Worldwide Satellite Magazine October 2012

SatMagazine

This issue...

***The Right Tempo*: ILS, Arianespace, ULA, Sea Launch, Lockheed Martin, China Great Wall Industry, SpaceX**
NASA's *Aqua*
Forrester, Gough, Pulham
The HPA Corner
Interorbital
SSC's *Gardefjord*
iDirect's *Bettinger*
Wireless GaN

SES-5 launch cover photo courtesy of ILS

SatMagazine—October 2012—Vol. 5, #5

ILS Proton Successfully Launches SES-5 For SES

SES-5 Hosts First L-Band Payload For European Geostationary Navigation Overlay Service (EGNOS)

Publishing Operations

Authors

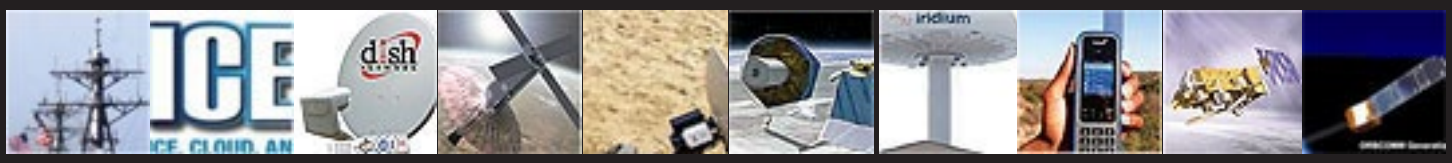
David Anhalt | JoAnn Spolidoro | David Bettinger
C. Damian | Cheryl Dybas | Chris Forrester
D. Gelerman | David Leichner | Hartley Lesser
Randa Relich Milliron | Elliot H. Pulham | Pattie Waldt

Advertisers

Published monthly by
SatNews Publishers
800 Siesta Way
Sonoma, CA 95476 USA
Phone: (707) 939-9306
Fax: (707) 838-9235

SatMagazine—October 2012—Vol. 5, #5

InfoBeam



Features

SatMagazine—October 2012—Vol. 5, #5

Prominent Presences @ World Satellite Business Week

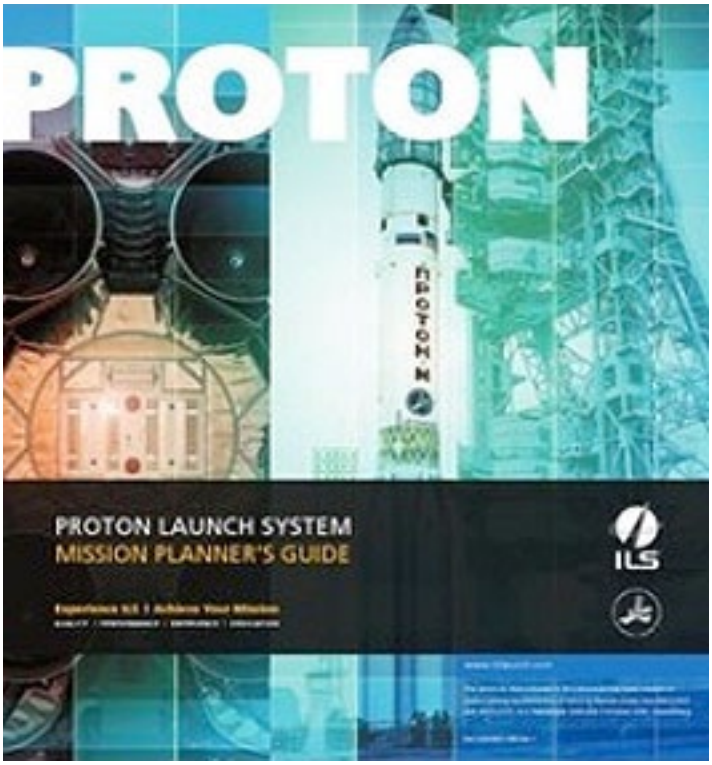
The 14th annual Euroconsult World Satellite Business Week held September 10-15, 2012 in Paris, France, welcomed several hundred attendees including some of the most influential business executives in the commercial space industry.

The session entitled "Launch Service Providers Seek the Right Tempo," on September 12, was moderated by Warren Ferster, Editor of Space News and included top executives from the commercial and government launch market: International Launch Services (ILS), Arianespace, Sea Launch, Lockheed Martin Commercial Launch Services, China Great Wall Industry Corp. and SpaceX.

Ferster summarized of the current commercial launch industry with new entrants such as SpaceX, the re-entry of Sea Launch and industry veterans such as ILS and Arianespace, all actively competing for launch orders in a softening market.Panelists responded to a wide range of industry topics and questions posed by the moderator. The following are McKenna's remarks and responses to questions during the panel.

There have been seven Proton launches performed this year; five commercial and two Russian Federal Missions. On August7, the seventh Proton launch of the year, the Russian Federal mission with the Telkom 3/Express MD-2 satellites, failed to reach the intended orbit. The Russian State Commission issued a report that identified a component in the pressurization system that was not manufactured to specifications. This caused a shutdown of the Breeze M Main engine by the Breeze M flight control system during the third burn of the mission.

The ILS Failure Review Oversight Board (FROB) was established after the anomaly and was comprised of representatives from nine ILS customers, two insurance underwriting representatives and an independent outside subject matter expert.



The FROB concluded its review on September 11 and concurred with the findings and corrective action plan of the Russian State Commission. The corrective actions will include broad and thorough oversight of all rework procedures, testing, support equipment, and personnel, both at the Khrunichev (KhSC) production facilities and in Baikonur. ILS and KhSC will also develop specific initiatives to enhance the long-term Quality Management System (QMS) that has been in place and operating at all KhSC production facilities.

The return to flight mission will be the ILS Proton launch of the IS-23 satellite for Intelsat S. A. of Luxembourg in mid-October. Following that mission will be a Russian Federal launch. By the end of the month, the remainder of the Proton launch manifest for this year will be established. We expect that there will be 2-3 additional Proton missions before the end of the year.

ILS will be conducting a comprehensive and independent review of the quality systems, processes and measures following the August 7 Russian Federal mission anomaly. It is expected that the series of risk-based audits and new initiatives will be implemented in the fourth quarter of this year.

The modern framework of the Quality Management System (QMS) began in 2008, when 46 unique short term, intermediate and long-term quality initiatives were defined and funded, involving not only quality but also the design and production of the Proton vehicle. This led to a unified QMS for ILS and KhSC. Since that time, most Proton suppliers and manufacturers have been integrated under KhSC, the Proton production rate has increased substantially and all phased enhancements to the vehicle have been successfully flown.

Proton Launch History/Robust Production Throughput

McKenna spoke about the launch pace of the Proton vehicles with some facts and figures:

- *There have been 29 consecutive successful commercial launches since July 2008.*
- *ILS has a backlog of 19 missions and has held an average of over 20 for five years.*
- *Proton has also conducted 45 flights over a four-year timeframe. This is a higher launch rate than all other commercial launch systems combined.*

Over the past seven years, Vladimir Nesterov held the position of director general at Khrunichev, the majority owner of ILS and one of the pillars of the Russian space industry with over 43,000 employees and multiple product lines from launch vehicles and launch vehicle upper stages, communication and Earth observation satellites to rocket engines and Space Station modules.

McKenna said that during Nesterov's tenure, Proton production has increased dramatically and all of the suppliers and manufacturers of the Proton system have been vertically integrated. Nesterov was instrumental in the development of the next generation Angara system, which will conduct its maiden flight in 2013.

On September 3, 2012, Russian President Vladimir Putin signed a Presidential Decree accepting Nesterov's resignation as director general of Khrunichev, with Vasily Sychev appointed as acting Director General. Sychev was formerly acting in the capacity of First Deputy General Director at Khrunichev. The position will be formalized with a permanent replacement announced when the governmental process is completed.

There has been reduction in commercial communications satellites ordered over the past two years after operators have largely completed their planned replacement cycles. At the peak, there were 26 commercial launches to GEO, but this has tapered off and will return to a long-term average of roughly around 20.

Important dynamics have reshaped the small-to medium-lift marketplace. SpaceX has won nearly $1 billion dollars in commercial business without a real flight record; a tremendous achievement. Those missions would most likely have been awarded to Arianespace, who has enjoyed a monopoly in that market segment until SpaceX's arrival. "This creates an interesting dynamic in the marketplace," said McKenna, "and we are happy to participate in it."

McKenna said that ILS developed the ILS Proton Duo offering in direct response to operators' demand for lower costs/kilogram to orbit and the concerns regarding the monopoly position of Arianespace and the sharp rise in prices for the small to medium satellite launches.

ILS Proton can offer a performance rocket to bring satellites using electric propulsion for orbit raising to a higher transfer orbit. This capability would reduce orbit-raising time from 6 months down to 4 weeks. ILS Proton can offer the capability to launch electric propulsion satellites in a single or stacked configuration to support the smaller to medium size satellite trend.

With reduced demand and an increase in the number of launchers competing in the market; this will surely create stress in the launch industry. As we have predicted, oversupply will be damaging to the marketplace and will result in a restructure of the industry. In the near and long term, 2-3 players can adequately accommodate the market and demand.

ILS and Khrunichev are now preparing to launch the 75th ILS Proton mission next month with the IS-23 satellite for Intelsat S.A. with plans for 3-4 additional Proton launches by the end of the year. We thank our customers for their support, confidence and trust as we safely return to flight. As always, our focus is always to launch successfully with sustainedquality and performance.

#

Success Is In The Saving

Eighty-two people have been rescued from the sea near Java following a distress call using IsatPhone Pro.

At 08:21 (UTC) on August 9th, Australia Maritime Safety Authority's (AMSA's) Rescue Coordination Centre (RCC Australia) was contacted by Australian Federal Police after they received a distress call via IsatPhone Pro from a vessel requesting assistance.

"RCC Australia successfully contacted the satellite telephone number and a person on board reported the vessel's engine was not working and there were 82 people on board. At this stage, the vessel's unconfirmed location was south of Java," said AMSA's spokesperson Jo Meehan.

RCC Australia sent out a distress broadcast to the area to call for assistance. There was an initial discrepancy over the vessel's GPS position until Inmarsat confirmed from satellite phone positional information that the vessel was approximately 31nm south of Java.

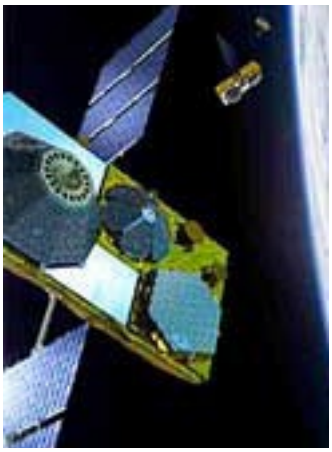
At 09:04 (UTC) an AP3 Orion maritime patrol aircraft, spotted the vessel and three merchant ships who had responded to the earlier broadcast were diverted to the scene, followed shortly after by Australian Navy vessels HMAS Glenelg and HMAS Childers. The MV Clipper Mayflower assisted in the rescue of two injured people from the water, while the remaining 80 people were taken on board the Defence vessels.

The diverted merchant ships were released and the MV Clipper Mayflower took the injured people to Indonesia for medical treatment, with support from an Indonesian rescue boat. Australian border protection command made arrangements for the people on board HMAS Glenelg and HMAS Childers to be transferred to Christmas Island, where they are undergoing security, health and identity checks and their reasons for travel are being established.

Inmarsat's maritime safety manager Peter Blackhurst said, "Our relationship with RCCs globally, of which we are extremely proud, has been developed over the years. It enables both parties to quickly pass essential information when required—once again Inmarsat communications was the conduit that enabled lives to be saved." #

Matters Are Resolved

Globalstar, Inc. and launch services provider Arianespace have entered into an agreement regarding the additional amounts that Globalstar will pay to cover costs associated with the delays experienced during three prior launch campaigns.



This resolution permits Globalstar and Arianespace to complete the fourth launch campaign under their current Launch Services Agreement.

Globalstar anticipates that satellite manufacturer Thales Alenia Space will complete the Pre-Shipment Reviews of the final six spacecraft purchased under the terms of the 2009 contract in the upcoming weeks in Rome. Once completed, the fourth launch campaign can begin. Due to available launch windows and the upcoming end-of-year holiday season, the fourth launch is now anticipated in early 2013. Globalstar will provide additional information regarding the specific launch date in the near future once its plans are confirmed with the launch participants.

"We are only months away from completing the fourth launch of our second-generation satellites to re-establish Globalstar's preeminent position within the Mobile Satellite Industry," said Jay Monroe, Chairman and Chief Executive Officer of Globalstar. "With our landline quality voice service, industry leading handset data speeds, high quality innovative M2M data solutions and low cost pricing plans, we are ready to mix it up in the MSS marketplace."

The Globalstar satellite is simple; Each consists of a communications system of both S and L-band antennas, a trapezoidal body, two solar arrays and each satellite operates at an altitude of 1,414km (approximately 876 miles). The second-generation satellites are manufactured by Thales Alenia Space.

The satellites utilize "bent-pipe" architecture. On any given call, several satellites transmit a caller's signal via CDMA technology to a satellite dish at the appropriate gateway where the call is then routed locally through the terrestrial telecommunications system. #

Solar Empowerment

EMCORE Corporation has been awarded a solar panel manufacturing contract by Orbital Sciences Corporation for NASA's Ice, Cloud, and land Elevation Satellite-2 (ICESat-2) mission targeted for launch in early 2016.

Solar panels populated with EMCORE's most advanced ZTJ triple-junction solar cells will power the ICESat-2 spacecraft manufactured by Orbital.

ICESat-2 builds on measurements taken by NASA's original ICESat mission. ICESat was the benchmark Earth Observing System mission for measuring ice sheet mass balance, cloud and aerosol heights, as well as land topography and vegetation characteristics. Data from ICESat, which was in orbit from 2003 to 2010, revealed thinning of the world's ice sheets. ICESat-2 will use precision laser-ranging techniques to measure the topography of the Greenland and Antarctic ice sheets and the thickness of sea ice.

EMCORE is the world's leading manufacturer of highly-efficient radiation-hard solar cells for space power applications. With a Beginning-Of-Life (BOL) conversion efficiency nearing 30 percent and the option for a patented, onboard monolithic bypass diode, EMCORE's industry-leading multi-junction solar cells provide the highest available power to interplanetary spacecraft and Earth orbiting satellites. #

ICESat-2
ICE, CLOUD, AND LAND ELEVATION SATELLITE-2

Pumping Up The Portfolio + The DVBS2-RCS

NSSLGlobal has a new partnership with Iridium Communications Inc.

The new agreement sees the addition of Iridium Pilot™ terminals to NSSLGlobal's portfolio. Iridium Pilot, powered by the Iridium OpenPort® service, offers strong IP connectivity, pole to pole coverage, and is engineered to perform in the toughest of sea conditions.

Iridium Pilot will be offered as part of NSSLGlobal's combined Ku-/L-band global solution, where it will be combined with NSSLGlobal's own Cruise-IP VSAT service as part of NSSLGlobal's Service Assurance Package. The inclusion of Iridium Pilot in the maritime portfolio also provides a cost-effective option for vessels with lower data volume requirements than other products currently offer.

Service Assurance combines the high speed and capacity of a Ku-band service with the added security offered by an L-band service, which provides a backup connection outside of the Ku-Band footprint; a solution NSSLGlobal first introduced to its customers in 2009.

The addition of Iridium Pilot to NSSLGlobal's portfolio gives customers a second L-band option for the first time, having previously used Inmarsat's FleetBroadband exclusively for the package.

Additionally, NSSLGlobal has announced industry-leading improvements to its DVBS2-RCS network.

Following on from other recent announcements, in what is a first among Ku-band operators, NSSLGlobal has launched of its Premium Max service with broadband speeds up to 8Mbps.

Iridium's Pilot

Speaking about the latest improvements, Sally-Anne Ray, COO at NSSLGlobal, said, "2012 has seen a paradigm shift in the number of different mobile applications demanding ever more bandwidth and network resource being used by our Customers. This is particularly the case in the Super Yacht market where monthly data demand can reach over 100GB during the sailing season. Our new 8Mbps Premium Max broadband service has been specifically designed with the Yachting market in mind as we move a step closer to providing true global mobility, ensuring that our Customers can use the latest applications and devices wherever in the world they are sailing."

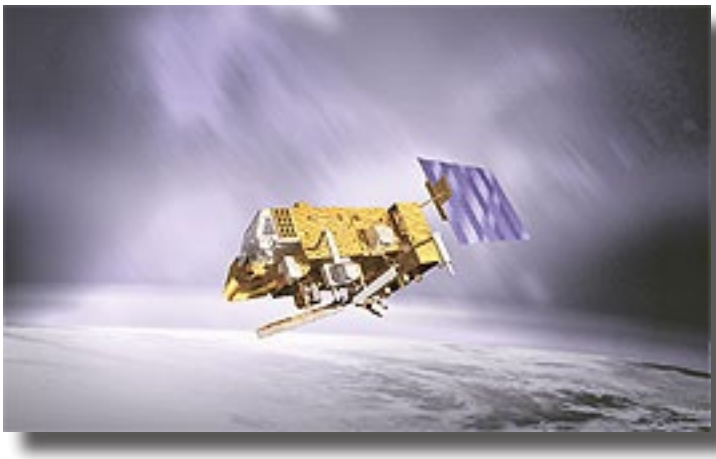
#

Metop-B, Going For Activations

Four of the instruments on the Metop-B weather satellite (AMSU-A, ASCAT, MHS, GRAS) have been activated this week and are delivering data.

