialist, SIS Live

The company, which has two bases in Milton Keynes and at MediaCityUK, Salford, owns and operates an impressive inventory of facilities including two teleports and Master Control Rooms; a national and international media fiber network; a satellite Internet department; and the largest mobile satellite uplink fleet in Europe.

The Task

In July of 2012, SIS announced the development of a brand new teleport at MediaCityUK, Salford. As the largest broadcast teleport ever built in the north of the U.K., the state-of-the-art facility includes nine satellite dishes; two 3.8m, two 4.8m, two 6.3m, two 8.1m and one 9m, as well as a handful of smaller dishes. Making use of optimized viewing angles of at least 45 degrees East to 45 degrees West, and via careful placement and separation, the dishes are able to see most satellites in use in the U.K.

"We have been working with SIS for nearly ten years and it is extremely pleasing to see our equipment play such a vital role in their day-to-day operations."—Andrew Bond, Sales Director, ETL Systems

In addition to the teleport, the SIS base at Salford also offers new broadcast facilities that include a master control room, production galleries, studios, voice-over booths, edit suites and data control centers. These core technical and production facilities are critical to the broadcast of tailor-made programming which bookmakers rely on and SIS Betting not only has to transmit live footage from on-site to the betting shops but in many cases also provide specific graphics on top of the content.

SIS Live's new waterside dish farm at the Salford Media City.

Meanwhile, when a major news story breaks, the U.K.'s available satellite uplink fleet congregates from all corners of the country. As Europe's largest uplink supplier, SIS Live is also the only company with multiple regional bases throughout the U.K. and Europe—the odds are highly likely that one of SIS Live's uplinks will be among the first on the scene to deliver the story through the Salford teleport.

The Action

Due to the nature of the content broadcast, it is essential that SIS delivers high quality and reliable broadcasts and, as such, the teleport and master control room have been fitted out to a high specification

SIS Live's new Monitoring + Control Room

ETL Systems, an experienced global designer and manufacturer of RF distribution equipment, had already provided products for the Milton Keynes base and was again brought in by SIS to provide their Enigma transmit and receive matrix distribution system. Designed to route high quality and dependable 24/7 signals, the system forms the backbone of SIS' Salford operations.

ETL Systems equipment in use at SIS Live.

ETL also provided combiners and splitters from its LD series for fixed satellite feeds and also Alto Amplifiers to allow input signal levels to be controllable and balanced.

The Result

The established and evolving Enigma Matrix range has been designed with reliability and resilience in mind. Through use of this product, SIS Live is delivering broadcasts of the highest quality to its customers, with a focus on high linearity and enhanced flatness.

The high performance solution has been developed for busy satellite teleports and allows for frequent signal routing changes, as well as offering a touch screen and full remote control for monitoring and control.

By selecting ETL Systems, SIS has ensured the efficient delivery of the U.K.'s live news contribution feed along with bespoke television to thousands of betting shops across the country. The Enigma matrix system is also expandable to allow future upgrades as SIS continues to grow.

For additional information regarding SIS Live: ***http://www.sislive.tv/***

ETL Systems information is available at: ***http://www.etlsystems.com/***

In The Pursuit Of SATCOM Opportunities

By Jacob Keret, Senior Vice President of Sales, North America, Europe and the Middle East, Spacecom

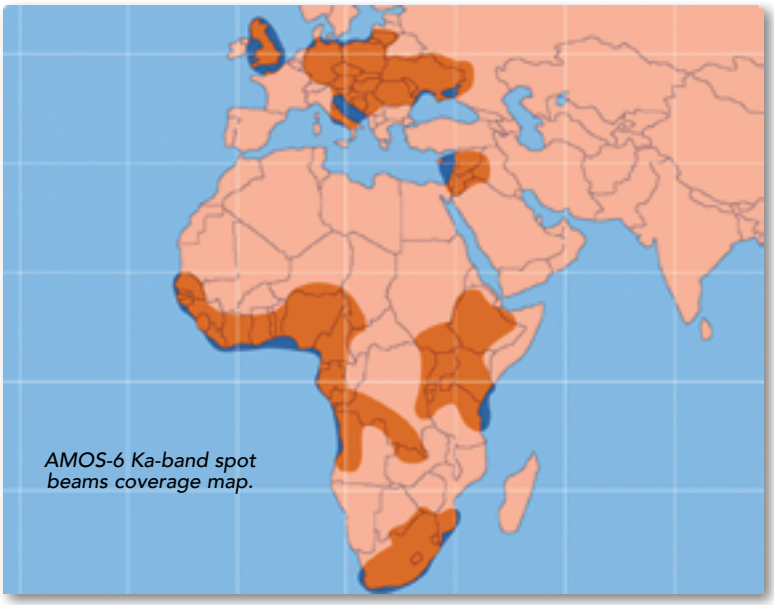
As a growing, multi-national satellite services provider, well known name across the globe are the Spacecom and AMOS brands.

Spacecom's fleet provides satellite services to customers in North America, Europe (primarily Central and Eastern Europe), the Middle East, Africa and Asia. New technologies have been introduced into every satellite and the company ensures that customer service and fast response times are part of the services repertoire to ensure clients are placed first.

In North America, as in every other market, we pursue international opportunities. Whether in broadcast, broadband, data communications and telecom services, Spacecom is, above all, a reliable international satellite provider. We offer a wide range of communication and broadcast services for the telecom, broadband and broadcast markets, such as Direct-To-Home (DTH) and payTV operators, Internet service providers (ISPs), telecom operators, network integrators and government agencies.

During the past year, business was generated in all areas of the spectrum: broadcast, broadband, government and corporate. Telecom operators are using the AMOS fleet for data backhaul and innovations in the area of Internet broadband, whereas our traditional broadcast business is enabling clients to move to digital from analog technologies. Spacecom continues expansion of the AMOS brand and entry into new markets.

One of those markets is the oil & gas (O&G) industry. Multinational O&G companies have an increasingly huge part of the industry with installations, platforms, oil fields and refineries around the world. Our satellites at the 4 degrees West and 17 degrees East orbital locations can fulfill the international needs of these companies. For instance, our 4 degrees West 'hot spot' position, where we currently have two co-located satellites, AMOS-2 and AMOS-3, provides an Atlantic bridge to the U.S. East Coast as well as coverage extending to Europe and the Middle East. Here, we cover a large swath of the world with strong signals which can be advantageous for connecting U.S. headquarters to European offices to Middle East operations and oil fields.