This demonstrates that Metop-B, launched on September 17th, is performing well and is on its way towards replacing the ageing Metop-A as prime operational satellite in polar orbit, after the six-month commissioning phase.

The Advanced Scatterometer (ASCAT) and Microwave Humidity Sounder (MHS) are innovative European instruments.



Artist's concept of the MetOp-B satellite. Credit: ESA/Eumetsat

ASCAT delivers information on near-surface wind speed and direction over the global oceans and soil moisture over land, while the MHS delivers information on atmospheric humidity in all weather conditions. The Advanced Microwave Sounding Unit-A (AMSU-A) is an American heritage instrument already flying on the US NOAA satellites, providing temperature soundings in all weather conditions. The Global Navigation Satellite System Receiver for Atmospheric Sounding (GRAS) instrument is delivering data which are used to provide atmospheric temperature and humidity profiles by measuring the bending of GPS signals through the atmosphere. Data from GRAS are also used for precise orbit determination of the Metop-B satellite before and after the nominal stop-drift manoeuvre, in conjunction with traditional ranging and Doppler measurements.

Temperature and humidity soundings, wind at the ocean surface, and soil moisture are essential inputs to Numerical Weather Prediction (NWP) models, the basis of modern weather forecasting. The all-weather wind measurements provided by ASCAT are used worldwide to track mid-latitude storms and tropical cyclones. These instruments also contribute to the long-term data sets needed for climate studies and monitoring.

The first data delivered by the European instruments are a joint achievement by ESA, EUMETSAT, and the European space industry. For its mandatory programs, EUMETSAT relies on ESA for the development of new satellites and the procurement of recurrent satellites like Metop-B. This cooperation model has made Europe a world leader in satellite meteorology by making best use of the respective expertise of the two agencies.

#

Rural Relevance

DISH is expanding the availability of its broadband service with the launch dishNET, a high-speed Internet service via satellite nationwide.

Available October 1st, dishNET offers customers the convenience of one bill, one installation, one customer service number and a $10 monthly discount when bundled with DISH's most popular TV programming packages.

Ideal for rural residents underserved, or unserved, by wireline broadband, dishNET offers 4G-level speeds that are about 50 percent faster than the typical residential broadband connections in American homes. The affordable, reliable high-speed Internet service starts at $39.99 per month and is available with next-day installation.

In August of 2012, the Federal Communications Commission (FCC) reported 19 million Americans lack access to high-speed Internet, including 14.5 million who live in rural regions. The FCC highlighted that 23.7 percent of rural residents lack broadband access. The dishNET satellite service offers rural residents download speeds up to 10Mbps. These speeds are fast enough for typical Internet applications, including social media, telecommuting, music streaming, online video streaming and even Voice Over Internet Protocol (VoIP) services.

The dishNET brand leverages advanced technology and high-powered satellites launched from Hughes and ViaSat to provide broadband coverage nationwide. DISH will tailor its service to suit a customer's needs, location and budget. All services are sold, installed, billed and supported by DISH under the dishNET brand. #

Second Generation Ships

Sierra Nevada Corporation's (SNC) first prototype spacecraft of the ORBCOMM Generation 2 constellation has successfully completed pre-ship review at the company's Space Systems headquarters in Louisville, Colorado.

The satellite was shipped to the Cape Canaveral, Florida, launch site, where it is scheduled to be integrated as a secondary payload on the SpaceX Falcon 9 launch vehicle as part of the first Cargo Resupply Services (CRS) mission to the International Space Station.

The satellite's deployment, after the Dragon capsule is released, will define it as the first secondary commercial payload launch on a CRS mission, fulfilling the potential of government and commercial missions to coexist in a single launch. The prototype satellite, currently scheduled to launch on October 7, 2012, is based on SNC's SN-100 satellite bus, with capacity to launch highly capable optical, RF and science payloads. The SN-100 is specifically designed to be rapidly produced on SNC's fleet satellite production line.

This spacecraft is the first of an 18 satellite constellation being designed, built and managed at SNC's Louisville, Colorado, facility. SNC successfully directed the development and integration of the complex communications payload, and assisted in the key roles of launch planning and mission operations. In preparation for launch, SNC has installed a state-of-the-art satellite operations center. The Louisville Satellite Operations Center will support essential communications with the satellite prior to launch and during early on-orbit checkout and operations. #

Dam The Jam

ITT Exelis has announced a significant development in the field of GPS technology.

To be known as the Exelis GPS Interference, Detection and Geolocation (IDG), it will provide near real-time geolocation of intentional and unintentional GPS jamming sources through a network of sensors and advanced geolocation technology.

IDG technology is based upon a network of threat detection sensors that are networked to a centralized server running Exelis-developed geolocation algorithms. These sensors would be strategically located around high-risk areas, such as airports or utility grids, to instantaneously sense and triangulate the location of the jamming source. Should a threat be detected, users would receive pin-point geolocation information and actionable intelligence in order to respond.

The Exelis solution would benefit a broad range of GPS customers and users. Jamming devices can send out signals capable of disrupting the synchronization of a utility power grid and creating significant infrastructure and economic damage. In each of these scenarios, IDG would detect, analyze and geolocate the hostile signal, sending the intelligence through a secure network in order for the user to mitigate the threat.

"From security to transportation and almost every sector of the economy, the world relies on receiving precise GPS timing and positioning data," said Mark Pisani, vice president and general manager, Precision Instruments and Positioning, Navigation and Timing (PNT) Systems, ITT Exelis Geospatial Systems. "As GPS jamming devices become cheaper and more accessible, there is a greater need to protect military, commercial and industrial systems from a diverse range of threats. This technology is a major step forward in delivering actionable interference intelligence to an array of GPS users."

IDG builds on the legacy Exelis has established in the field of GPS and PNT. Exelis payloads and payload components have been aboard every GPS satellite for almost 40 years. Today, Exelis is involved in building tomorrow's Global Positioning System, developing and integrating the navigation payloads for GPS III. Exelis is also providing navigation processing components, precision monitor station receivers, and key components of the system security design for the GPS Operational Control System, also known as GPS OCX. #

DEO Robotics In Space—From Maintenance To Disposal

What an amazing first show of capabilities as Astrium, Europe's major space company, is preparing a new technology mission for the maintenance and disposal of satellites.

Today, at the ILA Berlin Air Show, the DLR Space Administration announced Astrium Friedrichshafen will be the prime contractor for the definition phase of the DEOS (German orbital servicing mission) project.

The order is worth a total of around 13 million euros. The definition phase is the last decisive step before construction begins on the space vehicles themselves.

The DEOS project will for the first time demonstrate technologies for the controlled in-orbit disposal of a defective satellite. In addition, DEOS will practice how to complete maintenance tasks—refuelling in particular— that extend the service life of satellites. DEOS consists of two satellites, a "client" and a "servicer". The client acts as the satellite requiring maintenance or disposal. The servicer carries out the necessary work on the client. The two satellites will be launched together and brought into orbit at a height of 550 kilometres. According to current planning, DEOS will be ready for launch in 2018.

Testing of disposal and maintenance on a client satellite specially launched for this purpose, as opposed to tests on old existing satellites, means that a wide variety of defects can be simulated. This enables DEOS to demonstrate a complete range of relevant tasks, right up to capturing a satellite that is spinning out of control. Experiments will be performed in an increasing order of difficulty.

The maintenance or disposal of a satellite requires mastering a large number of individual tasks: the servicer has to approach the client without a tracking signal or similar help from the client. The servicer has to remain at a distance of around one metre from the client for an extended period (>1 orbit) while adjusting its position to avoid collision with the client. Throughout the orbit, the approach navigation and attitude control must function reliably even when the satellite is in the full glare of the sun or in eclipse.

Before maintenance work can begin, the servicer must establish a firm grip on the client satellite. It must be capable of establishing electrical connections with the client and connecting a vacuum-tight fuel valve. In order to perform such a wide range of tasks, DEOS will be equipped with a robot arm that can move through seven degrees of freedom.

To a large extent, DEOS is reliant on technologies that have not yet been tested for space operations. In the definition phase, therefore, initial prototypes of the key technologies will be developed, so that subsequent realisation of the project can progress swiftly. This development work will be carried out by Astrium itself and by specialist companies and research institutions subcontracted by Astrium.

Astrium's Friedrichshafen location has long been the leader in the field of space robotics in Germany. A particular highlight was the ROTEX experiment on the Spacelab D-2 mission in 1993, which was the first time a robot arm in space was controlled in real-time from the ground. The Bremen location also worked on the European ATV supply vehicle, with which Europe regularly delivers new supplies to the International Space Station.

The DEOS project will be carried out by DLR Space Administration with funding from the German Federal Ministry of Economics and Technology (BMWi). Sustainable space operations has been a stated objective of the German government's space strategy since autumn 2010. This made in-orbit maintenance on "uncooperative" satellites—and even disposing of them when necessary—a topic of major interest at the National Conference on Space Robotics 2012, which was held in Berlin in March 2012 by the DLR with the support of the BMWi.

DEOS allows Germany to continue its long and successful tradition of providing innovative robotics technology for use in space. And DEOS represents the final technological step in developing robotics that can be used in the disposal of dangerous space debris and the cost-effective extension of the service lives of satellites that are already in orbit. ***More information about DEOS is available here... #***

Pictured above...
Top: Rendezvous & Capture, Bottom: Servicing & Refuelling

Loaf Of Bread Sized Satellite Could Have Huge Impact

USC's Space Engineering Research Center (SERC) launched the first "CubeSat", a miniature satellite built in cubic compartments—with the ability to deploy a parabolic dish and track a point on the surface of the Earth.

The satellite, dubbed "Aeneas", is the first CubeSat with this tracking capability, which it will use in an attempt to track shipping containers on the open ocean. While satellites are generally operated pointed towards a fixed location (the earth, the sun, a star, etc.), Aeneas will employ three-axis stabilization control to track the moving containers, demonstrating that global satellite tracking can be performed by nanosatellites.

Part of a widespread effort to build nanosatellites at relatively low cost, CubeSats represent a cost-effective way to explore new satellite architectures and address niche applications, as they can easily piggyback onto other space launches. What used to require a $6 million spacecraft and a $20 million launch could theoretically be done for a fraction of the price, provided the mission is not too complex.

"This is yet another testament to the great nanosatellite work being done at USC Information Sciences Institute and the Viterbi School's Astronautical Engineering Department," said Yannis C. Yortsos, Dean of the USC Viterbi School of Engineering. "It continues a strong tradition of USC engineering involvement in space. We couldn't be more pleased to be part of the Aeneas mission."

Aeneas was launched on a United Launch Alliance Atlas V rocket from Vandenberg Air Force Base near Lompoc, California.

Built at USC's Information Sciences Institute (ISI) by a rotating team of students and staff members, Aeneas marks two firsts for cube satellites: It will be both the first CubeSat in history to ground track (or track a point on the surface of the earth) and the first to deploy a half-meter parabolic dish, the largest deployable from a nanosatellite. A system nearly three years in the making, the dish is a high gain antenna, to be deployed from a structure not much larger than a loaf of bread.

Aeneas' main payload is a 1-watt WiFi-like transceiver that will be used to track the cargo containers and that will aid the Department of Homeland Security in its Secure Corridors program. A secondary payload that was designed and built but missed integration was a space qualification demonstration of the MAESTRO (the next generation of space computer) processor developed by Boeing and funded by the National Reconnaissance Office (NRO). A 49-core processor, the chip is being launched to test its capability of working in orbit. As SERC's Associate Director Tim Barrett explains, "You can't fly something in space unless it's flown in space." The MAESTRO processor is now scheduled to fly on an upcoming launch.

Work on Aeneas began in the fall of 2009, but was briefly interrupted when SERC was approved to design, build and launch Caerus, USC's first nanosatellite subsystem, two years ago. The brief interruption proved fruitful, however, enabling the team to utilize already space-tested equipment built for the earlier project on Aeneas.

After its launch, Aeneas will be monitored by SERC students and employees from ground stations at USC's University Park and ISI campuses, as well as a mobile ground station in Barrett's backyard. The mission is expected to be completed in three months, though the satellite itself could remain in orbit for several years.

While the basic satellite bus was provided by the NRO Colony CubeSat Program, funding for Aeneas enhancements, flight software, payloads, staff and students was provided by Congressional STEM funding, California Space Grant Consortium, Northrup-Grumman, Boeing, Jet Propulsion Laboratory, Lord Foundation, the Rose Hills Foundation, internal ISI funding and USC's Office of the Provost.

SERC was established in 2006 by staff from USC ISI's Space Group and the faculty of USC's Department of Astronautical Engineering, including Professor Joseph Kunc, SERC's director since its creation. Created out of discussions with local space industry and national labs, SERC seeks to develop sustainable and achievable low cost rapid design-to-orbit space systems.

"Most industry professionals only see a few space flights in their entire career. The fact that we've had two in only a few years is huge," said Barrett.

Adds Kunc, "An educational hands-on program where undergraduates from freshman to seniors can directly participate in the designing, building and testing of fully operational space hardware and software is indeed a very unique accomplishment." In fact, when launched in May 2010, Caerus contained a deployment burn wire designed by a USC freshman.

In fact, SERC may even surpass that feat as staff and students already have other Nano-Sat projects underway, including the use and test of a space qualification MAESTRO (the next generation of space computer) processor, a Ka band radio science experiment and expanding CubeSats from month-long missions to 36 month mission life NanoSats. SERC's willingness and ability to produce and integrate Aeneas into its upcoming government launch resulted in the opportunity to fly on the next NanoSat-equipped government mission scheduled for the fall of 2013.

Enemies Will Be Praying...Mantis

"...meets the exacting, high-bandwidth, connectivity requirements now demanded by forces around the world to address an increasingly difficult operating environment. It is an extremely complex sector..."

Vislink International has announced the immediate availability of the military spec. Mantis MSAT, the world's smallest and lightest satellite data terminal. At 12.5kg (27.5 lbs) MSAT is designed for one man operation in challenging operational environments. It is a rugged terminal, resistant to extreme environmental conditions, that is deployed from a single lightweight backpack.

Initial military orders are now being filled and MSAT terminals are currently undergoing field trials for battlefield, command center and special operations implementations.

Stephen Rudd, Chief Executive of Vislink International, said, "MSAT meets the exacting, high-bandwidth, connectivity requirements now demanded by forces around the world to address an increasingly difficult operating environment. It is an extremely complex sector but we have not only met the core need, we have created a rugged, highly reliable and lightweight package that can be deployed anywhere in the world.

At only 27.5lbs (12.5kg) it is the lightest satellite data terminal on the market and compliments a range of manned and unmanned solutions Vislink already provides for land, sea and air based communications and surveillance."

Vislink developed the military spec. MSAT to address demand from forces around the world that require a highly portable solution capable of delivering high bandwidth voice and data communications.

Providing up to 5Mbps upstream data throughput, MSAT can be used to deliver high definition video intelligence in addition to standard voice and data requirements. Even in the most hostile operating environments, the terminal can be unpacked and operational within five minutes.

MSAT meets the MIL 810F & DEF-STAN military specifications for shock, vibration, sand and rain and is provided as a 'one box' solution incorporating antenna, modem and all electronics. A high performance parabolic antenna is coupled, according to customer requirements, with interchangeable modem & encoder options. The terminal is available to operate in X-, Ka- and Ku- bands.

Visit Vislink at MILIPOL 2012, DOHA, QATAR, October 8th – 10th (booth number G063) or at MILCOM 2012, Orlando, Florida, October 29th—November 1st (booth number 205). #

Riding the Explosive Wave of High-Speed Satellite Internet

By Arunas Slekys Vice President, Corporate Marketing & GM Russia/CIS Business, Hughes Network Systems

Following the successful launch on July 5, 2012 of EchoStar® XVII with JUPITER™ high-throughput technology, Hughes Network Systems has put into orbit one of the world's highest capacity satellite systems. Designed with a flexible, Ka-band multi-spot beam architecture and well over 100 Gbps capacity, it is the cornerstone of a new generation of HughesNet® high-speed satellite Internet services for consumers and businesses in North America. Let's briefly summarize the key milestones achieved in reaching this significant threshold and the promise of high-speed satellite Internet technology globally.

The EchoStar XVII satellite was built by Space Systems/Loral, image courtesy of SS/L

Steps to Success

Hughes pioneered the development of satellite Internet technology and services in the late 1990s, employing an architecture that built on its success in satellite *direct-to-home* TV (DTH) services. Called ***DirecPC***, this early system employed a one-way satellite connection over the forward channel to the consumer receiver site, with the return channel over a dial-up modem. Though subscriber demand was modest and the business case risky, it nonetheless proved there was a sizeable and addressable market unserved, or underserved, by terrestrial broadband technologies, such as cable and DSL.

Indeed, it justified development of the first, two-way satellite Internet service, ***DirecWay***, launched by Hughes in 2000, and later followed by the competing WildBlue service. Continued investments during the past decade in steadily improving technology price/performance have ushered in today's highly successful satellite Internet business—now with well over 1 million subscribers in North America alone, growing at 15 to 20 percent annually, and served by two providers, ***HughesNet*** from Hughes and ***Exede*** from ViaSat. Though North America is where the business case to date has proven most successful, the performance and cost advantages of the latest generation of high-throughput Ka-band satellites and technology hold the promise of unlocking a huge market to close this so-called 'digital divide' around the globe.