AMOS-6 Ka-band spot beams coverage map.

Spacecom's ability to reach the entire operational stream can be valuable to worldwide, intra-company communications.

Our 'bridge' position will be strengthened later in 2015 after the launch of AMOS-6. The new satellite at 4 degrees West will be larger than both of its partner satellites combined and will incorporate new technologies, such as High Throughput (HTS) Ka-band spot beams for improved broadband Internet access. AMOS-6 will expand our European coverage with a new Pan-European beam that reaches Western Europe. With the beams covering Europe and Africa, as well as Ka-band technologies for HTS, Spacecom will also be reaching the oil producing regions of Africa, including the off shore installations of West Africa.

Maritime is also an exciting market segment where Spacecom's satellites can provide solutions. For North American corporations needing to reach ships or installations off the coast of Africa or throughout the Mediterranean Sea basin, AMOS satellites offer top notch solutions, thanks to strong orbital positions at 4 degrees West and 17 degrees East.

Another key international market requires more security and discretion than usual. This is due to the nature of operational protections that various governmental agencies, such as the U.S. Department of Defense (DoD) and others demand. The exacting needs of various national agencies and government bodies present an exciting challenge for satellite operators. Transmission security is fundamental to these communications—especially true when two-way communications travel internationally over great distances and where unencrypted message interception could prove to be catastrophic.

With more than one satellite at the 4 degrees West position, Spacecom can supply full redundancy. With the capability to use more than one band type, different bands can be used to send communications to various regions requiring secure connectivity. This service and support is now possible, from the U.S. to Europe or to the Middle East, Asia and Africa.

Data communications between continents by corporations and telecom providers is yet another growing market. Here, the growth of mobile traffic and the prolific increase in mobile data are the driving business engines. From Wall Street to Main Street, from the hotel to the office, or from the trade floor of the Walter E. Washington Convention Center to HQs across the seas, the flow of data communications needs to be reliable, secure and quick.

With reliability and high speeds, satellites are the backbone of international data communications. Having ground partners, teleports and service providers working with Spacecom, the company is well positioned to supply all of these services. The North American markets are poised for more growth and Spacecom's teams are continuously developing products and services for these arenas and new business opportunities are constantly being generated.

The AMOS brand is well known as reliable and nimble when responding to any customers' needs. This service and support will continue in the future for North America as well as around the globe.

Further information: ***http://www.amos-spacecom.com/***

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A Game Changer: Crossing The "RF Over IP" Chasm

By Scott Criley, Product Director, RT Logic

Imagine our world pre-IP—hard to imagine— unless you're in the satellite industry, where ground systems continue to be defined by their analog nature. Restricted by the short distances that RF signals can be routed before they degrade, antennas and signal processing equipment have essentially been shackled together in close proximity—a constraint otherwise not found in the IP-enabled world. That's limited how ground architecture could evolve to solve issues such as site diversity and centralization.

However, if those analog RF signals could be digitally manipulated and transported over IP networks to any point in the world, new possibilities would be opened up to resolve rain fade, as just one example. Well, that time is now because the technical obstacles that have obstructed "RF over IP" use, namely managing jitter, packet loss and delay (problems common to IP transport) have been overcome, much like the breakthroughs that now enable Voice over IP (VoIP), video chat, and live event streaming.

Why Digital IF?

Digital IF (Intermediate Frequency), also referred to as "RF over IP," "packetized IF" and "IF over IP" theoretically holds far-reaching promise. For satellite and teleport operators, RF over IP is a game-changer that can unleash newfound flexibility in ground system architecture. The ability to digitize and transport RF signals in real-time without data loss effectively removes the limitations of distance and signal degradation imposed by analog RF.

With Digital IF, antennas can now be placed at the optimal location based on costs, real estate availability and signal reception, fully independent of the processing, which can occur anywhere, at any distance from the antenna itself. This site diversity solves a host of issues for commercial, military, broadcast, and telecom use. However, before we explore those possibilities, it's best to understand what's prevented RF over IP transport to appreciate the advances that now make such possible.

The Promise

Digital IF isn't exactly new. There has been significant progress developing Digital IF standards and technology and even cases of the technology being integrated into operations. Generated by I&Q sampling of RF spectrum, the sampled digital signals converted to and from their original form can be moved across local data lines for use with DSP equipment and to replace expensive and fragile analog cables and switch equipment within a site. And, they aren't subject to the introduction of noise when being transported between the antennas and the processors.

The greatest value of RF over IP, however, may be its (theoretical) ability to move digital spectrum over an IP network of any distance, where it can be reconstructed at the destination for processing by legacy equipment. Until now, that's also been the greatest hurdle, stymied by the technical limitations and behavior of IP networks and the issues of jitter, packet loss, and latency. For those reasons, RF over IP hasn't been ready for prime time. That's why it's been relegated to limited use, mostly in local on-premise networks, or for non-real-time processing applications.

The IP Conundrum

TCP/IP is reliable, but due to its packet-based behavior, is unsuited to long-distance, real-time Digital IF transmission. IP packets aren't always received in the same order as they are sent, can be delayed by network traffic, then lost or discarded when the disordered packets are reassembled on the other end.

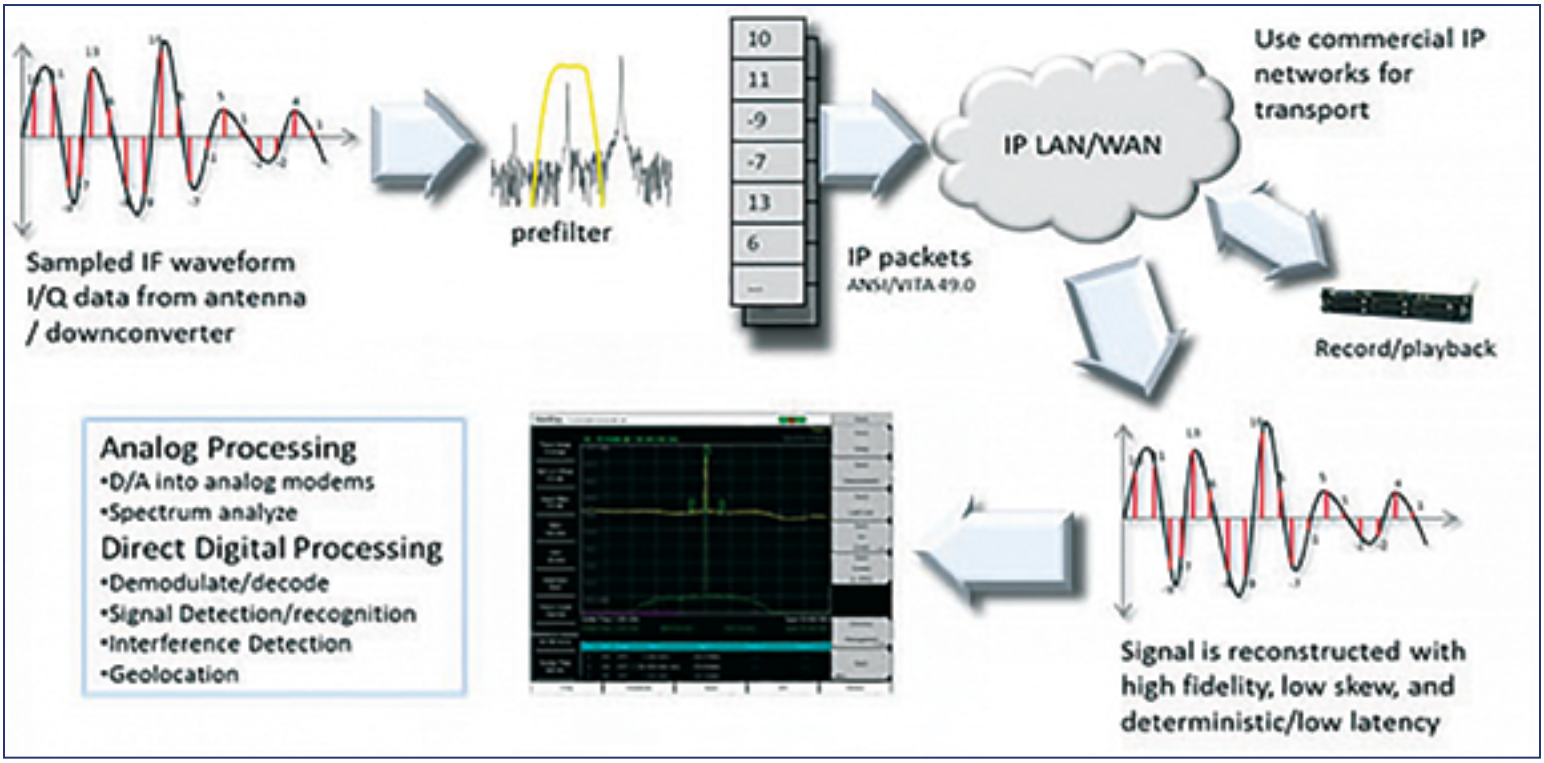


Figure 1. Packetized IF decouples transport and processing from receive/transmit

The human ear may not discern missing packets when an MP3 is played, or care about the 30 seconds required for an email to arrive, but RF signal processing equipment is quite particular; packets ingested out of order, with delays and incomplete data, cause modem time-outs, reboots, and transmission failures.

Overcoming The Hurdles

As IP network protocols neither transport data deterministically (without change or variance), nor with minimal latency, the implementation of packetized IF requires several innovations. Kratos has addressed these problems with the following technical advances that are now available:

Deterministic Latency of transported data: To accurately regenerate the analog spectrum at the destination, new algorithms are employed to leverage precision time references at either end of the link and for handling the data, ensuring the accurate time-release of (signal) data to its output D/A converters. This allows modulation and coding schemes that rely on precise timing, such as TDMA and frequency-hopping waveforms, to be correctly processed after WAN transport.

Packet Loss Protection: Typically, if a bit error occurs within a packet, traditional forward error-correction (FEC) codes provide no protection against IP data loss; the IP checksum fails and the entire packet is lost. New algorithms which include Packet Forward Error Correction (P-FEC) treat successive packets in a digital IF data stream as data elements subject to loss/repair, essentially using information in nearby encoded received bits to reconstruct the lost packet data. This overcomes packet loss caused by network congestion, traffic load balancing, or other unpredictable network behavior that result in lost, duplicated, or out of order packet delivery.

Managing the IP bandwidth for digitized IF transport: Digital IF requires large amounts of IP transport bandwidth, with the rule of thumb that it takes 20 times the amount of transport bandwidth (Mbs) as the size of RF signal captured (MHz); i.e., 40 MHz of RF bandwidth requires 800 Mbs per second of transport bandwidth. Advances now enable the desired signal center frequency and bandwidth to be sub-band tuned from the input spectrum source so that no unneeded data is sent over the network, minimizing transport bandwidth.

This spectral channel capability also allows multiple signals of interest to be selectively tuned and distributed to different destinations for either digital or analog processing. The bit resolution of the A/D sampler is also adjustable to optimize the network loading while preserving signal integrity for modem processing.

In sum, these new techniques push the protected packets in a real-time data stream over the IP network, using buffering and measurement processing on each end. By delivering the full and accurate data set, the digital IF signal can be faithfully reconstructed at the destination for either analog or digital processing. This enables 1) the use of digital IF over long-haul IP networks of unlimited distance without of signal degradation or delay effects, and, 2) conversion of the digital IF back to the original RF analog signal so it can be used with existing analog equipment and ground architecture, until mainstream digital IF hardware is available. (*See Figure 2 on the next page.*)

Figure 2. SpectralNet brings analog RF data to the IP network world.

Real World Applications

By reconstructing the digital IF back to the original format, the modem equipment expecting L-band input won't know or care it's not next to the antenna; it only knows it's still receiving the RF signal as if it were still hardwired directly to the antenna, while in fact it may be hundreds or thousands of miles away.

The benefits of this technology for long-haul network transport and RF signal reconstruction can bring new dimensions to ground segment architecture. Satellite and range networks can now follow the lead of other industries, like telecommunications which have already transitioned to IP- based infrastructure.