Closing the Digital Divide: Satellite's Advantage

It's hard to believe in 2012 that about 14 million American households and small businesses are beyond the reach of terrestrial broadband service, according to the latest FCC reports, and of which nearly five million still use dial-up for Internet access—with people in rural America particularly disadvantaged. Just consider that they could easily start a download of images or a video, take a leisurely walk and return to find it still trying to complete!

This population represents approximately 10 percent of all households, making up America's digital divide, which globally represents a far greater number. In Europe, the estimate is close to 30 million households, and worldwide it's staggering. Consider that in a world population exceeding six billion there are only an estimated one billion broadband subscribers, less than half of all Internet users.

Satellite technology is the key to successfully unlocking this huge market. Unlike the distance-dependent cost of terrestrial technologies, whether fiber, cable or DSL, the unique advantage of geo-stationary satellites is that transport cost is uniformly the same, independent of location. However, prior to new generation Ka-band satellites, early Ku-band systems were challenged in ways which created high service costs and relatively low throughputs, primarily because operators were using satellite capacity that was designed for broadcast applications such as TV.

EchoStar XVII satellite lifts off on July 5, 2012 at 5:36 p.m. Eastern Time from Europe's Spaceport in Kourou, French Guiana aboard an Ariane 5 ECA launcher. Arianespace placed the satellite in a geosynchronous transfer orbit at approximately 6:03 p.m. Eastern Time.

In fact, most of the Ku-band satellites still in orbit today are designed for the broadcast industry, which means that the transponder coverage illuminates a very wide area, even continent-wide. This type of coverage is excellent for broadcasting—simultaneous distribution of a signal to many locations—but is less efficient for unicast date, delivered to only one location, which is the foundation of Internet access.

The Game Changer: High-Throughput, Ka-band Satellites

Unlike broadcast satellites, Ka-band HTS satellites utilize narrowly focused beams covering a small area—perhaps 200-500km. Focusing available power on a small area results in higher spectral efficiency, or bits per Hz. In addition, HTS satellites utilize frequency reuse across multiple beams much like a cellular system, resulting in high capacity delivered to targeted subscribers, thereby maximizing revenue per megahertz.

The Hughes Ka-wave began in earnest with the launch of its award winning ***SPACEWAY® 3*** satellite in August, 2007, the world's first with onboard switching and routing, delivering a 10-fold increase in capacity over conventional Ku-band satellites, to approximately 10Gbps. This step function increase enabled introduction in 2008 of the highest speed plans available at the time—from 1Mbps to 5Mbps, nationwide. It was wildly successful, as the HughesNet customer base skyrocketed from a few hundred thousand to more than 640,000 customers in just four years, with now over 500,000 on SPACEWAY® 3—making it the world's largest Ka-band service network.

A Ka-Band Juggernaut: SPACEWAY 3 and Echo Star XVII

In fact, with this explosive subscriber growth the ***EchoStar XVII*** launch couldn't have come at a better time. SPACEWAY 3 is approaching its capacity limit while subscriber growth continues at a healthy rate and demand for higher throughputs escalates, fueled by users' insatiable appetites to share images and videos. With well over 100 Gbps capacity—a performance improvement of more than 100 times over conventional Ku-band satellites, EchoStar XVII is estimated to serve approximately 1.5 million new HughesNet subscribers.

And as Hughes has made these successive substantial performance gains, we've been able to lower the cost-per-bit of service with each next-generation technology. The additional "headroom" provided by EchoStar XVII's capacity will allow Hughes to offer a suite of multi-Mbps service plans, to meet every budget as well as offer the highest speeds ever—up to 15Mbps downstream—at a competitive price. The EchoStar XVII satellite has 62 beams that deliver extensive coverage and capacity "fine tuning" capabilities. Thanks to Hughes' 30+ year history in the business, the Company has become experts at determining precisely where the demand is heaviest. And if traffic patterns change, they can change with them.

Due to start commercial service in October, EchoStar XVII will complement and build on SPACEWAY 3's success to result in a continent-wide Ka-band network that's unprecedented in coverage and capacity, enabling Hughes to deliver 5 to 15Mbps service across the U.S. and much of Canada. EchoStar XVII is targeted at the high density populations, primarily on both coasts. With EchoStar XVII doing most of the heavy lifting, SPACEWAY 3 now has additional capacity to serve the central parts of the country. No matter where they live, HughesNet customers all gain a high level of performance and reliable service.

Consumers will receive numerous options for buying HughesNet ***Gen4***, this next generation of high-speed satellite service. The service and support will be offered through an extensive list of Hughes distributors, local resellers, and online sales promotions, as well as national retailers and service providers. For example, Dish Network and other major providers will be selling HughesNet Gen4 along with their high-definition satellite TV service.

Going Global

As noted earlier, closing the digital divide with Ka-band technology represents a huge opportunity and Hughes is leading the way. In Europe, Hughes customer Avanti was the first to launch its Ka-band satellite ***Hylas 1*** in 2010, followed just recently by ***Hylas 2***; both operate using Hughes HN and HX NOCs and customer networking equipment. And in April 2012, Al-Yah satellite communications company launched its Ka-band ***Y1B*** satellite to offer ***Yahclick*** services throughout the Africa/Middle East region, also employing Hughes NOCs and customer equipment, in addition to the company's powerful back-end operational and customer care systems and services.

On this side of the Atlantic, Hughes Brazil was awarded an orbital slot in an auction conducted in August last year by Anatel, the Brazilian telecom regulator, and with selected partners will provide DTH services and expand HughesNet Gen4 in one of the fastest growing regions in the world.

The high capacity and resulting economic advantages that EchoStar XVII with ***JUPITER*** high-throughput technology brings to the marketplace continue the rich history of innovation by Hughes and portend a global explosion—to make high-speed Internet access available and affordable to everyone across this ever-shrinking planet, regardless of where they live or work.

About the author

Dr. Arunas Slekys is vice president of Corporate Marketing, as well as vice president and general manager of the Russia & CIS Business for Hughes. In these dual positions, he is responsible for managing all of Hughes' marketing and advocacy initiatives worldwide, along with overall P&L responsibility for the company's broadband satellite business in Russia, Ukraine and the CIS countries.

PTC'13

Capacity, Capability, Collaboration

20—23 January 2013 | Honolulu, Hawaii

PTC's annual conference is the Asia-Pacific's premier telecommunications event. Now in its 35th consecutive year, the annual conference is a strategic springboard for the global telecommunications industry. The conference provides all attendees with a three-day platform to focus on planning, networking, and discovering what the new year will bring.

PTC'13 *Capacity, Capability, Collaboration* will explore the increased capacity, greater intelligence, greater flexibility, and additional innovative capabilities required by today's applications along with the new era of collaboration enabled by this capacity and capability.

PTC'12 IN NUMBERS

1,500+ attendees
190+ speakers
55+ nationalities
50+ sessions
35+ sponsors

24% CXO attendance

AND 24% EVP/SVP/VP | 22% DIRECTOR | 18% MANAGER | 10% TECHNICAL | 2% ACADEMICS

Register for PTC'13 today at ptc.org.

www.ptc.org/ptc13

Pacific Telecommunications Council

914 Coolidge Street
Honolulu, HI 96826-3085
P +1.808.941.3789
F +1.808.944.4874
W www.ptc.org
E ptc13@ptc.org

Executive Spotlight: David Bettinger, CTO, iDirect

David Bettinger joined iDirect as the Director of Hardware Engineering in 1996 and took over responsibility of all hardware and software development as VP of Engineering in 2002. In 2005 he became Chief Technology Officer and is now responsible for the oversight of all technology decisions within iDirect, and serves to drive the strategic direction for product development, technology alliances, along with mergers and acquisitions. Mr. Bettinger currently serves on the Board of Directors for the Global VSAT Forum and is an active member of the Telecommunications Industry Association, IEEE and the IPv6 Forum.

Previous to iDirect, Mr. Bettinger was a senior member of the technical staff at Hughes Network Systems in the Satellite Networks Division. Mr. Bettinger is a graduate of Virginia Tech with a Masters of Science degree in Electrical Engineering and has been awarded six patents in the area of satellite communications.

The advent of next-generation High Throughput Satellite (HTS) technology marks an important change in the satellite industry. Not only will HTS bring a huge influx of new bandwidth, overcoming longstanding capacity issues, but it will also deliver significantly higher performance throughput for a range of increasingly demanding enterprise applications.

New HTS capacity will help overcome long-standing quality, reliability, and cost issues, bringing satellite to a level of growth and adoption that far exceeds traditional usage. However, while HTS brings considerable opportunity, it comes with its own set of challenges.

In this Q&A feature, iDirect Chief Technology Officer David Bettinger explains the technology behind HTS and discusses how HTS will benefit satellite operators, service providers, and end customers.

SatMagazine (SM)
Why does HTS matter and how is HTS technology different than traditional satellite technology?

David Bettinger
From its humble origins as a technology of last resort, our industry has taken tremendous strides in making satellite a more reliable, high-quality communications technology that is suitable for a wide range of applications. However, one challenge we've always faced is an undersupply of capacity. This issue, coupled with the additional costs of purchasing, installing and managing hardware has kept the price for satellite service high and hindered much broader adoption.

That's why HTS technology is such an exciting opportunity for our industry. HTS will provide a huge influx of bandwidth capacity, allowing satellite operators and service providers to deliver higher speeds at a lower cost. Of course, there are some technical complexities to HTS that bear mentioning.

One thing that's important to realize about HTS is that it comes in a variety of different forms. While it was originally thought of as a Ka-band consumer offering, HTS has evolved to span a variety of different satellite bands, beam sizes, and Earth orbits.

For example, one satellite operator has launched Ka-band satellites that operate over spot beams satellites. To gain throughput improvements, these spot beams continuously re-cycle frequency on the remote side, while connecting through a feeder link to a hub infrastructure. Another operator followed this with the introduction a wide beam Ku-band satellite. Meanwhile, a third operator has debuted an MEO fleet.

The point is, satellite operators are choosing different architectures based largely on the markets and geographic areas they wish to serve. Our focus at iDirect has been on developing ground infrastructure technology that can support any satellite architecture and give operators and service providers the ability to deploy an HTS service quickly and affordably.

SM
What are some of the challenges of adopting HTS technology?

David Bettinger
As mentioned above, HTS can be technically complex, encompassing a wide range of different bands, beam sizes and Earth orbits—each with its own unique strengths and physics. That's one challenge.

Another challenge for satellite operators and service providers is adjusting to the new HTS value chain, specifically who owns and manages infrastructure and who owns and manages customer relationships. New business models for bringing HTS capacity to market will emerge alongside traditional business models, and both operators and service providers need to have the flexibility to manage multiple options.

A third challenge associated with HTS is meeting new end user expectations. From maritime to military and every vertical in between, end users are tuned in to the HTS opportunity and will be expecting seamless connectivity for high-bandwidth applications at a lower cost with easy-to-use and easy-to-deploy terminals.

These users also demand carrier-class reliability. That means your network must automatically optimize inbound and outbound traffic for high performance under any condition—adjusting to weather, beam location and terminal size. And it requires hub

diversity to overcome rain fade and hub redundancy to ensure network failover.

Finally, you need a single management system to make large-scale deployments manageable and also to automate, optimize and integrate with your NOC applications.

Fortunately for iDirect partners, the iDirect Intelligent Platform meets all of these challenges. From the beginning, we designed our platform for maximum flexibility. As we move into the HTS era, we are continuing to evolve our technology—from our hub and line card system to our versatile series of remotes to our network management software—to be significantly more powerful.

SM

Earlier you talked about new HTS business models—how will HTS impact the way capacity is delivered and impact satellite operators and service providers?

David Bettinger

HTS business models will involve the entire value chain, which includes six key elements: a satellite operator, teleport facility, hub infrastructure, network operations, service provider and end users. Here are just a few of the options.

The first HTS satellite offerings were marketed as a managed service model. The satellite operator owned and operated all infrastructure and network operations, relying on distributors to re-sell their service and manage customer relationships.

In this model, satellite operators assume responsibility for infrastructure and network management. Service providers have a narrower operational focus, but also a smaller capital outlay. Plus they gain speed to market since they can immediately access and market HTS capacity.

Another option is a hub co-location model, wherein a satellite operator invites a service provider to co-locate a hub in its teleport. In this model, the service provider gains greater control and higher margins, while the satellite operator is able to establish an accelerated path to market by gaining access to service provider that is ready to purchase significant amounts of HTS bandwidth.

A third option is the Virtual Network Operator (VNO) model, wherein a satellite operator leases hub space to a service provider. The service provider only needs to purchase a line card to establish an HTS service, maintaining full control of its own network and end-users. This is an attractive model for service providers that want to lower their investments while getting quick access to the HTS market and expand in response to demand.

iDirect recently produced a video that goes into detail on the benefits of each of these business models. You can check it out here: ***http://idirect.net/Company/Video-Library.aspx***

SM

What does the future of VSAT look like?

David Bettinger

The HTS era represents a huge step forward for our industry and will bring VSAT to new levels of performance and reliability—making it a viable mainstream communications technology for any application. In order to ensure that everyone can share in this vision, however, we need collaboration across the entire VSAT eco-system. Whether you're a satellite operator, a service provider, or a ground segment and technology provider, we all have an important role to play in taking VSAT to the next level. At iDirect, we're proud to be leading this charge.

Readers can follow-up and access additional information at ***http://www.idirect.net***.

Join your colleagues for the seventh annual Future Leaders Dinner in New York City on November 13, 2012 – celebrating the future of an industry unlike any other.

This inspiring and entertaining event, held on the evening before SATCON 2013, presents three Promise Awards to outstanding young satellite professionals who, before their 35th birthday, have already made a substantial contribution to their companies and our industry. To celebrate the role of mentorship in fostering talent, we will also celebrate an industry veteran for devotion to nurturing the talents of the next generation with presentation of SSPI's coveted Mentor Award.

WHEN: November 13, 2012, 6:00 – 9:30 pm

WHERE: The Harmonie Club, 4 East 61st Street, Manhattan

WHY: To celebrate & invest in our young talent and the future of our industry

REGISTRATION: www.satfuture.com

PREVIOUS WINNERS

2011 Mentor Tom Eaton, Harris CapRock

2009 Promise Winner Max Kamenetsky, Space Systems/Loral, with Intelsat's Dianne vanBeber

2010 Promise Winner Captain Cheronda Spann

SUPPORTING ORGANIZATIONS

SATCON Satellite and Content Delivery Conference & Expo

satnews publishers

Satellite TODAY

Via Satellite

KEYNOTE SPEAKER

One of the nation's most recognized special operations experts, **Dick Marcinko** is best known as the founder, creator, and first commanding officer of two of the military's premier counter-terrorist units: SEAL TEAM SIX and RED CELL. Since retiring from active duty, he has authored eleven *New York Times* best- selling novels, his autobiography and several business books. Mr. Marcinko acts as a corporate advisor to multi-national businesses including AT&T and Motorola.

SPONSORED BY

arianespace

ERICSSON

INTELSAT Closer, by far

SPACE SYSTEMS LORAL

KPMG

OWEN D. KURTIN PLLC Attorney at Law

SatBroadcasting™: SES To Boost Value Added Services

By Chris Forrester, Senior Contributing Editor + Editorial Director, Broadgate Publishing

Luxembourg-based satellite operator SES is well-known for its global supply of capacity. Back in 2004, SES acquired Digital Playout Centre, founded in 1996 by *Leo Kirch*, and created to supply Kirch Group's Premiere pay-TV operation, and then Sky Deutschland with technical services including playout, Asset Management and up-linking to its satellites.

Since then, **Astra Platform Services** as it was known, and now under its new name of **SES Platform Services** (**SPS**), has won a significant number of interesting contracts around the world, not the least a supply a full bouquet of channels for South African pay-TV service **TopTV**.

SES now intends to rapidly expand its reach into the services, facilities and value-added market for all things programming, content and Asset Management based. It has already placed staff in Johannesburg, Singapore, and the USA. SES is also looking to invest into further expansion in Latin America, India and elsewhere, as well as to tap into what SPS CEO *Wilfred Urner* describes as a logical next step for the fast-growing business, and well beyond traditional organic growth.

Last year, SPS invested in a purpose-built facility, adjacent to its existing building, and as part of what is increasingly seen as the central campus of Germany's broadcasters, at Unterföhring, near Munich in Bavaria, Germany. Now, further investment is being made in new reception antenna facilities throughout Latin America, for example.

Urner says the investment is more than paying off, helped by major recent contract wins with players such as TopTV in South Africa, the **Pro7 Group** in Germany and news broadcaster **N24** in Berlin, and with more in the pipeline. He admits that some industry players see playout and their related services as near-commoditized.

"It is hard for some at SES, especially when you remember that 25 years ago, few would have thought that the satellite business would ever have become a kind of commodity. But it has. In Europe we have an excellent position because of our powerful broadcast neighborhoods but looking to Asia, or Latin America, or Africa, where we are just one amongst many. If you cannot offer more to potential clients, and we can talk about what 'more' is, then we might not win the business.

'More' might include any number of incentives, or capacity agreements, or service bundles. This might include ensuring that the client gets to market a little sooner, or help with their business models, or aid them with their technology development. But what we have to avoid is in stepping into their businesses. They are the broadcasters, not us."

Wilfred Urner, CEO, SPS

Antennas for South America
SES is investing in a slew of reception antennas throughout Latin America. The move, scheduled to be ready in time for the launch of its SES-6 satellite early next year, will make it easier for cable operators and IPTV head-ends to receive SES-6's programming, and appeal to both FTA and pay-TV operators. The plan was unveiled by SES' VP/Sales for Latin America, Dolores Martos, who said they were targeting some 4000 head-ends throughout her region, but of which only about 300 were capable of handling HDTV signals.

He adds that this new expansion strategy might mean competing head-to-head with some very well established facility players such as **Arqiva** or **GlobeCast**, but he is also looking to build new relationships with these same names.

"GlobeCast and Arqiva are typical in that they are already sometimes partners, as well as customers and sometimes also competitors. However this is pretty normal in our industry. It could mean a challenge in some markets and for very few customers. But as we are mostly playing in different fields or value chains this has never become a major issue up to now and we do not expect it to become a real issue."

SPS' strategy is two-fold, explains Urner. "As an uplink facility you have a dual role, one aspect being almost like a factory with fixed routines and established processes. SPS does a great job in this aspect, but also carrying out the second role which is staying up-to-date, investing in the latest technologies as well as planning for the future. Over the years we have to improve the SES position as regards services, and this will make us more attractive to clients, and we have to make sure that all our teleports are up to this same SPS standard, and this includes fibre links. This applies also for teleports we are partnering with. We can then serve our customers with solutions that they want not only in Europe but around the world."

"[We might] include any number of incentives, or capacity agreements, or service bundles. This might include ensuring that the client gets to market a little sooner, or help with their business models, or aid them with their technology development. There's lots we can do."—Wilfred Urner, CEO SPS

"There are some parts of the world that we, as SPS, cannot uplink to. At SES we might own teleports but perhaps we don't have uplinks to this or that satellite. So we have to think about how we might upgrade the teleports that SES owns and operates all around the world in order to supply much more flexibility for

Ultra-HDTV "around 2015"
"We expect Ultra-HDTV to start making an impact by around 2015, with North America and Europe happening once the new transmission and compression systems are in place. This is all very good news for satellite operators."—Romain Bausch, CEO, SES

SPS playing out content to TopTV, South Africa

Overseas Expansion For SPS
"We have been part of SES since 2004. We see ourselves playing a much more active role on behalf of SES in expanding SPS services from [Europe] and matching the supply of those services wherever SES has a major position. This will certainly mean North America, because it already happens there, and the same with India and Asia, and increasingly over Africa and Latin America.

"The expectation of the core business of SES, that is the bandwidth specialist, is increasing every day to include the services and the expertise that we have. The expectation is that we support our bandwidth colleagues from the first moment of an enquiry and back them up and supply them with help so that they can talk a more complete service than just naked supply of MHz into a region.

"To help with this, SPS now has people on the ground in some of our overseas offices and they are skilled people with excellent knowledge of their local markets but also able to call upon our skills and experiences whenever and wherever necessary. They now know that they have a willing satellite operator in SES that's looking to expand and they can talk both to potential clients and to existing clients as to how we can help them." — Stephane Goebel, VP/Sales, Global, SPS

clients. Perhaps we have to improve the links we have with third-party teleports to improve connectivity for our clients.

Urner admits that not every broadcaster will want the SPS-level of service. "You can offer someone a Rolls Royce-type service, but perhaps they want something less expensive and we can manage that. However, if you only have a smelly old Trabant as a business model, which might, if you are lucky, still get you from A to B, then you can never upgrade. We decided to be position here in Germany to serve our backbone customers such as Sky Deutschland and the likes of Pro7. In addition we can and do offer extremely competitive services but where there are some add-on charges that entirely reflect what the client might want or would consider essential."

Urner says the whole broadcasting scene is changing, and fast. "The consumer is changing his behavior in terms of content, for example, and how media is consumed. On the one hand we have an increased perception of on-demand content, and the other is seen as the traditional linear distribution models. On-demand might end up being seen as the source for movies and 'catch-up' programming, while linear might be the model for big events, sports, reality programming and talk-shows, and such like."

"But broadcasters also have to change their focus in order to keep audiences watching," he adds. "It is no longer enough to buy a nice movie and screen it during the evening. They have to have much more in the way of primary entertainment to hold onto viewer's attention. Of course, a good broadcaster has some subsidiary channels where alternate programming can also be offered. This has proved to be a sound business model, and mix this in with some interactivity and this also helps. As to today's hype, and the suggestions that everyone will move from linear to non-linear, well I just do not believe this will be the case."

SES: Where Are The New Markets?
SES has had a good trading year, to date (numbers as at June 30th). Revenues were up 4.8 percent over the same period last year (to 892 million euros) and generating an operating profit up 2.4 percent to 411.5m euros, and at an improved margin of 74.6 percent (74.2 percent). Contracted backlog held steady at 6.8bn euros.

President/CEO Romain Bausch says that while European revenues were flat, not helped by the remaining unused 32 transponders that used to supply analogue TV for German viewers (German analogue was switched off in April). However, huge progress had been made in reallocating these transponders, and nine were sold during the period. Overall, utilisation for the Astra European fleet stood at 81.4 percent.

That's the good news. The even-better news is that SES is seeing real progress in the Asian and Latino markets, which SES reports under its 'international' segment. Revenues up 8 percent (y-o-y) and a useful slew of new orders and contracts secured. International utilisation grew by 48 transponders, and with an overall fill rate of 74.2 percent.

A major Telefonica contract for central America helped the international division. SES has six new craft under procurement, adding an incremental 242 transponders by 2014 (compared with the the position at the end of 2011). He revealed that SES had also identified two new segments for satellite investment. These, plus the upcoming pair of O3b launches now being readied, will add considerable new capacity and revenues opportunities for the operator. The current investment cycle is coming to an end, Bausch explained, and with the anticipated cash-flow now this would give flexibility to SES for further investment opportunities, including O3b (which is the project to circle the Earth with Ka-band MEO craft to servive the 'other 3 billion' with satellite communications).

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

Executive Spotlight: Stefan Gardefjord, CEO, SSC

Stefan Gardefjord became president and CEO of SSC on May 1, 2012. Most recently, he served as CEO of Logica Sweden, the country's largest IT services company, as well as served on Logica's executive committee.

With an IT career spanning more than 25 years, Gardefjord has held numerous senior management positions. He spent nearly two decades with the Nordic WM-data group, later assuming the role of CEO of WM-data Sweden, which was later acquired by Logica. Trained as an analyst programmer, Gardefjord began his career at Dow Chemical Company, where he became an IT manager in the Nordic countries.

Gardefjord is a past chairman of the Swedish IT and Telecom Employers Association and is currently a non-executive director of the publicly listed BTS Group (Nasdaq OMX Nordic).

SatMagazine (SM)
In your role as CEO of SSC, what strategic initiatives do you plan to implement in the near term to continue the company's growth?

Stefan Gardefjord
SSC has a broad portfolio of services and technologies, and we are taking an in-depth strategic look into the growth drivers for all areas.

Satellite Management Services is focused on economies of scale—growing our global ground station capabilities and grasping the vast opportunities that arise as the number of orbiting satellites increases and the demand for continuous, reliable communication services grows. We recently opened a new satellite station in Western Australia, and soon we will provide satellite services from our new station in *Punta Arenas*, Chile, which will service U.S. Earth observation clients.

Many of our clients operate their own satellite stations and rely on us for expertise and engineering services. This is an area where I see solid growth potential.

Our rocket range **Esrange**, in the northern part of Sweden, has provided access to space for research purposes with sounding rocket and large balloon services for 40 years in collaboration with space agencies in Germany, France, Japan, Canada and the United States. Through a program called ***Esrange 2.0***, we intend to expand our capabilities, so we can also launch rockets that can put satellites into orbit. We continue to develop leading-edge technologies in green propulsion and component miniaturization. In fact, our *High Performance Green Propulsion* (**HPGP**) system is currently in orbit on Prisma and we are nearing a wider commercial break-through.

SM
How does your strong background in Information Technology contribute to the mission and objectives of SSC?

Stefan Gardefjord
I believe my contributions to SSC are threefold, beginning with innovation. IT is driven by technology and service innovation. I have spent more than two decades in an industry where innovation has helped develop a better world.

SSC's Esrange rocket range in northern Sweden

SSC's new station in Punta Arenas, Chile

Space works similarly. As innovation brings new technologies to market, service must innovate (while maintaining reliability and affordability) for people to recognize the benefits of the emerging technology. Take the Internet, as an example. It was a great technology innovation brought to market in the early to mid-'90s. Today, it's all about providing a continuous service that the whole world relies upon, 24/7.

My second and third contributions are industrialization and globalization, and I think they should be grouped. Today's IT industry is one of the most competitive sectors I know; one that has globalized and industrialized over time. I remember when most IT was developed within very clear geographic boundaries and solutions were tailored to each client's needs—a very expensive approach.

Today, it's the opposite. We now have standard applications and shared services that are easy to use at a fraction of the cost. But, there are more complexities to manage. I understand that dynamic. I know how to manage complex technologies, and turn those into easy-to-use, value-added services.

SM

SSC has a very diverse portfolio of products and services. How does SSC distinguish itself from, and within, the competitive space industry market?

Stefan Gardefjord

While SSC has a broad portfolio of services and products, I actually think the company, as a whole, is very focused. Perhaps we will narrow our focus even more, over time, but it is already clear that our growth path is based upon our global capabilities in satellite management services. Our worldwide capability, combined with our local presence, is our key differentiator. Our history of working with the research community around sounding rockets and balloons has positively impacted our collaborative culture.

At the end of the day, the only element that counts is the end result you help your client achieve. This is a central to SSC and I intend to build on that tenet.

SSC's NanoSpace

SM

Access to space is not typically an environmentally sound business. Can you explain how SSC is addressing the environmental impact of space access?

Stefan Gardefjord

This is where our technology development activities come into play. Our HPGP system—***ECAPS***—is at the forefront when it comes to providing a benign alternative to the prevailing and very toxic hydrazine propellant and its existing propulsion systems. We are currently involved in several ECAPS demonstration initiatives in both Europe and the U.S.

There is immense interest and I am personally convinced that we are at a tipping point in this area. In addition, we are developing a miniaturized propellant gauging system within NanoSpace. Finally, our Esrange 2.0 vision is based on Esrange Space Center being a "green launch site"—no use of hydrazine.

SM
SSC celebrates its 40th anniversary this year. With such a solid foundation in the space industry, what is SSC doing to follow the trends of innovation in access to space?

Stefan Gardefjord
After 40 years in space, I think there is a strong innovation heritage that shines through all of our initiatives. Each one pushes the boundaries and increases access to space, including our global satellite management capabilities, HPGP system, and *Micro Electro Mechanical Systems* (**MEMS**) based gauging and propulsion systems, along with efforts to make Esrange Space Center a "green launch site."

SM
SSC owns and operates PrioraNet, the largest commercial network for ground station services in the world. As cyber security and efficiency are both vital to those who use such space networks, what is SSC doing to ensure these networks are safe and effective for customers?

Stefan Gardefjord
Cyber security is a "live or die" reality for internal and external providers of access to space—this will grow in importance in the years to come. This is another area of similarity between the IT and space industries. Great concerns were raised in the early days of externalization and commercialization of IT services. Through highly focused security efforts, these challenges are now closely, strategically monitored and operationally managed 24 hours a day and continuously adapted as security issues evolve.

I have seen this evolution first hand and know how it can be successfully applied to the space industry. The risks are very real, but they can be managed and overcome only if they are a top priority for senior management and supervisory boards. And that's where they reside at SSC. Given the nature of our business, we are working closely with our security-conscious clients, within the commercial and defense sectors in coordination with the relevant authorities, to always address these vital issues and challenges.

The HPA Corner: Foreign Launch Exemptions Processes

By David Anhalt, Vice President, U.S. Goverrnment Solutions, Space Systems/Loral

There has been a great deal of discussion over the past year in regard to how the commercial space industry can be leveraged by the U.S. Government to achieve the following goals:

- **Resilience**
- **Affordability**
- **Risk reduction**
- **Increased flexibility, capability, and capacity**

These goals would address the needs of national security, space exploration, and science missions.

One of the impediments to a clear road ahead for this strategy is the commercial satellite industry's reliance on affordable, reliable launch services by overseas providers. For the dozen years since 2000, more than 220 commercial GEO satellites were manufactured worldwide. Even though two thirds of the satellites were manufactured in the U.S., less than 10 percent of them were domestically launched.

The **2004 U.S. Space Transportation Policy** states that U.S. Government payloads shall be launched on U.S. vehicles unless exempted by officials in the White House after a thorough interagency vetting. If the timing of this exemption review is delayed until all the facts about the nationality of the launch vehicle are known, then the "legitimacy" of commercial hosting will be threatened. Some simple changes to the U.S. Space Transportation Policy would help improve the business case for hosted payloads.

Recommendations

The Hosted Payload Alliance (HPA) recently recommended three changes to the Space Transportation Policy:

- **The exemption process needs to be transparent and time limited**
- **Exemptions with conditions should be allowed even before the ultimate launch service provider is known**
- **U.S. departments and agencies should have the option of seeking an exemption for foreign launch as early in their planning process as possible, ideally before formal analyses of alternatives are performed**

Inquiries Made...

We asked members of the Hosted Payload Alliance's Board of Directors the following question:

When in the satellite procurement process do you think exemptions should be considered, and what kinds of conditions would make exemptions more workable?

Answers Offered...

James Mitchell, Vice President, **Boeing Commercial Satellite Services**:

"*The recent successes at SpaceX are encouraging for the United States launch industry, however, from a combined cost and access-to-space perspective, for the foreseeable future, commercial satellite operators will need to launch a significant percentage of their future satellites on French and Russian launch vehicles. Therefore, to the extent government payloads will seek commercial rides, there must be a corresponding flexibility in launch vehicle choices. Absent of this flexibility, commercial operators will see little or negative benefit to hosting government payloads and will turn their attention elsewhere.*"

Don Thoma, Executive Vice President, **Iridium** and President of **Aireon LLC**:

"*It is important that the exemption process in the Space Transportation Policy allows U.S. Government missions to assess foreign launch opportunities as early in the procurement process as possible. Launch costs represent a significant investment for companies and can often impede access to space.*

"*The HPA evaluated the current policy and the aforementioned recommendations will ensure that mission security requirements are met while making the exemption process transparent and time limited; allowing for conditional exemptions until the launch service provider is known; and providing U.S. departments and agencies the option to seek an exemption for foreign launch earlier in their planning process.*"

Robert Cleave, President of Commercial Launch Services, **Lockheed Martin**:

"*Exemptions should be considered whenever a viable alternative that is cost effective and does not infringe U.S. National Security Interests. Any loss of focus on the government's responsibility to its citizens to protect and serve the National Interest would result in disapproval, regardless the business case.*"

Rich Pang, Senior Director of Hosted Payloads, **SES Government Solutions**:

"*Government agencies are given the most flexibility and potential for cost savings and access to space when they are allowed to consider the use of and/or receive an exemption for foreign launchers as early in the planning process as possible. This in turn will allow the government and the contractor to have open and meaningful conversations as*

they determine the contractual and operational relationships. Reducing unknowns, reduces risks."

David Anhalt, Vice President, **U.S. Government Solutions, Space Systems/Loral**:

"*Fundamentally, we need to know if the U.S. Government will permit a foreign launch for a particular government payload when we are evaluating the business case for a new satellite. With nearly 90 percent of GEO commercial satellites launching on French or Russian rockets, the HPA's recommended changes to the exemption policy will reduce the business risk to satellite operators.*

"*Our commercial customers require us to bid spacecraft designed for the environmental requirements of a range of launch vehicles. That's why I favor an exemption process that provides at least a conditional OK for launch on certain foreign rockets dependent on an early assessment of the national security interests involved. Conditional exemptions will allow for programs to move forward when the launcher is still unknown."*

Content support for the article by...

Russ Gottfried and Cliff Perkins, **Lockheed Martin**

Don Thoma, **Iridium**

Rich Pang, Tim Deaver and *Kent Verner,* **SES**

Jim Mitchell, **Boeing**

David Anhalt, **SS/L**

Hosted Payload Alliance Charter

Justification

The Hosted Payload Alliance (HPA) is a satellite industry alliance formed to increase awareness of the benefits of hosted government payloads on commercial satellites. The U.S. National Space Policy published in 2010 calls for an increasing role for commercial space to meet government requirements. It also explicitly directs the use of non-traditional options for the acquisition of space goods and services, and cites hosted payloads as one of these non-traditional options. The policy notes that public-private partnerships with the commercial space industry can offer timely, cost-effective options to fill government requirements.