Site Diversity + Rain Fade Mitigation

In regions where rain and weather outages impact Ka/Ku band satellites, operators can deliver guaranteed service over high frequency satellites with an alternative approach. Rather than rely on single oversized expensive antennas and amplifiers, they can now site two smaller, low-cost geographically dispersed antennas, transporting the Digitized RF signal to a central facility for processing.

With two independent satellites (and paths), if one is affected by rain, the other can be used. These advances also allow the RF signal data captured at two different sources to be precisely aligned, switching between the sources for a best source selection. The digital IF is converted back to RF, controlled for output frequency and gain, and fed to downstream equipment with minimal data loss.

Resilience

RF over IP also supports site diversity for continuous military operations. Should sites be physically damaged or electronically jammed, the digitized IF stream can be routed to another transmission site. Because the digital IF data is already encrypted (prior to the modem), the data is no longer sensitive and can be transported without special equipment. The remote site can operate as a 'dumb' terminal/ground station, forwarding encrypted data through without requiring personnel to be located at austere or dangerous remote sites to receive and process classified data. This can reduce unneeded secured facilities and infrastructure.

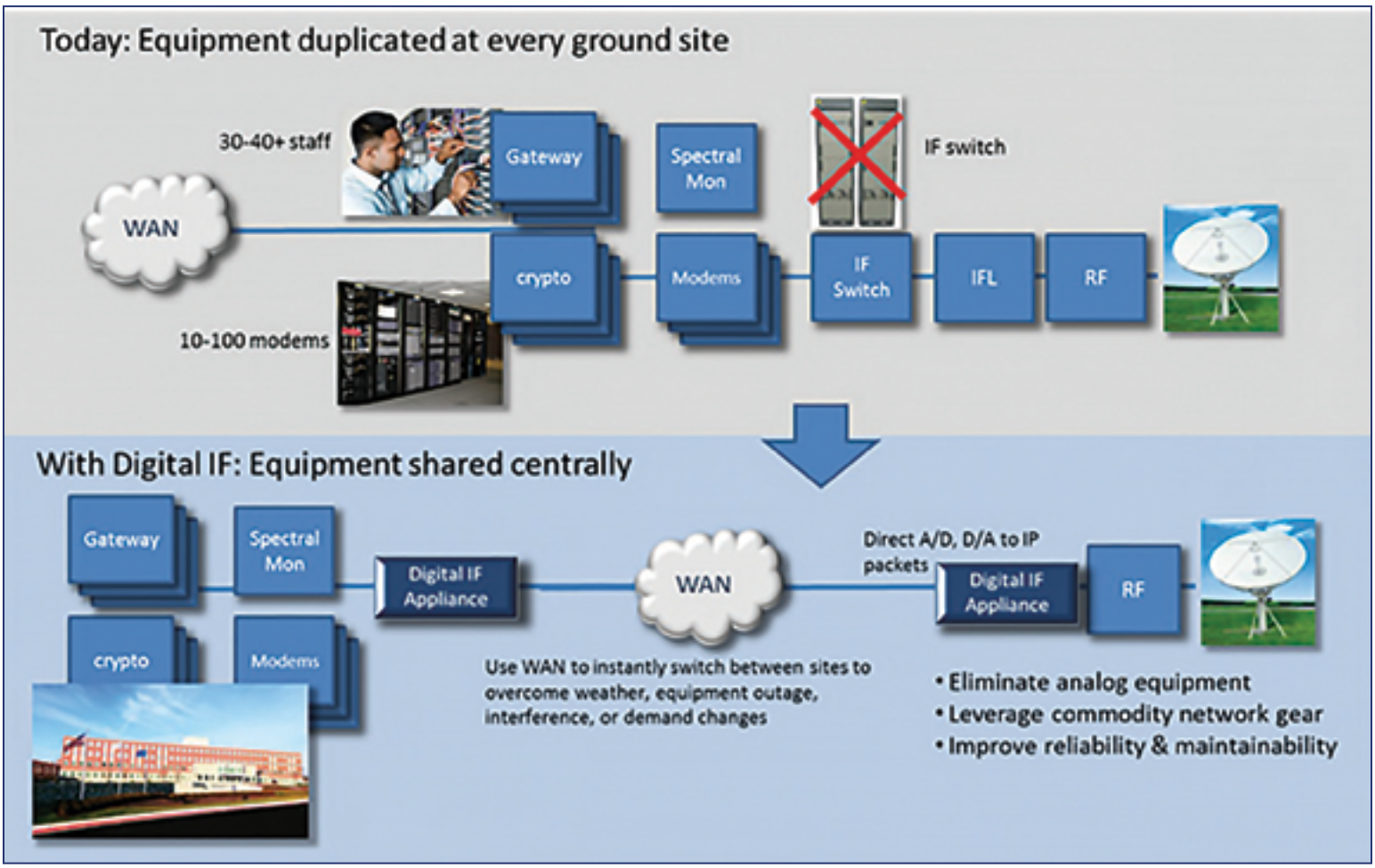
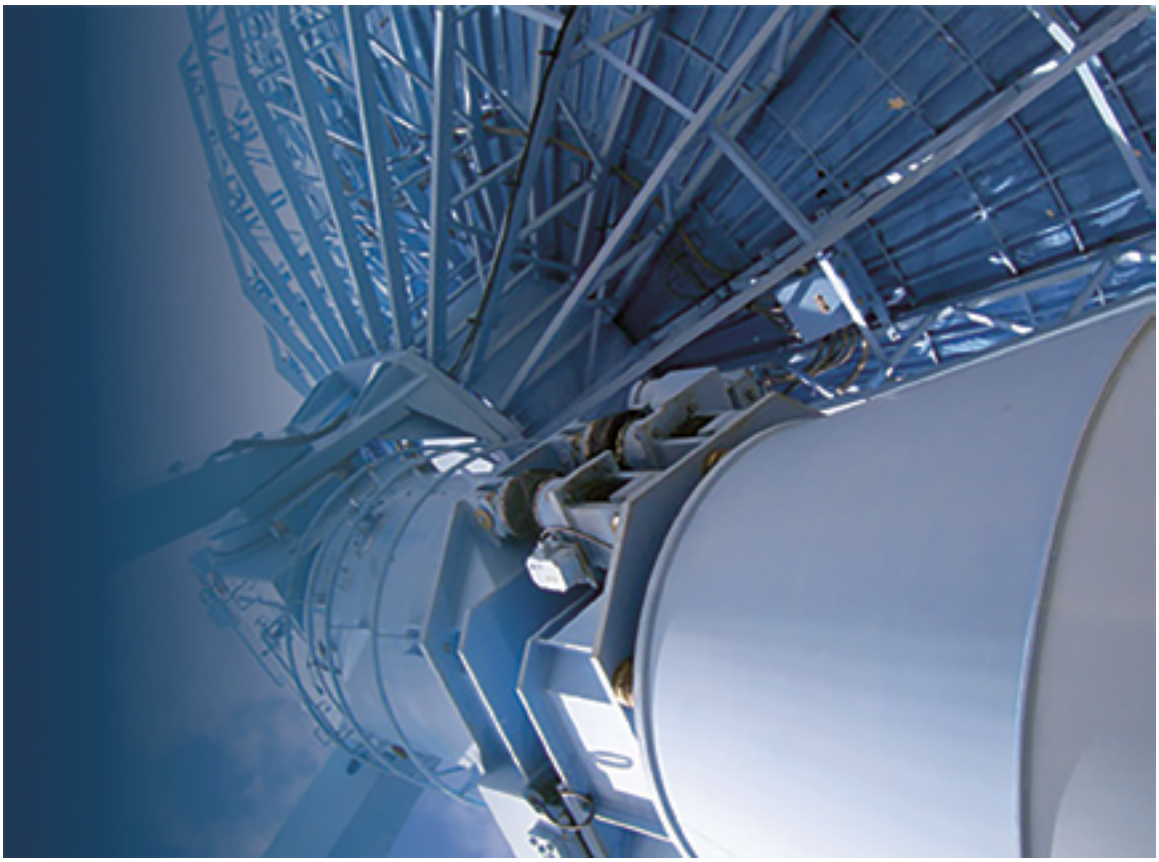


Figure 3. Packetized IF reduces needed equipment footprint at ground sites



industry will be swept along in a wave of transformation.

Solving the technical limitations of RF over IP transport are foundational steps for the future of the ground segment. The industry can take advantage of these advances to not only realize immediate benefits, like site diversity, but to also envision a migration path from analog defined infrastructure to the advantages of an IP-enabled world. For further information, please visit the RT Logic infosite at ***http://www.rtlogic.com/***

Scott Criley is Product Director at RT Logic, a Kratos Company.

Path Diversity + Disaster Recovery

Teleport operators or content originators with stringent service level agreements (SLA) for broadcast and video will l have new path diversity and backup options to better meet SLA requirements. Digital IF provides new backup and path diversity options via terrestrial routing of RF data to deliver SLAs.

Virtualization + The Way Of The Cloud

Because the future often arrives before we're ready for it, digitized IF will ease the transition to IP and the advantage of less expensive, more flexible software defined processing and cloud infrastructure. A purely software-based modem application becomes feasible, with modulation, coding and framing algorithms performed by commodity servers, like that in a centralized cloud processing center.

Eventually, expensive, specialized analog hardware can be changed over to IP-based computing. If the algorithms are adjusted or updated, no equipment changes are required at the ground antenna site, and software-only modifications to the modem application can adapt in a virtualized processing environment. This lowers overall costs and boosts flexibility in reusing the ground equipment as space platforms and waveforms change.

The Way Forward

With transport distance no longer a factor, teleport and satellite operators can rewrite their ground architecture models. Comms and TT&C that can be sent from antennas to any location in the world for processing, supports new concepts of centralization. Operators can start to move forward to consolidate expensive ground equipment and operations, realizing cost-savings and efficiencies by reducing real estate, duplicative RF equipment and infrastructure, and the overhead of distributed personnel and administrative functions.

For many reasons, the satellite industry has been measured and deliberate in its approach to technology adoption, preferring incremental refinement and proven reliability rather than wholesale change for the sake of change. However, the footprints of change are all around us—before long, the satellite

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RT Logic, a Kratos company, recently announced SpectralNet ™ the only commercially available product that digitizes RF signals for transport over virtually any distance on IP networks in a way that preserves both frequency and timing characteristics and restores the RF signals at their destination, enabling reuse of existing analog equipment.

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Careers: The Path To The Future—Measuring Wealth... What Has Changed?

By Bert Sadtler, Senior Contributor

A company's prosperity and success is measured by wealth. However, is financial acumen the only—or the best—measurement of wealth in today's business world within a retail chain, in a corporate structure and on Wall Street?

We know the only constant is change. With the constant changes in business, are there other measurements of wealth on which we can focus? Let's look at wealth from three perspectives:

- ***"Wealth" from financial related assets***
- ***"Wealth" from information***
- ***"Wealth" from your network of contacts/connections***

The Wealth Of Assets

A Google search of "wealth" reveals... "Wealth is about more than money: It's about assets. Assets being the stuff that you own: your car, your house, your collection of Rembrandt paintings, your Cartier watch. Cash money is an asset, too—so include your bank account on the asset side of the equation."

As everyone knows,just because a definition has been sourced from the Internet doesn't necessarily make it true. But shouldn't the discussion of wealth extend beyond simply financial considerations?

The Wealth Of Information

Once upon a time, the value of a businessperson was measured largely by the information s/he possessed. Many believe their information protects them and keeps them as a valuable member of their business community. After all, "information is power."

As the Internet became an integral part of the fabric of everyday life, data and information became available to anyone who could access a keyboard and monitor. Want to make a repair to your home? Simply look up the solution on YouTube. Need a mechanic? Just "Google it."

Value nowadays is much more about the businessperson's problem solving abilities and critical thinking. In fact, business experts today are referred to as "thought-leaders". We could say that the person who relies heavily on what data they possess is less "wealthy" than when compared to an earlier time. With technological changes, data and information have become a commodity.

The Wealth Of Human Connections

In spite of all the recent technological advancements, human relationships in business carries far more weight than ever before. As an example, several decades ago, making a business "cold call" was a natural way to drive sales revenue. Today, most businesses have locked doors and there is no pathway in without an appointment. In order to obtain that appointment, one first needs to have developed a personal relationship within that business.