Goals

1. *Serve as a bridge between government and private industry to foster open communication between potential users and providers of hosted payload capabilities.*
2. *Build awareness of the benefits to be realized from hosted payloads on commercial satellites.*
3. *Provide a forum for discussions, ranging from policy to specific missions, related to acquisition and operation of hosted payloads.*
4. *Act as a source of subject-matter expertise to educate stakeholders in industry and government.*

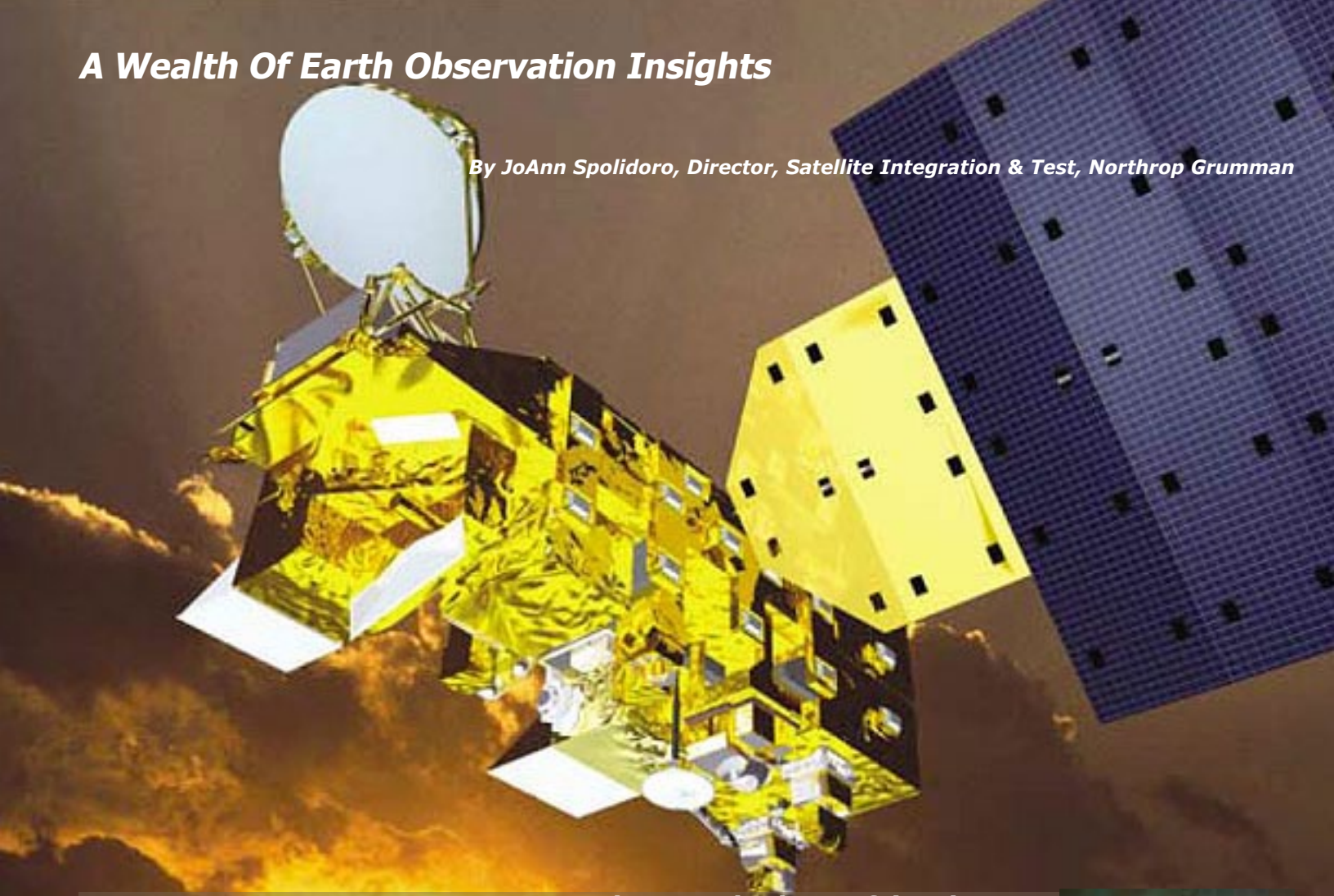
Membership Criteria

Membership in HPA is open to satellite operators, satellite manufacturers, system integrators and other interested parties.

For additional information, respond to the HPA website.

A Wealth Of Earth Observation Insights

By JoAnn Spolidoro, Director, Satellite Integration & Test, Northrop Grumman



Ten years ago, a weatherman's best friend was launched and on-orbit has delivered unprecedented data about the Earth's climate, water cycle and much more. Aqua is one of the primary satellites in NASA's Earth Observing System (EOS), designed to help scientists understand the Earth and make more accurate weather and climate predictions.

The Aqua satellite in the shuttle processing bay at Vandenberg AFB. Photo credit: Northrop Grumman Corp.

Aqua's instruments are uncovered in a chamber at Vandenberg AFB in preparation for launch. Photo credit: Northrop Grumman Corp.

On May 4, 2002, the **Northrop Grumman**-built satellite ***Aqua*** lifted off from **Vandenberg Air Force Base**, California, and began a new era in **NASA**'s space-based observation of the Earth's water systems.

Designed for a six-year mission, Aqua has already extended that by four years, with four of its six onboard Earth-observing instruments still downloading data. Those data have answered a multitude of scientific questions about water processes in the atmosphere, on land and in the oceans.

Aqua had a flawless launch and deployment in important part due to the discipline and dedication of Northrop Grumman's satellite *Integration and Test* (**I&T**) team.

"Like a doctor in an operating room, I&T is responsible for the patient living or dying and must operate with urgency and an almost fanatical discipline," said *JoAnn Spolidoro*, director, Aqua I&T. "That discipline was required for Aqua because it presented some huge challenges—the I&T process was scheduled for sixteen months but actually took about 31 months. To successfully launch Aqua, we needed to bring together several complicated elements: the flight software had to be tested and validated; the command and telemetry database and the harness had to be refined and tested. And the communications network had to make sure the components all talked to each other correctly. To meet these challenges, we forged a common vision for the Aqua team and focused on our successes. This team worked long hours and weekends throughout I&T to ensure a more than perfect on-orbit performance for Aqua."

During this mission, the Northrop Grumman team also developed an especially strong partnership with NASA. One example was an early request from **Goddard**'s system manager to tailor the spacecraft's communications design to relay an emergency broadcast. The ***TDRS*** spacecraft would detect the broadcast and then notify the appropriate satellite control center. The payload instruments, including the two ***CERES*** instruments Northrop Grumman provided, were developed around this concept as well. This came to be called the 911 broadcast, which was tested extensively and performed well during flight rehearsals.

Then came launch. All was going smoothly until the satellite controller notified the team that Aqua was emitting the 911 broadcast. The team all jumped from their seats to man their consoles. The spacecraft had gone into survival mode and was safely transitioning itself to sun point mode. The anomaly came as the bus was exiting eclipse and a cloud on the horizon blocked the sun. Not only did the fault management system and 911 broadcast work properly, but its development and implementation had no appreciable effect on cost or schedule.

Aqua makes measurements of the Earth at the same time, all the time. This is because the satellite orbits the planet on a nearly polar route, passing over different points on the ground at approximately 1:30 p.m. and 1:30 a.m. By maintaining a consistent time for taking readings, the integrated suite of sensors on Aqua facilitates sophisticated measurements of planetary processes that until now have been challenging to collect and calibrate.

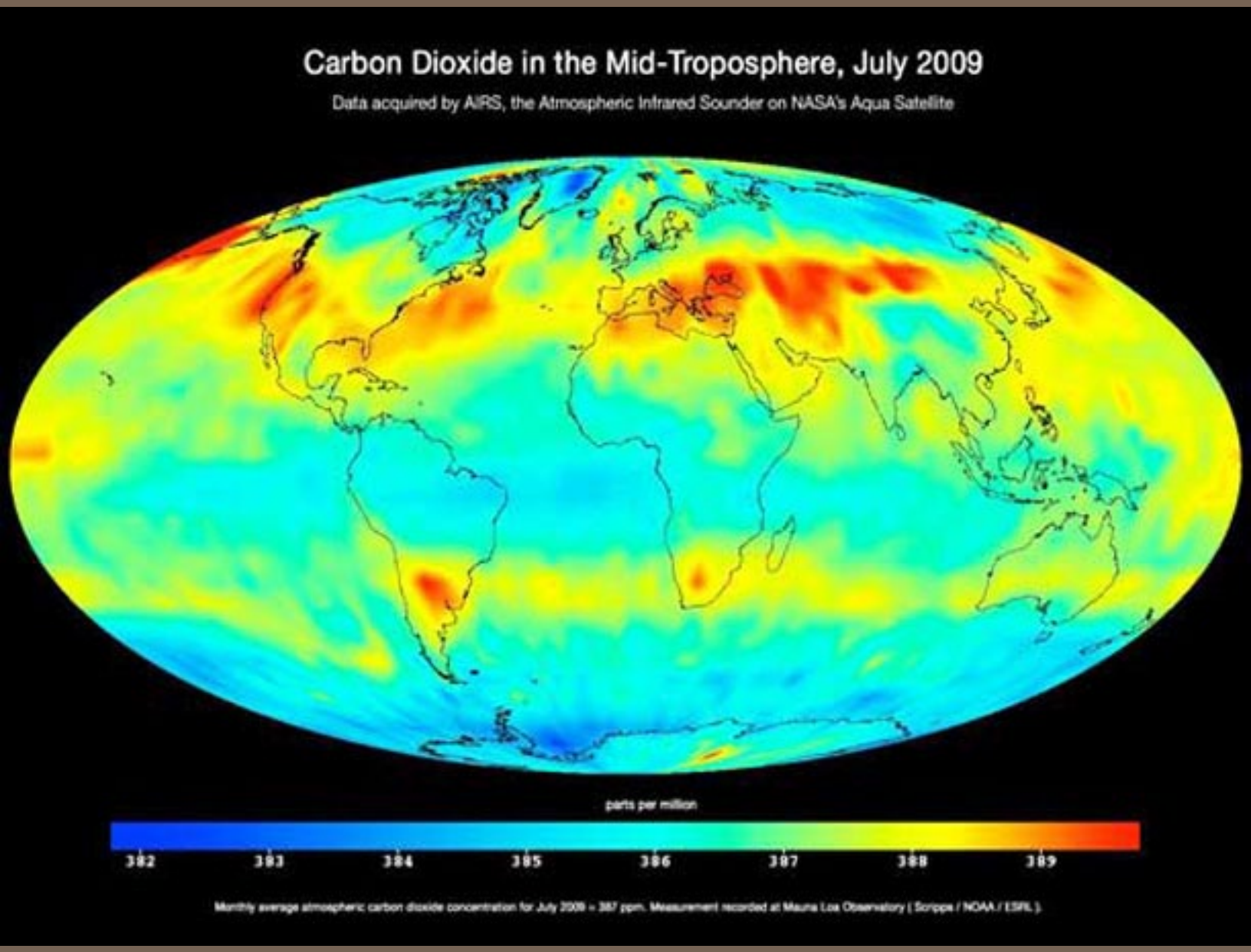
Aqua's scientific hardware is used to study climate change, vegetation, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice, snow cover and more. Its six instruments are designed to work together as well as separately in order to study the Earth's processes in the same way those processes operate—as a system.

"We are thrilled with the success of the Aqua mission so far, especially the widespread use of the Aqua data both for advancing Earth sciences and for practical applications," said *Claire Parkinson*, Aqua project scientist, NASA Goddard Space Flight Center.

A Wealth Of Earth Observation Insights (Cont.)

Parkinson continued, "In recent years, the number of science publications using Aqua data has exceeded 700 per year and the number of citations to Aqua publications has exceeded 10,000 per year. Some of the key near-real-time applied uses of the Aqua data are their use in weather forecasting, in monitoring such events as forest fires and hurricanes, in monitoring volcanic ash, with its impact on air traffic, and in air-quality analyses. All of these add to the value of the mission and are thrilling for many of the people who have worked hard to make the mission a success."

Aqua's instruments include the *Atmospheric Infrared Sounder* (**AIRS**) and the *Advanced Microwave Sounding Unit* (**AMSU**).These enabled scientists to build the first global map of mid-troposphere carbon dioxide. The troposphere starts at the Earth's surface and extends 8 to 14.5km high (5 to 9 miles). Aqua's measurements are so accurate that scientists can detect C02 to plus or minus 1.2ppm (parts per million) and they can measure it from day to day to construct dynamic maps. Together, AIRS and AMSU also monitor air temperature and water vapor to generate higher quality data meteorologists use to forecast from one to six days, far more accurately than before.



This image was created with data acquired by the Atmospheric Infrared Sounder instrument (AIRS) on NASA's Aqua satellite July 2009. The image shows large-scale patterns of carbon dioxide concentrations that are transported around Earth by the general circulation of the atmosphere. Dark blue corresponds to a concentration of 382 parts per million and dark red corresponds to a concentration of almost 390 parts per million. A belt of enhanced carbon dioxide girdles the globe in the southern hemisphere, following the zonal flow of the southern hemisphere mid-latitude jet stream. This belt of carbon dioxide is fed by biogenesis activity in South America (carbon dioxide is released into the atmosphere through the respiration and decomposition of vegetation), forest fires in both South America and Central Africa, and clusters of gasification plants in South Africa and power generation plants in south eastern Australia. Image credit: NASA/JPL

During the long polar night, AIRS and AMSU are able to monitor the ozone hole in the Antarctic. Another Northrop Grumman-built NASA satellite, the ***Total Ozone Mapping Spectrometer – Earth Probe***, measures ultraviolet light from the sun. Scientists can now combine these two data products and construct a total ozone map.

The *Advanced Microwave Scanning Radiometer for the Earth Observing System* (**AMSR-E**) can monitor sea surface temperatures even in the presence of cloud cover. As a hurricane passes over the ocean surface, it churns up the water underneath and leaves a cold wake, which AMSR-E can detect. In the buildup and aftermath of *Katrina*, animation from AMSR-E data products appeared extensively in TV news. During the active 2008 hurricane season, AMSR-E tracked Hurricanes *Dolly*, *Ike* and *Gustav*, which all made landfall in the U.S.

AMSR-E provides a higher resolution look at sea ice in the Arctic and Antarctic, seeing passages between floes and detecting the retreat of the Arctic ice and associated climate changes.

The *Moderate-Resolution Imaging Spectroradiometer* (**MODIS**) measures ocean, land and atmospheric processes. MODIS measures visible and infrared light in 36 distinct bands. In other words, it views the world in 36 colors. MODIS is not helpless at night, either. The dramatic reduction in visible light when the planet turns away from the Sun does not curtail the instrument's ability to collect data of other wavelengths. These measurements are used to generate scientific products about land surface cover, vegetation, phytoplankton in the oceans, fires on land, sea ice cover, snow cover on land, and properties of clouds and aerosols in the atmosphere.

MODIS provides important forest fire data to the **U.S. Forest Service**, which uses the direct broadcast capability on the spacecraft to access the information and deploy firefighters. MODIS also pinpoints the location of volcanic plumes and ash for aircraft pilots and tracks the location of dust storms in the Middle East.

The *Clouds and the Earth's Radiant Energy System* (**CERES**) instrument measures key elements of the energy balance of the Earth. The instrument looks at clouds and the Earth's radiation balance. More specifically, CERES studies how much heat is emitted and reflected by the Earth on a broad scale.

By studying how clouds function in relation to the larger planet, scientists can develop improved predictive models about weather systems and how the Earth maintains its delicate temperature balance. The first CERES instrument went into space aboard the TRMM satellite, launched in 1997. Designed to study rainfall in the tropics, TRMM successfully showed how an instrument of this kind could provide valuable data for weather and climate related research. The second and third CERES instruments launched onboard the Terra platform in 1999; Aqua enables the fourth and fifth of these to fly above the Earth.

All CERES instruments on-orbit have been built by Northrop Grumman. The company has a long history supporting Earth science and also built NASA's other Earth Observing System's satellite ***Aura***, and recently supported mission operations and launched another CERES instrument on NASA's newest climate satellite, ***Suomi NPP***, formerly known as the *NPOESS Preparatory Project*.

There was a sixth Aqua instrument, the *Humidity Sounder* for Brazil, which failed in February 2003, but other instruments were configured to provide scientists with the needed data products.

In the last 10 years, Aqua has led to a deeper understanding of short and long-term climate change, critical to understanding our planet and its living, breathing systems.

The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite captured this image on June 9 and 10, 2012 of the High Park Fire, about 15 miles west of Fort Collins, Colorado. Red outlines show the approximate boundaries of actively burning fires. Thick smoke was carried eastward on both days. Started by a lightning strike, the fire quickly grew, fueled by high winds and dry vegetation. By the morning of June 12, the fire had burned more than 43,000 acres making it the third-largest fire in Colorado history. Image uses data provided by the LANCE MODIS Rapid Response team. Image credit: NASA.

About the author
JoAnn Spolidoro is the Director, Satellite Integration and Test, for Northrop Grumman.

Satellite Networks For Education

By David Leichner, Vice President Corporate Marketing, Gilat Satellite Networks

The Modern University of Humanities (MUH), Eurasia's largest open university with 170,000 students, provides higher education to 830 towns and cities that include some of the most remote regions in Russia. Gilat's SkyEdge, through the company's Teleport Services, provides the communication network that powers MUH satellite e-learning applications.

The **Modern University of Humanities** is the largest open university in the world, providing educational services to students that cannot attend conventional universities. MUH serves students all over Russia, including some of the most remote regions of the vast country; enabling citizens to receive higher educations that otherwise would not be possible. Studies include law, management, economics, psychology, computer engineering, linguistics, philosophy, political sciences, and pedagogy, and are provided for Baccalaureate, Specialist's Studies, Master's Degree Studies, and Post-Graduate education. In addition to serving students in Russia, MUH also serves 14 other countries that include...