People want to do business with contacts they know and trust. Technology has given everyone and anyone the ability to send email and text blasts and to program robo-calls 24x7. Thanks to technology, and in spite of all of this access to the prospective purchasing audience, nothing obtains an appointment faster than having established personal familiarity and trust with the potential client's representatives.

Technology can enhance and accelerate business, but human interaction continues to trump all. For example, LinkedIn has helped companies and individuals to network faster and more efficiently. But the one-to-one networking occurs when people meet and connect, face-to-face. LinkedIn is a tool. No more, no less.

The value of connections can elevate an experienced employee with several years in a position more valuable than a younger business professional, thanks to the former's accumulation of more reliable data and information.

Today, the seasoned professional has had more time and more opportunity to develop strong connections and business relationships. In reality, some have done a far better job of leveraging their experience than others. However, this is all part of the rule of change. Nothing stays the same—you must remain agile in your business life. For the business professionals who have invested in building relationships find themselves in a valuable position today.

Think about it—how many internal business conversations include a discussion about, "Who in our company knows someone that our partner/competitor/prospective customer knows?"

Knowing people isn't enough. Are your business relationships active with people of influence? Is there a two-way relationship of give and take between your firm and the external contacts? Will those contacts return that important call? Have you made them comfortable enough to speak with you in confidence?

Businesses demand growth. Growth is derived through the successful penetration of new markets, building revenues in existing markets, teaming, partnering and acquisitions. All of these events happen between human beings. These tasks become more difficult when none of the human beings involved knows one another. There is a much higher degree for success when there are established human connections. Several examples of such personal interactivity include:

- ***Research local industry events and attend them to make new contacts***
- ***Schedule meetings within your current network and ask to be connected with people they know who are "well connected and well regarded"***
- ***Ask your contacts what you can do to help them***

Effort is required to nurture the human connections which, in turn, can build financial wealth. ***Good hunting.***

Bert Sadtler is the President of Boxwood Search and a Senior Contributor for SatMagazine—There is a ongoing battle for senior level talent. A great hire can make a long term positive impact and a failed hire can prove to be quite expensive. How does a company recruit and hire the right talent? This activity requires more than simply networking within the community of friends and business associates—focus on results through a process oriented approach is required. Boxwood Search is committed to reaching a successful outcome when seeking human resources. The recruitment methods used have successfully proven the delivery of qualified senior talent for firms. Contact Bert at ***BertSadtler@BoxwoodSearch.com*** *for additional information.*

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The Space Data Center's Beta Test

By Mark Rawlins, Chairman, The Space Data Association (SDA)

In last month's issue of *SatMagazine*, the Space Data Association (*http://www.space-data.org/sda*) talked about the Space Data Centre and the organization's role in managing data for Radio Frequency Interference (RFI) mitigation.

By the time we get to Satellite 2015 in DC, together with AGI, we plan to have a beta version of a geolocation solution set optimizer tool operational. You can arrange for a time slot at AGI's booth to obtain additional information and a demonstration. In this article, I will explore in more detail just how this part of optimizer function will work and how such will help resolve interference much more quickly and efficiently.

Geolocation

Geolocation is an extremely useful tool for identifying the source of interference, especially when there is no Carrier ID. There are a number of solutions available, but we see a need to make geolocation better and faster to drastically reduce the time to resolution once interference occurs. The challenge with geolocation is that to be truly effective, you need more than one satellite to conduct the search and find the source. In most cases, an operator won't have two owned satellites together. We saw a need to share data that helps them identify another satellite they can use to perform the geolocation.

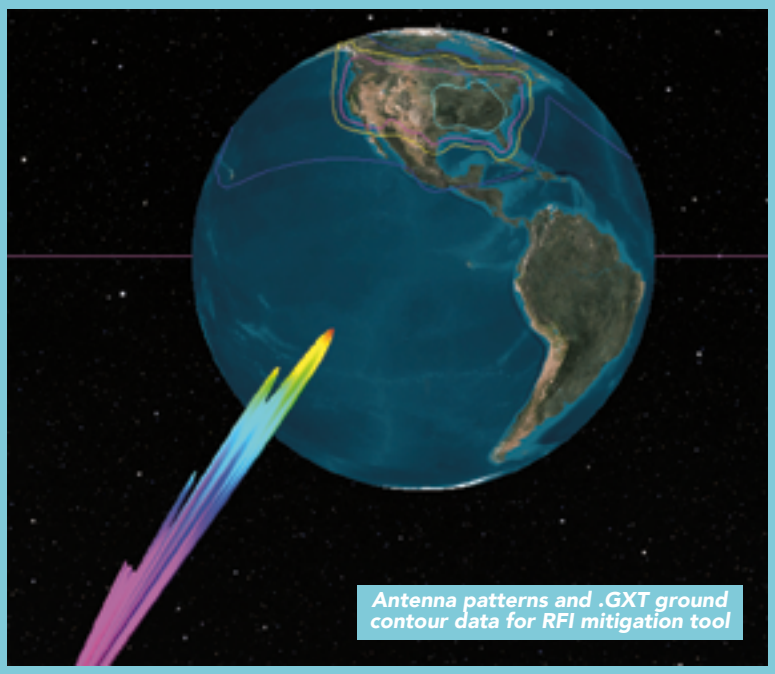
However, the difficulty in selecting the best neighboring satellite, reference emitters, and time for geolocation which meets all geolocation requirements can be quite daunting. Geolocation requirements include: (1) a neighboring satellite that is positionally well known and has simultaneous coverage of both the interfering uplink signal and the downlink geolocation system ground antennas; (2) compatible reference emitters residing within the same local oscillator range on each satellite as the interfering signal; (3) times of day when TDOA and FDOA contours (isochrones) best complement (i.e., are roughly normal to) each other.

This problem led to the idea of creating an SDC tool to automatically analyze all geolocation solution set possibilities and rank-order them within the Space Data Centre (SDC). When the SDC is alerted to an interference event, data stored in the database can be used to provide feasible and optimized solution sets that consist of secondary satellites, reference emitters and optimal times-of-day for geolocation measurements.