- **Russia**
- **Armenia**
- **Belarus**
- **Kazakhastan**
- **Kyrgyzstan**
- **Modova**
- **Tajikistan**
- **Uzbekistan**
- **Ukraine**
- **Georgia**
- **Vietnam**
- **Israel**
- **China**

Teleport Service realized Gilat could provide:

1. **Common outbound for multiplexed video and data transmission**
2. **High performance broadband network, supports video conferencing, e-learning applications, the Internet and more**
3. **Excellent Total Cost of Ownership (TCO) takes into account satellite capacity, operations as well as the equipment costs**
4. **Reliability and availability for remote regions**

Distance learning is based on standard solutions such as Video broadcasting, Internet, email, VoIP and video-conferencing; however, MUH has also developed specific education applications that improve the learning experience covering a range of student needs, such as:

- Tele-lectures that can be viewed both online and recorded
- Electronic text books
- Training applications and computer simulations
- Q&A applications allowing students to receive assistance from remote teachers
- Access to databases and an electronic library

All of these applications need to be provided to MUH's education centers.

The Challenge

Providing distance education to the huge student body of MUH, dispersed throughout the largest country in the world, is a challenging task. MUH needed a communication network that would deliver broadband rates as well as cost efficient.

As the communication network had to span all of Russia, broadcasting video transmissions on a terrestrial network would be extremely expensive. Each node in the network needed to receive very high throughput and this would have translated to high connectivity costs, especially when taking into account the large distances and scarcity of fiber connectivity in Russia. Also, as not all sites have broadband connectivity, especially in the remoter regions of Russia, the complexity of a terrestrial network is even greater.

MUH's communication requirements also mandated interactive learning—not only did the network need to provide high throughput and efficient broadcast, it also had to provide connectivity from remote sites back to the center. Applications such as Internet, training applications, network-based simulations and others needed to be supported by the network.

Students also needed to be able to interact with their teachers, either using VoIP technology to ask questions or video conference sessions for an even more interactive learning experience. All this meant that standard TV transmission was not a viable solution, as this is not an interactive medium.

Lastly, MUH wanted a communication network that, cost effectively, enabled reliable services in and outside Russia. Terrestrial networks depended on interconnectivity with other national carriers, which would have complicated the network and increased the operational costs. Reliability was also an important issue, as support in remote regions, especially in the more distant locations within Russia, can be quite difficult.

MUH already operated a mix of one-way and two-way satellite solutions—based on Gilat's ***360e*** platform, together with standard **PCI DVB-S** receivers.

Teleport-Services General Director Kramar Vitaly

"Gilat's solution combines advanced technology, ultimate reliability and dedicated customer support. SkyEdge will enable us to provide the greatest possible variety of services to the Russian market, in the most cost-effective manner possible."

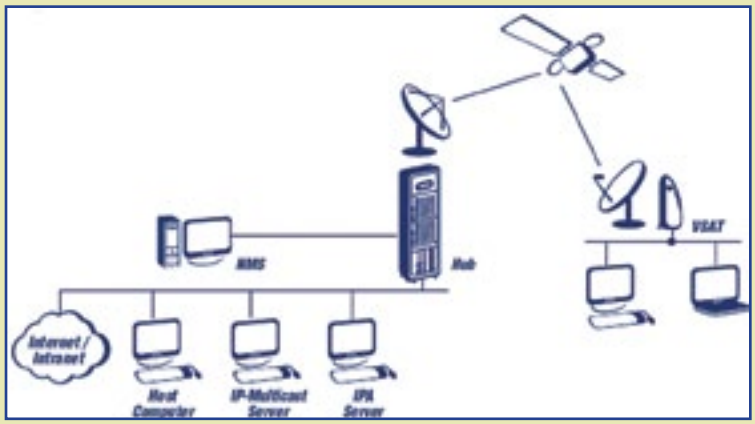
Network Operations Center

The DVB-S receivers were installed in PC's and used for broadcasts while the 360e VSATs were used for interactive services. While MUH was happy with these solutions, the newer educational programs and network, called *Platon*, required higher performance and more capabilities.

The Solution

MUH decided that satellite technology was the best choice for their complex and diverse needs. They are now using ***SkyEdge*** VSATs for the communication network. A SkyEdge network provides efficient broadcast and multicast services—transmitting content only once, to be received by all the remote sites.

In addition, satellites provide coverage outside of Russia and can be used for international sites as well. Due to the huge size of Russia, two satellites are required to provide complete coverage.



Gilat's 360E star network

In order to operate the satellite network, MUH established *Teleport Services* as a satellite-based communication service provider. Teleport Services can then focus on its expertise in satellite communication, delivering the highest quality communication services at the most competitive cost.

Following a detailed market survey, Gilat's SkyEdge was found to be the best available platform for MUH's needs. Gilat's SkyEdge network enables MUH to operate all applications for broadcast and interactive requirements on one platform, benefit from the reliability of satellite technology and provide for future expansion. In addition, SkyEdge's efficiencies meant that the operating expenses of the network would be minimized.

The SkyEdge platform is based on the industry standard DVB-S. This enables MUH to work with the standard MPEG-2 video format running over IP. The video programs are multiplexed with the interactive data, resulting in efficient use of satellite capacity. When there is no video multicast, the bandwidth can be used for other IP applications. SkyEdge's large capacity of more than 66Mbps and scalability to encompass 32,000 VSATs ensures any increase in MUH's network requirements will be more than adequately covered.

SkyEdge's high inbound data rates allowed the addition of video conferencing capabilities to the remote sites. While most of the interactive sessions are based on VoIP, the ability to see the students at the remote sites improves the learning experience tremendously.

In order to make this real-time applications function well, an advanced QoS solution integrated with the inbound access scheme is required. SkyEdge's QoS is based on the full DiffServ definition, and ensures that real-time applications receive the required throughput. Latency and jitter are minimized and other less time-sensitive traffic does not interfere with the real-time applications.

Teleport Services has already deployed a SkyEdge hub, installed the SkyEdge VSATs in MUH's facilities, and the network is now operational.

About the author

David Leichner is the Vice President of Marketing for Gilat Satellite Networks.

Success is accompanied by an exhilaration that lifts the spirits of all involved. Such is especially true of launches... whether a client is commercial or a member of the mil/gov markets, placing into orbit a crucially needed satellite is an accomplishment requiring intense scrutiny for each and every aspect of the launch build and satellite placement. A company that has certainly enjoyed its fair share of such success is... United Launch Alliance (ULA).

United Launch Alliance is now celebrating a decade of ***Evolved Expendable Launch Vehicle*** (**EELV**) missions. The company's ***Atlas V*** and ***Delta IV*** proven launch vehicles have successfully delivered more than 50 critical capabilities to orbit for the **U.S. Air Force**, **National Reconnaissance Office**, **NASA** and commercial users around the world.

The EELV program was established by the United States Air Force to provide assured access to space for Department of Defense and other government payloads. The commercially developed EELVs support the full range of government mission requirements, while delivering on schedule and providing a 33 percent cost savings over the heritage Atlas, Delta and Titan IV launch systems.

Kudos...

"For more than 50 years, Atlas and Delta launch vehicles have supported America's dominance in space, launching weather, communications and national security missions that protect and improve life on Earth, as well as science and exploration missions that improve our understanding of the universe," said *Michael Gass*, **ULA** president and CEO. "ULA is so very proud to serve our customers and is truly humbled by the trust they place in us by allowing us to put their critical and most valuable assets of our nation into space."

"Congratulations to the entire joint EELV team on the 10th anniversary of the program and achievement of 50 plus successful launch missions," said R*oger S. Correll*, *Air Force Program Executive Officer*, **Space Launch**. "The reliable performance of EELV is a critical enabler of our war-fighting and national security intelligence missions. Each and every day soldiers, sailors, airmen, Marines and intelligence operators rely on the satellite capabilities EELV enables. We look forward to continued performance excellence as EELV maintains support to National Security Space." This statement is highly important, for the commercially developed Atlas V and Delta IV are the only fully certified launch vehicles capable of supporting the full range of government launch requirements.

"Congratulations to the EELV and ULA teams on the 10th anniversary of EELV," said *Betty Sapp*, director, **National Reconnaissance Office**. "The reliable performance of EELV is a significant enabler of our national security mission. We look forward to sustained excellent performance as EELV continues to support the Intelligence Community and Department of Defense."

Since the first EELV launch in 2002, EELV has delivered extraordinary capabilities for the nation. Atlas V has launched 33 times and Delta IV has launched 20 times, delivering nine commercial payloads, 10 NASA spacecraft and 34 national security satellites. Currently, ULA is on track to complete its most aggressive EELV launch campaign to date.

The Belts-way

In example, a recent ULA launch addressed an area most spacecraft try to avoid—the **Van Allen Belts**, which are two doughnut-shaped regions around Earth filled with "killer electrons."

A United Launch Alliance ***Atlas V*** rocket carrying the ***Radiation Belt Storm Probes*** (**RBSP**), the first twin-spacecraft for NASA, lifted off from **Space Launch Complex-41** at **Cape Canaveral** on September 3rd. These two, heavily-shielded spacecraft were launched directly into the belts. The Radiation Belt Storm Probes are on a NASA two-year mission to study the Van Allen Belts and to unravel the mystery of their unpredictability. This was ULA's 7th launch of the year, the 32nd Atlas V launch, and marked the 63rd launch since ULA was formed in December 2006.

"The ULA team and our many mission partners are very proud of our role in delivering the twin RBPS spacecraft to orbit to conduct research about our space weather and gather important data that impacts our everyday life on Earth," said *Jim Sponnick*, ULA vice president, *Mission Operations*. "The successful launch of

Atlas V RBSP launch, photo courtesy of ULA

Launch of NROL-36 on an Atlas V, credit ULA

this mission is a tribute to the partnerships with the highly skilled and professional teams from NASA's Launch Services Program and The Johns Hopkins University Applied Physics Laboratory."

This mission was launched aboard an ***Atlas V EELV 401*** configuration vehicle, which includes a 4m diameter payload fairing. The Atlas booster for this mission was powered by the ***RD AMROSS RD-180*** engine and the ***Centaur*** upper stage was powered by a single **Pratt & Whitney Rocketdyne *RL10A-4*** engine.

RBSP will explore space weather—changes in Earth's space environment caused by the sun—that can disable satellites, create power grid failures, and disrupt GPS service. The mission will also allow researchers to understand fundamental radiation and particle acceleration processes throughout the universe. The belts are affected by solar storms and coronal mass ejections and sometimes swell dramatically. When this occurs, they can pose dangers to communications, GPS satellites and human spaceflight.

"Scientists will learn in unprecedented detail how the radiation belts are populated with charged particles, what causes them to change and how these processes affect the upper reaches of the atmosphere around Earth," said *John Grunsfeld*, associate administrator for the **Science Mission Directorate** at NASA's headquarters in Washington. "The information collected from these probes will benefit the public by allowing us to better protect our satellites and understand how space weather affects communications and technology on Earth."

The two satellites, each weighing just less than 1,500 pounds, comprise the first dual-spacecraft mission specifically created to investigate this hazardous regions of near-Earth space, known as the radiation belts.

"We have never before sent such comprehensive and high-quality instruments to study high radiation regions of space," said *Barry Mauk*, RBSP project scientist at the **Johns Hopkins University**'s *Applied Physics Laboratory* (**APL**) in Laurel, Maryland. "RBSP was crafted to help us learn more about, and ultimately predict, the response of the radiation belts to solar inputs."

The hardy RBSP satellites will spend the next two years looping through every part of both of the Van Allen belts. By having two spacecraft in different regions of the belts at the same time, scientists finally will be able to gather data from within the belts themselves, learning how they change over space and time. Designers fortified RBSP with special protective plating and rugged electronics to operate and survive within this punishing region of space that other spacecraft avoid. In addition, a space weather broadcast will transmit selected data from those instruments around the clock, giving researchers a check on current conditions near Earth.

"The excitement of seeing the spacecraft in orbit and beginning to perform science measurements is like no other thrill," said *Richard Fitzgerald*, RBSP project manager at APL. "The entire RBSP team, from across every organization, worked together to produce an amazing pair of spacecraft."

For the 60 days following the launch, operators will power up all flight systems and science instruments and deploy long antenna booms, two of which are more than 54 yards long. Data about the particles that swirl through the belts, and the fields and waves that transport them, will be gathered by five instrument suites designed and operated by teams at the **New Jersey Institute of Technology** in Newark; the **University of Iowa** in Iowa City; **University of Minnesota** in Minneapolis; and the **University of New Hampshire** in Durham; and the **National Reconnaissance Office** in Chantilly, Virginia. The data will be analyzed by scientists across the nation almost immediately.

APL built the RBSP spacecraft and will manage the mission for NASA. NASA's *Launch Services Program* at Kennedy is responsible for launch management. United Launch Alliance provided the Atlas V launch service.

Security Sat...

The next successful event for ULA was the Atlas launch of ***NROL-36*** for National Defense... as well as cool Cubes that were also delivered to their target via this launch. On Thursday, September 13, from *Space Launch Complex* (**SLC**)*-3* at **Vandenberg Air Force Base**, California, the launch occurred with precision—the mission is in support of national defense.

"The successful launch of the NROL-36 mission occurred on the same day as the national memorial service honoring American hero Neil Armstrong. The scientists and engineers developing and operating these remarkable current-day launch and spacecraft systems reflect Neil's incredible legacy to mankind," said *Jim Sponnick*, ULA vice president, *Mission Operations*. "This launch marks the fourth and final EELV mission for the NRO's Road to Launch 2012 accomplished in the last five months. This launch tempo is a tribute to all of the mission partners' dedication and continued focus on mission success—one launch at a time."

This mission was launched aboard an ***Atlas V EELV 401*** configuration vehicle, which included a 4m diameter payload fairing. The Atlas booster for this mission was powered by the ***RD AMROSS RD-180*** engine and the ***Centaur*** upper stage was powered by a single **Pratt & Whitney Rocketdyne *RL10A-4*** engine.

In addition to the NROL-36 payload, 11 CubeSats took advantage of the available volume and structural capacity of the Atlas V launch vehicle for a ride share. The NRO and ULA partnered to develop an *Aft Bulkhead Carrier* (**ABC**) on the Centaur second stage, which is a platform for accommodating auxiliary payloads aboard Atlas V missions.

Affixed to the ABC was an auxiliary payload called ***Operationally Unique Technologies Satellite***, or ***OUTSat***, carrying the 11 CubeSats in various configurations. The CubeSats are sponsored by the **NRO Mission Support Directorate** and **NASA**'s *Launch Support Program*, and were developed by the U.S.A.F.'s **Space and Missile Defense Command**, **The Aerospace Corporation**, **University of Southern California**, **University of Colorado**, **California Polytechnic State University**, **Morehead State University**, **University of California Berkeley** and the **Lawrence Livermore National Lab**.

"These auxiliary payloads are the first of their kind for an Atlas V mission," said *Sponnick*. "We are pleased we could support the NRO, NASA, and all of the associated institutions to deliver these important CubeSats which will study space weather and communications, debris mitigation, maritime shipping container tracking as well as space flight safety and orbit refinement."

Latest Launch

Just prior to going to "press" with this issue on October 4th, ULA's ***Delta IV*** launched the U.S.A.F.'s ***GPS IIF-3*** from *Space Launch Complex 37* at **Cape Canaveral Air Force Station** in Florida. The ***Navstar GPS*** is a constellation of satellites that provides navigation data to military and civilian users worldwide. The

The U.S. Air Force's GPS IIF-3 satellite, encapsulated inside its 4-meter diameter payload fairing, is mated to a United Launch Alliance Delta IV launch vehicle. Photo ULA.

system is operated and controlled by the **50th Space Wing**, located at **Schriever Air Force Base**, Colorado.

GPS uses 24 satellites, in six different planes, with a minimum of four satellites per plane, positioned in orbit approximately 11,000 miles above the Earth's surface. The satellites continuously transmit digital radio signals pertaining to the exact time (using atomic clocks) and exact location of the satellites.

The GPS IIF series have a design life of 12 years. With the proper equipment, users can receive these signals to calculate time, location, and velocity. The signals are so accurate that time can be measured to within a millionth of a second, velocity within a fraction of a mile per hour, and location to within feet. Receivers have been developed for use in aircraft, ships, land vehicles, and to hand carry.

As a result of increased civil and commercial use as well as experience in military operations, the USAF has added the following capabilities and technologies to the GPS IIF series to sustain the space and control segments while improving mission performance:

- *Two times greater predicted signal accuracy than heritage satellites*
- *New L5 signals for more robust civil and commercial aviation*
- *An on-orbit, reprogrammable processor, receiving software uploads for improved system operation*
- *Military signal "M-code" and variable power for better resistance to jamming hostile environments, meeting the needs of emerging doctrines of navigation warfare*

Addressing The Accomplishments

Since the inaugural flights in 2002, Atlas V and Delta IV launch vehicles have delivered more than 50 critical capabilities including vital national security missions for the U.S. Air Force and National Reconnaissance Office, science and exploration payloads for NASA and commercial imaging and communications satellites.

ULA's Atlas V and Delta IV launch vehicles provide a 33 percent cost savings over heritage launch systems and are the most commercially developed vehicles flying today, with **Lockheed Martin** and **The Boeing Company** having funded 80 percent of their development.

Developed by the United States Air Force to provide assured access to space for Department of Defense and other government payloads, the commercially developed EELV Program supports the full range of government mission requirements, while delivering on schedule and providing significant cost savings over the heritage launch systems.

ULA program management, engineering, test, and mission support functions are headquartered in Denver, Colorado. Manufacturing, assembly and integration operations are located at Decatur, Alabama, and Harlingen, Texas. Launch operations are located at Cape Canaveral AFS, Florida, and Vandenberg AFB, California.

Since 1998, NASA's Launch Services Program has been based at Kennedy Space Center, Florida, and provides oversight as the designs of the rocket and mission are integrated with each other.

Additional information regarding United Launch Alliance may be obtained *at their website.*

ULA launch of the USAF's GPS IIF-3 satellite aboard a Delta IV vehicle

A New Gen Of GaN

By C. Damian, Vice President, and D. Gelerman, President, CEO, Advantech Wireless

The introduction of Gallium Nitride High Electron Mobility Transistors (GaN HEMT) in early 2000 has left an undeniable mark on the entire satellite communication landscape. It is now possible for the first time since the introduction of the Solid State Microwave Technology to design and manufacture Power Amplifiers that exceed by several orders of magnitude the reliability, linearity, power density and energy efficiency of all existing technologies, being GaAs, LDMOS, or TWT. A comparison study between these technologies is presented in this article, with emphasis on linearity and efficiency.

The Technology

Today for both military and commercial satellite markets, GaN-based technology, without a doubt, is a hot topic. GaN-based devices began to surface in the commercial applications about 8 years ago. They were primarily used for low-frequency L, S, and C-band applications like radar, cable TV and power management.

In early stages of technology Advantech has realized the tremendous potential of these new types of devices for high frequency satellite communication. As a result, and ambitious R&D program was put in place back in 2006 to design and manufacture a complete line of C, X, and Ku-band Solid State Power Amplifiers, able to meet the most demanding and stringent requests.

In partnership with key technology providers, Advantech engineers have focused on technology transition to high frequency, high efficiency, and high performance, as demanded by the growing Satcom on the Move, Mobile, man pack, broadcast and teleport markets

Early challenges were identified in the non-linear characteristics of these devices, difficulties in processes and materials and in biasing new devises, as well as in their poor yield and hence very high cost, making them an exotic material.

A number of patent pending technologies were developed during the last six years that have succeeded in obtaining the highest linearity ever achieved on the market by both Solid State and linearized TWT techniques.

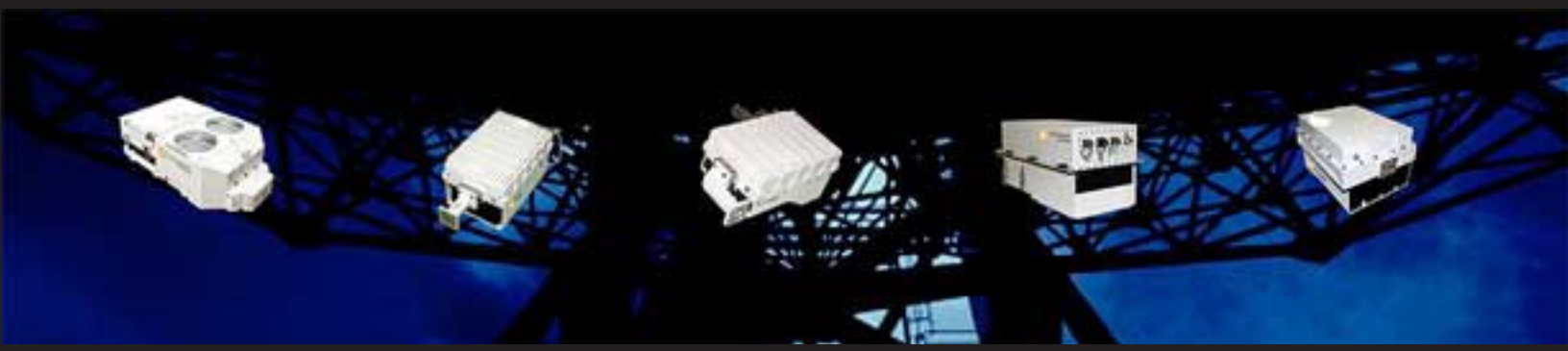
Initially, it seemed GaN-based devices would be affordable only for expensive military applications, like radar, electronic warfare, and high security communication systems. Recent hard work of scientist in many fabs around the world, led to the material maturity, yield improvement, development of lower cost substrates; and increase in demand, have driven the GaN-based devices cost and now they are a very viable economical option to the current GaAs solid state technology as well as to TWTA.

What Is Gallium Nitride (GaN)?

Gallium Nitride (GaN) is a binary III-V direct band gap semiconductor. The material used to create working transistors is actually a crystal, and these crystals are grown layer-by-microscopic layer, using a precise mixture of different gases, flowing into a reaction chamber. The electrical properties of GaN make it an ideal choice of material for optoelectronic, high-power and high frequency devices. Because GaN offers very high breakdown voltage, high electron mobility and saturation velocity, it is also an ideal candidate for high-power and high-temperature microwave applications like RF power amplifiers at microwave and mm frequencies, and high-voltage switching devices

The entire GaN semiconductor is grown into a crystal lattice structure material that has a very high threshold for electron mobility, hence behaves similarly to the diamond: can be both subject to very high temperatures before performance degradation and has excellent thermal conductivity properties, allowing high temperature operation and effective heat transfer. Therefore the devices using GaN can operate at very high temperatures (up to 350 degC) and can dissipate all the heat generated by these devices at very high temperatures.

Obviously, the best match is to grow GaN transistors on GaN substrates, because they have an identical crystal lattice structure; however this is slow growing and hence expensive process. Recently non-lattice-matched substrate materials have been developed and now are commonly used. Among them, silicon carbide is the current favorite because of the low cost/high performance combination. Therefore due to these technological advancements and refinements of the processes and use of composite materials, GaN devices can be produced in large volumes relatively cost effective. Future ramp up in the demand will drive the price down to make it competitive and to match or surpass the price of the similarly rated GaAs FETs, making GaAs HPA, spatial combined HPA and TWTA disappear.



First, a thin layer of high-purity mono-crystalline GaN is grown, ranging from one to two microns thickness. Next, a separate layer of aluminum gallium nitride, 15-25 nanometers is made. These two layers, with dielectric passivation adding an insulation layer to the device surface, form the basic transistor layer structure. Metallization layers are then added to make electrical contacts, and to form the transistor drain, gate and further interconnects.

Finally, the wafer is reduced in thickness in order to establish the electrical source and ground links through via holes that connect the front face to back. This is by no means a trivial process, because the silicon carbide material is a very hard material. That implies grinding the wafer down from 500 microns to around 100 microns, and chemically etching around 50 micron-diameter via holes.

It can take on average 3 to 4 months to grow and fabricate a batch of GaN devices, and the thread of contamination, crystal strain, structural mismatch or other defects is very high and real. If the defects and surface passivation layers are not properly controlled, a rapid degradation in device performance can be noticed.

Performance

Generally regarded as the most promising semiconductor since Shockley discovery of the silicon transistor, gallium nitride (GaN) works much better at higher voltages and temperatures than silicon (Si) or widely used at high frequencies gallium arsenide (GaAs).

Today GaN is a mature, robust technology with extraordinary reliability. Compared to GaAs and Si, GaN has much higher breakdown voltage (~ 100VDC) and power densities, enabling applications not possible with competing process technologies. GaN high power density also allows for smaller devices, reducing the capacitance, enabling high impedances, wider bandwidths, and reduced size and cost. Additional benefits include industry-leading efficiency of operation, reduced cooling requirements, and lighter weight.

Significantly for space applications, GaN is also inherently radiation-resistant, surpassing in performance GaAs and it can perfectly withstand the EMP.

European Space Agency (ESA) has identified GaN as a "key enabling technology " for space, and has established the "GaN Reliability Enhancement and Technology Transfer Initiative " (Great2), bringing together leading research institutes and manufacturing industry to set up a supply chain to manufacture high-quality GaN space based components.

In space applications, the vacuum tube based traveling wave tube amplifier (TWTA) is still used, because of high Power Added Efficiency (PAE). However, because the TWTA uses the filament in electron gun, that is subject to wearing out with time and needs an extremely high voltage of the order of several thousands of volts (~10KV), and reliability is considered not ideal due to the hot electrons and vacuum depletion in tube with time, the solid-state power amplifiers (SSPA) is often considered to be a favored solution. GaN based SSPAs are now in development, in order to replace TWTAs in many space applications and plans are in place to soon launch GaN SSPAs into space.

For the traditional SSPA manufacturing, while GaAs HEMT and LDMOS have traditionally been widely used, GaN HEMT offers the major advantages:

- Higher Power Added Efficiency (PAE), which not only saves electrical power usage (OPEX), but also can reduce the size and cost of SSPAs, due to lower amount of heat dissipated, and ease of manufacturing (CAPEX). For instance in C-band GaN devices have up to 48% efficiency, as compared to 25-30 percent for GaAs. As a result cubical volume of the power supply can be reduced by factor of two, or for the given volume the greater derating can be utilized. As failures of the power supply are critical failures, this translates in much higher MTBF, and reduced OPEX

- High Operating Voltage—GaN HEMT operates with a power supply of up to 50 VDC, similar to the range of power feeder voltage of 48 VDC, which is commonly used for communication equipment. Furthermore, for any given output power and supply voltage, the operating current can be reduced, when comparing with other technologies. It is to be noted that the breakdown voltage for GaN devices is above 100VDC, which makes them extremely difficult to damage

- This translates into a much more reliable power supply design, as output current is reduced up to 75 percent on average. Operating voltage is moving from 10VDC required to operate GaAS FETs to 20-48VDC, but there is no fear that if interlock in TWTA power supply is failed, of personnel to be electrocuted as it could happen with TWTA, due to high voltage (~10KVDC) anode power supply required to operate TWT.

- GaN HEMT devices have higher impedance then other technologies. Hence, the SSPA design engineer can use the benefits of GaN to enhance the performance, such as wider frequency band coverage, and higher PAE, depending on the required performance of the SSPA.

- Much higher reliability—The crystal lattice structure, and the high temperature handling capabilities of the GaN device, makes them an extremely robust and reliable part of the SSPA design. It is known that the traditional GaAs FET transistor will stop operating, or will rapidly degrade at junction (channel) temperatures higher than 175 deg Celsius. At 175 deg Celsius junction temperature, GaN devices have many millions of hours MTBF.

From the reliability point of view, for all SSPAs designs, the power supply which needs to generate high current and the RF output stage where all the heat is generated, are the highest stress, highest points of failure, and 90% of failures are indeed fall into these areas.

By using power supplies with lower power consumption and higher operating voltages, we can reduce operating current by 75 percent, and that solves one of the key design issues.

By using GaN devices in RF and microwave frequencies we can handle much higher operating temperatures, and that addresses the second reliability aspect. Having these two key elements addressed with a much more robust design, increases the reliability and the MTBF numbers of the SSPA by orders of magnitude.

SSPA Performance, GaN Vs. GaAs, + Vs. TWTA

Advantech Wireless has developed in the last 6 years a full line of GaN based SSPAs and SSPBs (Block Up Converter integrated with SSPA). The product line, launched at Satellite 2010 in Washington, included up to 200W Ku-band offering, the first product line worldwide.

Since then, major deployments in both the commercial and military markets have been taken place, with thousands of devices operating now in the field. This is now a mature, stable, low OPEX, high reliability technology. By using patent pending technologies and in close cooperation with key technology suppliers, Advantech Wireless has managed to perfect the design, and to raise the performance of GaN based SSPA/SSPB above all existing technologies.

These units now exceed the linearity, energy efficiency, and reliability of anything that existed prior to their introduction to the market, being it solid state or TWT based products.

For the purpose of performance analysis and comparison, the following section will compare Advantech Wireless made SSPAs, using GaN vs. GaAs technology, as well as third party TWTAs with the same or similar operating power rated performance. The main focus is on linearity, noise power density and PAE characteristics, as well as reliability.

Linear Power

For the purpose of link budget, or satellite system design, choosing the right amount of requested RF Transmit power to meet a required link margin is not always obvious. The system designer will have the option of selecting between Solid State or TWTA technology, but both of them define RF Power in a different way.

TWTAs will define Saturated Power, or Power at the Flange, as well as Third Order Intermodulation Products.

Third Order Intermodulation Products will specify what is the maximum total transmitted power with two equal carriers, for which the third order (odd order) Intermodulation products will not exceed a specified value. It is commonly known that these undesirable products are in-band products, and therefore cannot be filtered. They have to be kept low by proper design of the high power amplifier (HPA) by utilizing either inherent devices linearity (GaAs), or deploy linearization techniques like analog or digital predistortion, feedback amplifiers (not commonly used due to their low efficiency) and that known as feed forward amplifiers (TWTA and GaN).

On the next page are the description of the tests performed for the linearity measurements. The currently most used method is to apply to the HPA two equal carriers with combined output power backed off 3-4 dB (OPO) from P1dB and measure the unwanted in-band intermodulation products.

Solid State technology has introduced a new concept, P1dB, or 1dB compression point. This is transmit output power at which gain will be reduced by 1dB. P1dB, more then anything else, will define a power level that should not be exceeded when operating a single carrier. In Solid State, the difference between P1dB and Psat is typically within 1 dB, and operating about P1dB and above will generate rapid grows of odd order in-band intermodulation products, or spectrum re-growth and hence degradation of link performance in terms of BER.

Intermodulation will also be specified, same as for TWTA, but general performance, depending on manufacturer is 3 to 4 dB better on GaAs Solid State as compared to TWTAs.

In order to compensate for this, the later will use various linearization techniques described above, but these are usually narrow band, and analog, non-adaptive ones require periodic adjustments due to aging.

None of the parameters specified above, Psat, P1dB, Third Order Intermodulation products, or Third Order intercept point (yet another concept), will give much usable information to the satellite link designer, in case the application requires just one carrier, or multicarrier, but more than two carriers.

Operating in single carrier mode depends on data rate, and on modulation type. Neither Psat nor P1dB can give much information in this case.

Operating in multi carrier modes (three or more) will raise questions, which are not answered by Third Order Intermodulation products, as the behavior will be totally different.

In order to answer these questions, Advantech is aligning its own specifications, to a new, uniform, more explicit set of standards. These standards have emerged few years ago, with the intention to allow the system designer to select the right product, from the multitude of offerings, based on his own application. Standardization institutes, as well as military organizations now adopt them (as an example MIL-STD-188-164 standard).

The new set of standards is not mentioning P1dB any longer, due to the above-mentioned limitations.

They specify " Linear Power" as:

- Operating Power at which Spectrum Regrowth for a single carrier, operated in a certain modulation type (usually QPSK or OQPSK), at a certain data rate, at a certain offset from carrier (1 or 1.5 symbol), will not exceed a specified value. Spectrum Regrowth will cause unwanted "shoulders" on the main carrier, that will spill over into the next satellite channel, and create inter symbol interference among others.

- Total operating power for which two equal transmitted carriers will generate Third Order Intermodulation Products below a specified value (usually 25 dBc).

Linear Power—Spectrum Regrowth
A number of Spectrum Regrowth tests were performed on Advantech made 400W Ku-band SSPAs using GaAs and compared with GaN versions.

Both the units are tested with an QPSK signal, 5 Mbps, 1 Symbol rate offset. The desired target specification is –30 dBc.

The 400W Ku-band GaN is specified as Psat=56 dBm.

The 400W Ku-band GaAs is specified as P1dB = 55 dBm, and also Psat = 56 dBm

The results are summarized in the tables on the next page, and the areas highlighted in green indicate that the required performance is met:

Net Benefits
The test results outline the net benefit of GaN technology.

Advantech XXX-series 400W Ku-band GaN SSPA will outperform by 2 dB a 400W Ku-band GaAs SSPA when operated in single carrier mode.

In fact, in terms of linearity, as defined by single carrier operation mode (Spectrum Regrowth), a 400W Ku-band GaN SSPA will be the equivalent of a 600 W Ku-band GaAs SSPA.