Gathering The Data

In addition to RFI prevention, the SDC already has a number of significant operational capabilities and roles, with a key one being the safety of flight. As safety-of-flight already requires much of the data necessary for this new RFI mitigation function (e.g., authoritative satellite ephemeris data incorporating maneuvers), the next step was to establish what additional RF data would be needed for the geolocation tool to be effective. These include detailed RF parameters such as transponder frequency bands, conversion frequencies, local oscillators, antenna patterns or .GXT files (*as shown in the figure at the top of the right column)*, transponder connectivity configuration, reference emitters, and so on.

Data is already being fed in by satellite operators across the globe. For testing and development, Eutelsat, Intelsat and SES collected data for a few of their own satellites that were specifically selected to have other operators' satellites in close proximity—we have provided this information to AGI for use in the prototype demonstration system. Of course, the more data we obtain, the more we can do with that information and the SDA is continuously working to expand that reach. We are talking to satellite operators who are not already onboard with us and we are discussing ways for effective data sharing with various government agencies.



Antenna patterns and .GXT ground contour data for RFI mitigation tool

Calculating Workable Geolocation Scenarios

As noted above, there are many elements of information and constraints in the process of identifying optimal RFI geolocation solution sets. There are also at least six error sources which degrade the geolocation solution: (1) TDOA measurement error; (2) FDOA measurement error; (3) unknown turn-around time on the primary satellite; (4) positional error on the primary satellite; (5) unknown turn-around time on the secondary satellite; (6) positional error on the secondary satellite.

Additionally, the relative geometries and range rates of the satellites, interferer, geolocation system, and reference emitters affect the efficacy of any given potential geolocation solution set. The algorithm that AGI is developing uses the aforementioned RF payload data from satellite operators and the SDC's live positional knowledge. This data is then used to generate the relevant numerical partials of each of these effects to assess the impact of each of the six error sources listed above and determine the best solution set(s) which minimize the resultant geolocation error.

Prototype System

AGI is currently pulling all of this together to build a prototype system which, in this first phase, will be manually operated. This will enable us to validate the proof of concept and to refine the system so that we can transition toward an automated system in the not-too-distant future. AGI can provide the latest status and details at the upcoming Satellite 2015 conference. We would like as many people as possible to learn more about this tool and give AGI and the SDA feedback to help us improve the tool and make it as useful to communications satellite operators as possible.

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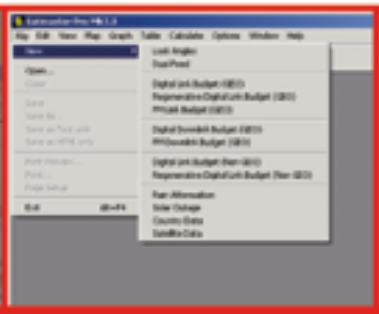

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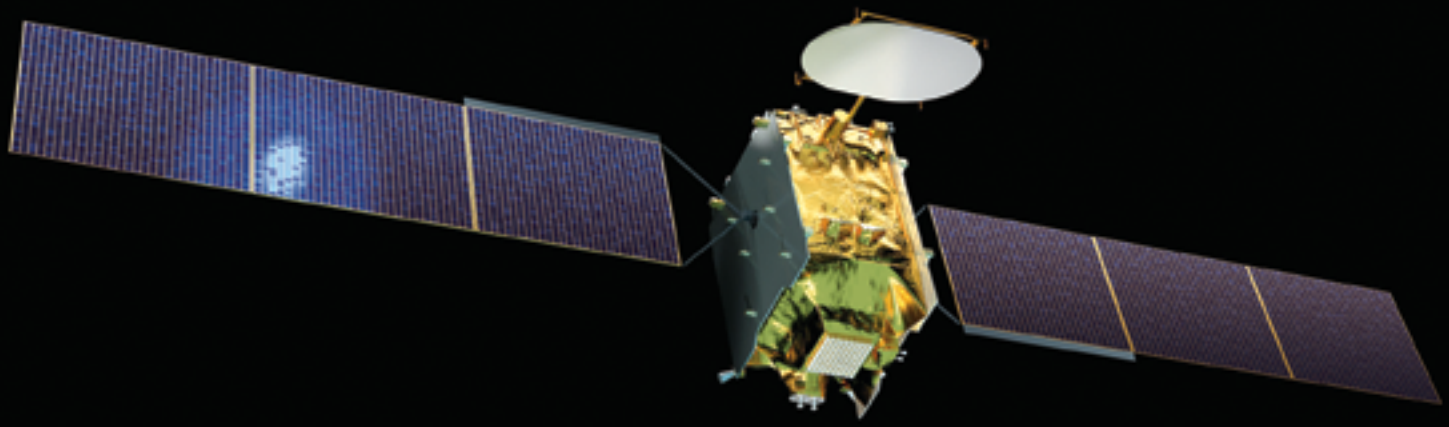
SSTL Joins The GEO Club

By Maurizio Vanotti, Head of Telecommunications, Surrey Satellite Technology Ltd.



The Eutelsat Quantum spacecraft.
The image is courtesy of Airbus Defence and Space.

For some years now, Surrey Satellite Technology Ltd. (SSTL) has been working on a new, small, geostationary platform design, the SSTL GMP-T, under ARTES funding from the European Space Agency.

Then, in December of last year, the company announced that the firm had been selected to build the first "Eutelsat Quantum" class telecommunications spacecraft, which is due to launch in 2018.

Eutelsat Quantum Spacecraft

Sir Martin Sweeting, Chairman and CEO of SSTL, said, "We are delighted to be teaming with Eutelsat, ESA and Airbus Defence and Space in the development of this highly innovative, flexible satellite solution. Not only is this an exciting mission and application, it is a milestone for SSTL providing an anchor customer for the transfer variant of our Geostationary Minisatellite Platform (GMP-T)."

The new Eutelsat Quantum spacecraft design, which incorporates a payload and software from Airbus Defence and Space, will represent a first in the commercial satellite industry, as the satellite will enable the complete electronic synthesis of "receive" and "transmit" coverages in the Ku-band. The satellite will give Eutelsat's customers access to premium capacity through footprint shaping and steering, power and frequency band pairing, and the ability to define their own performance and flexibility requirements.

Highly Flexible + Scalable

SSTL's small geostationary GMP-T platform design is a variant deriving from GIOVE-A, which has operated successfully for more than nine years in MEO orbit. SSTL's small geo GMP-T platform is designed to keep the configuration as simple as possible, streamlining construction so that the sub-systems have a modular design wherever possible. The GMP-T platform provides reliable and flexible mission solutions for ever increasing telecommunications needs and is suitable to address broadcasting (DTH), fixed VSAT communications (FSS) and mobile communications (MSS).

The GMP-T platform has a design life of 15 years and a launch mass of 1,000 to 3,500Kg. A scalable design can accommodate commercially available payloads with three ranges of power requirements up to 7kW and up to 450 kg. with a construction schedule that is dependent upon payload requirements.

Using the mid-sized platform of the GMP-T power range, SSTL can stack two platforms onto a single launch vehicle, thereby significantly reducing total customer expenditures. Available launchers are the Falcon-9, Zenit, Ariane and Proton.

SSTL is also currently designing a variant platform without a central cylinder. The company can offer a direct injection variant based on an external load bearing structure.

SSTL's GMP-T central thrust tube SQM.
Photo courtesy of SSTL.

SSTL's GMP-T SQM under test at Intespace, Toulouse.
Photo courtesy of SSTL.

The platform is designed to cover a wide mission range, from GEO, to HEO and MEO. The modular structure is compatible with a dispenser and base-mounted launch configuration and offers maximum flexibility in terms of launch opportunities.

Small GEO Under Test

The various GMP-T sub-systems are currently undergoing qualification tests, conducted under ESA's ARTES-3/4 programs, and are close to completion.

Earlier this year, SSTL's GMP-T Structural Qualification Model (SQM) was tested at the Intespace facility in Toulouse.

The SQM has been built to fully represent the flight model design and uses mass dummies of all of the equipments throughout the structure. Testing included Sine vibration, shock and acoustic noise to demonstrate:

- Complete structural qualification
- Characterization of the structure dynamically with full and empty tank dummies
- Validation of the finite element model

SSTL is also aiming to bring their expertise in successful Know-How Transfer and Training programs into the communication satellite arena. They are offering a training program that includes academic qualification, theoretical, and hands-on training for as many as 20 trainees, targeted at organizations aiming to build self-sufficient space capability.

SSTL has always pushed at the boundaries of space technologies and is now making the leap to GEO orbits a reality. SSTL will be attending Satellite 2015 in Washington, at Exhibit 6120.

The SSTL infosite is located at http://www.sstl.co.uk/

Diversity Is The Key For Today's North American VSAT Marketplace

By Robert Smibert, Founder + Chief Executive Officer, Virgin Technologies

The recent and dramatic drop in commodity prices has brought into stark relief that any manufacturer confined to a single vertical is always at the mercy of that particular market.

While Virgin Technologies Inc.'s history has been predominately servicing the oil and gas (O&G) markets in Western Canada—everything from drilling rigs, camps, mobile data vans and pipeline—the company is in the fortunate position of diversification in the energy sector internationally, as well as benefiting from a burgeoning Global Dealer Network for the original equipment manufacturing (OEM) division.

In the North American antenna marketplace, there are a myriad of choices for educated consumers, while the static satellite marketplace is awash with local, regional and large telecom players providing consumers an almost unlimited number of options. Factor in BGAN, satellite telephony and other handheld options and this market is extremely competitive for customers who are not always certain what product best aligns with their needs.

Similarly, in our experience, the VSAT auto-aiming marketplace in different segments of the North American is still playing catch up in terms of sophistication and education of the benefits that auto-aiming antennas provide over much less expensive static antennas options, for example. Even within well-established verticals, some end-users have a good understanding of the need for satellite communication and its ubiquity, while others simply do not.

For instance, one recent emergency response customer added a Virgin Technology antenna after experiencing a catastrophic flood in which they were cut off from outside communication for three days. That is a tough lesson to learn, and a difficult sale to make if the need of satellite technology is essential, but only when such is required by an end user.

For our business, we note two key challenges before us as North American manufacturers. First, customer eduction is a continual process to show to potential clients the benefits of auto-aiming satellite technology, while constantly being challenged stay abreast of new developments and innovations across the globe.

Secondly, there is the ever-present challenge of finding homes for these products amidst extremely differentiated end-users and market applications.

In the North American marketplace, Virgin Technologies is focusing diligently, and generating great interest in, our Global Dealer Network as this puts our highly-regarded products into local markets. The education and sales cycle is relegated to those who know the end-user best—the local dealers and resellers.

As manufacturers, the company is fortunate to have a great deal of control over costs and have the flexibility to customize for different end user needs. Such allows us to compete with many of the more entrenched players in this space; an opportunity that will continue to lb leveraged as more brand and product recognition is gained in North America.

In 2014, a big step forward was taken from being a regional player to an international manufacturer by developing and launching Virgin Technologies' 1U DVB Antenna Controller, which is ideal for the broadcast and satellite news gathering (SNG) marketplace, among other markets.

This universal controller is compatible with any modem and teleport platform. Again, the North American marketplace demands product diversification. These developments are the direct result of listening to customers and end-users and developing a customizable strategy for individual client needs.

Additional information is available at ***http://www.virgintechnologies.com/***

Robert Smibert, with more than 25 years of experience in telecommunications and technology, founded Virgin Technologies in 2001 after serving as Director and Chief Technology Officer for Saflink Corporation (NASDAQ:SFLK). Rob led a team of more than 40 software engineers and R&D personnel and transformed that company's technology vision for their biometric products.

Prior to Saflink, Rob was co-founder and Chief Technology Officer of Jotter Technologies, where he developed the Internet's first "e-Wallet" application, which PC World Magazine dubbed as better than Microsoft's Passport and Novelle's Digital Me products. Rob was instrumental in the sale of Jotter Technologies to Saflink Corporation and remained as Managing Director of Jotter Technologies, managing investor's interests and debt reconciliation.

Rob's extensive experience also includes technology innovation and management roles with RedCell, a Canadian battery startup, and Acu-Trol Canada, an aquatic automation equipment company Smibert founded in 1994.

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