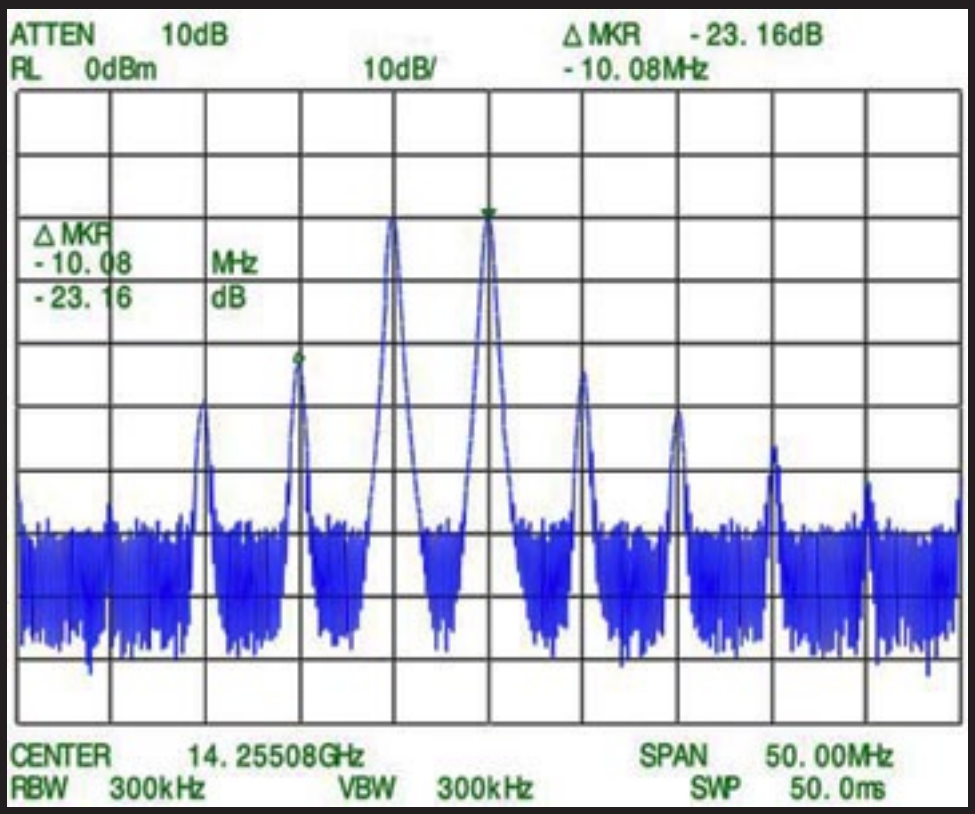


Figure 1. Third Order Intermodulation Products

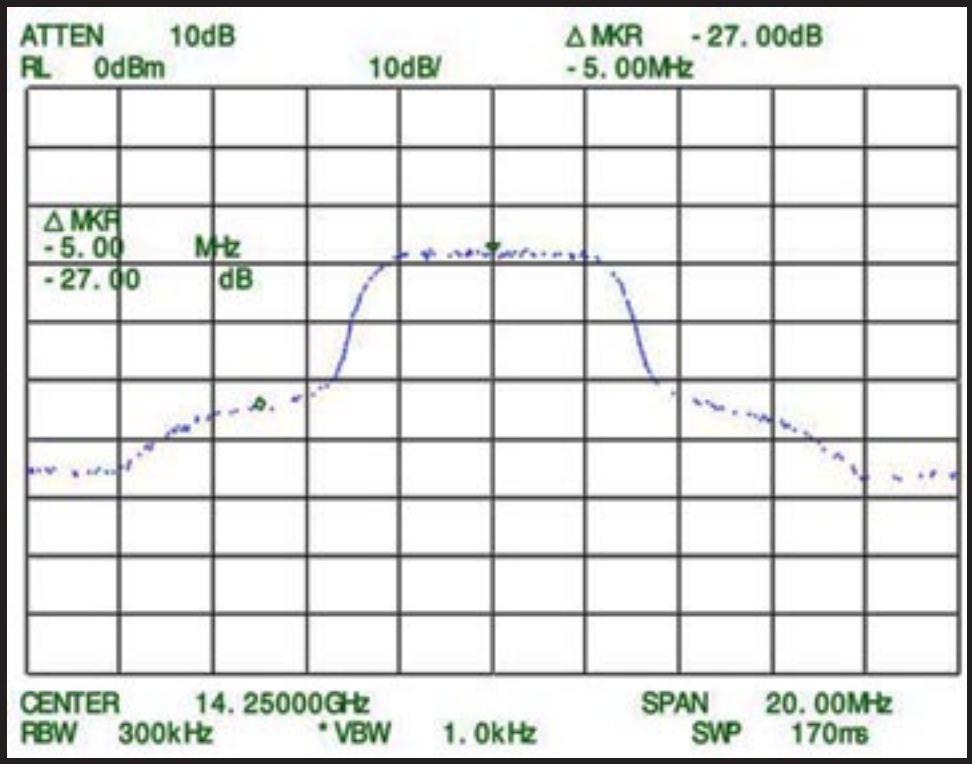


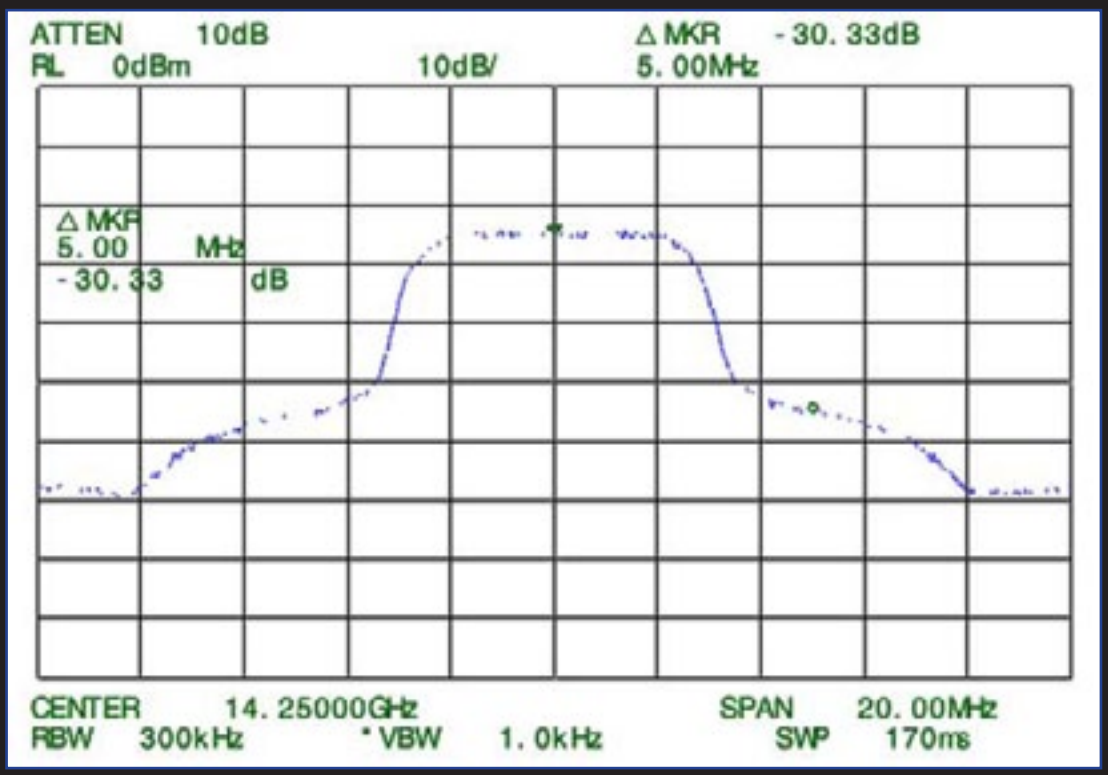
Figure 2. Spectrum Regrowth, one carrier, QPSK, 5 Msps, 1 Symbol Offset from carrier

Linear Power—Third Order Intermodulation
In order to determine the linearity under two carrier operations, a number of Third Order Intermodulation tests were performed on the same 400W Ku-band SSPAs, build with different architecture, i.e. GaN versus GaAs. The results are also compared with published data of similar power rated non-linearized TWTA. The desired target specification is –25 dBc. See ***Table 2*** and associated charts on ***Page 53***.

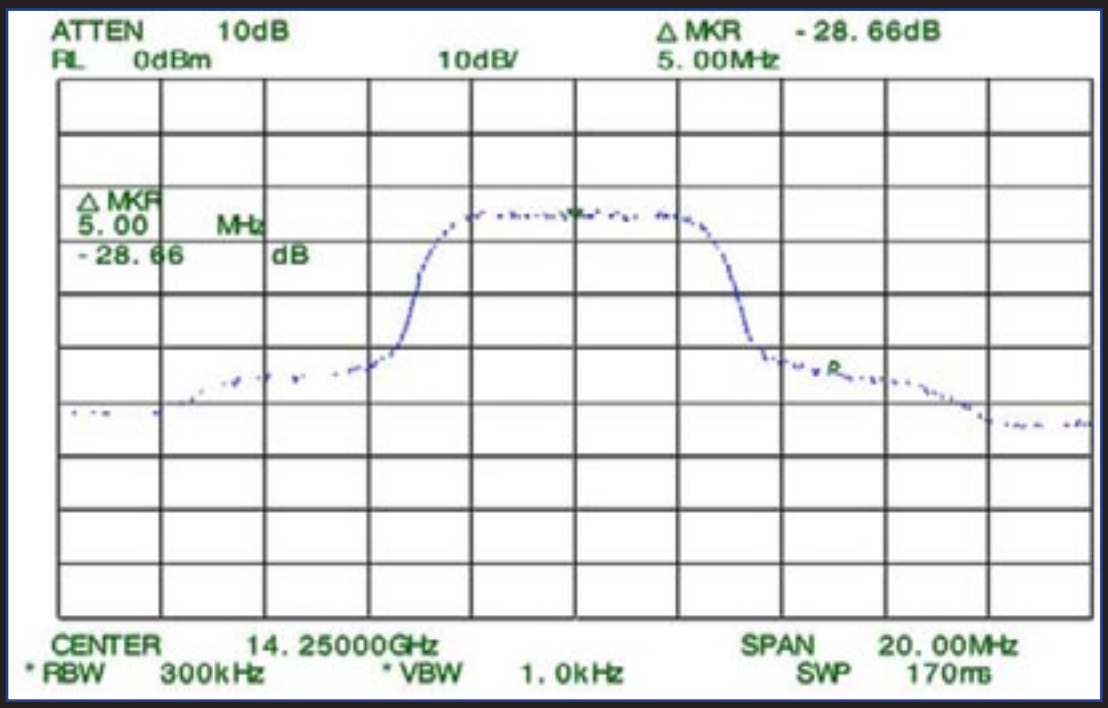
The measured results indicate that 400 W Ku-band GaN will exceed by 1 dB the performance of the same rated 400W Ku-band GaAs and by 2 dB the performance of 750W Ku-band non linearized TWTAIn fact, in terms of linearity as specified by two carries transmission (third order intermodulation), a 400W Ku-band GaN SSPA is equivalent to a 500W Ku-band GaAs SSPA.

No.	Operating Power	400W Ku-band GaN	400W Ku-band GaAs
1	55 dBm	-30.3 dBc	-28.6 dBc
2	54 dBm	-35.7 dBc	-29.3 dBc
3	53 dBm	-37.5 dBc	-34.3 dBc
4	52 dBm	-38.3 dBc	-37.6 dBc

Table 1. Spectrum Regrowth, GaN versus GaAs, 400 W Ku-band SSPA



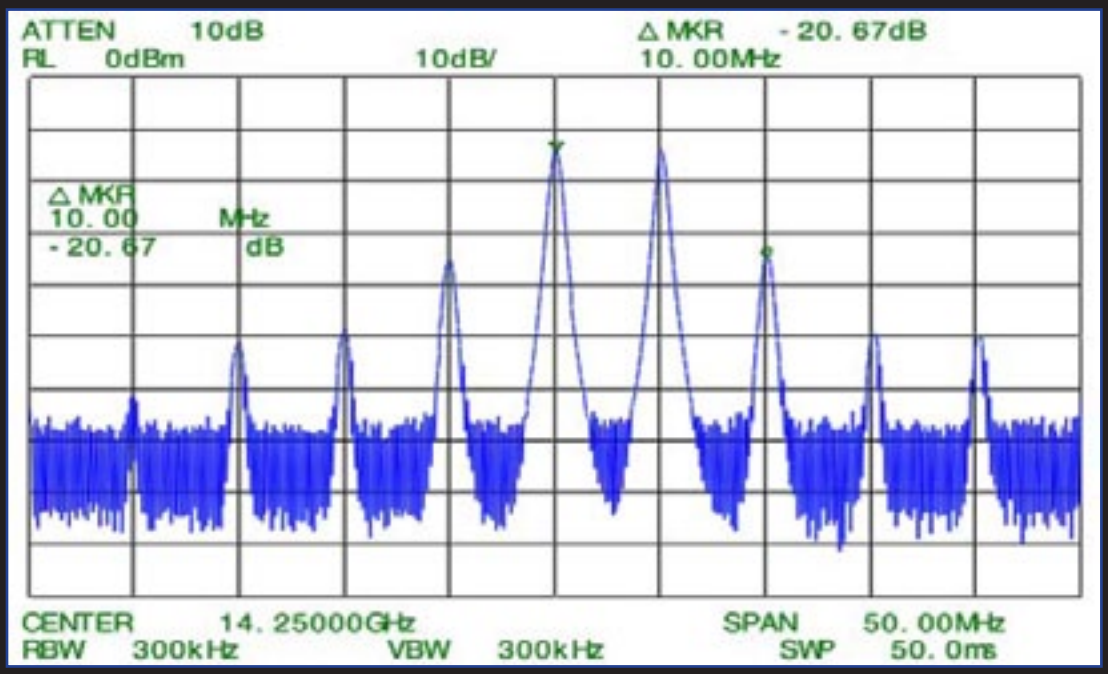
GaN SSPA, 55 dBm output



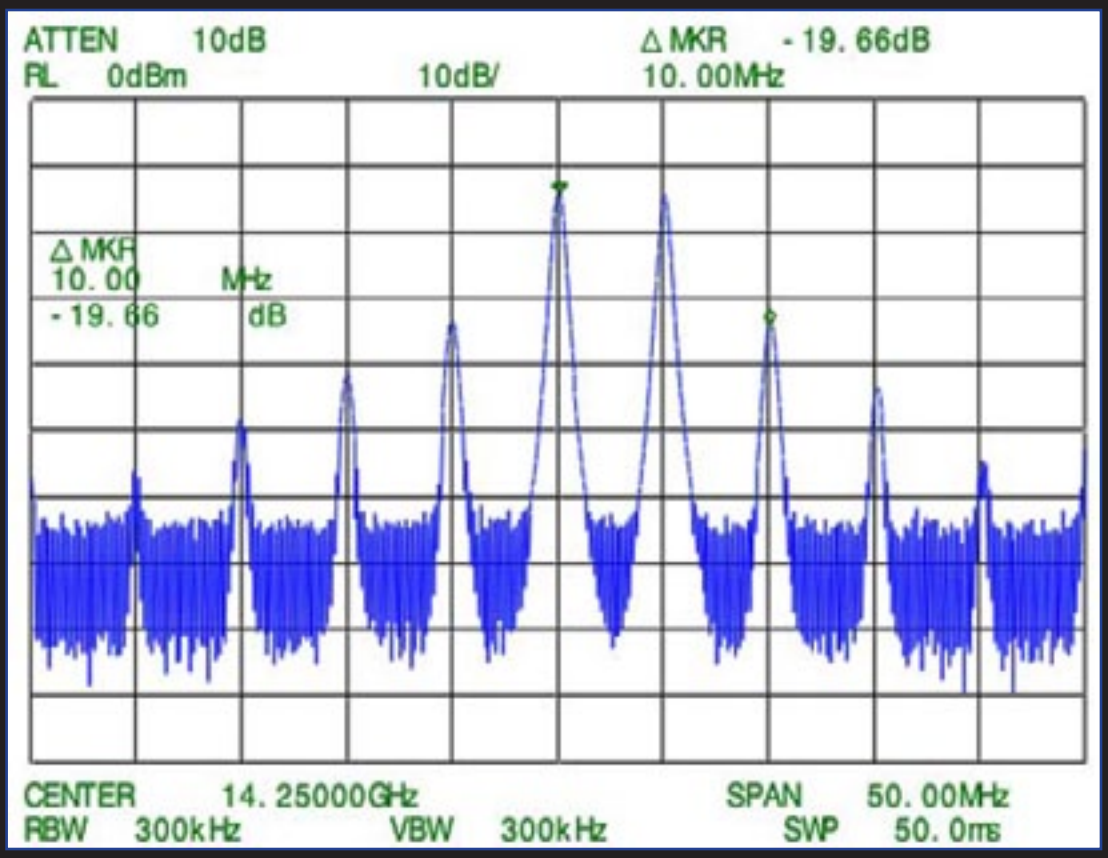
GaAs SSPA, 55 dBm Output

No	Operating Power	400W Ku-band GaN	400W Ku-band GaAs	750W Ku Non linearized TWT
1	54 dBm	- 20.67 dBc	- 19.86 dBc	- 18 dBc
2	53 dBm	-26.63 dBc	- 23.16 dBc	- 20 dBc
3	52 dBm	-31.63 dBc	- 27.50 dBc	- 22 dBc

Table 2. Third Order Intermodulation products, GaN versus GaAs, versus TWTA



Intermodulation 400W Ku-band GaN, 54dBm



Intermodulation 400W Ku-band GaAs, 54 dBm

No	Operating Power	400W Ku-band GaN	400W Ku-band GaAs	750W Non linearized TWTA
1.	55 dBm	1.5° / dB	2.5° / dB	4.0° / dB
2.	54 dBm	1.0° / dB	2.0° / dB	3.5° / dB
3.	53 dBm	0.8° / dB	1.5° / dB	3.0° / dB
4.	52 dBm	0.5° / dB	1.0° / dB	2.5° / dB

Table 3. AM/PM, GaN versus GaAs, versus TWTA

Parameter	400W Ku-band GaN	400W Ku-band GaAs	750W TWTA
Weight	30 Kg	80 Kg	37 Kg
Volume	29 dm^3	142 dm^3	74 dm^3
Energy Consumption	2,200 W	3,500 W	2,500 W

Table 4. Weight, volume, and energy consumption GaN versus GaAs, versus TWTA

In fact, in terms of linearity as specified by two carries transmission (third order intermodulation), a 400W Ku-band GaN SSPA is equivalent to a 500W Ku-band GaAs SSPA.

Linearity As AM/PM Conversion

Another important parameter that will define the linearity performance in presence of high order modulation schemes is AM/PM conversion. An amplitude modulated signal going through a non linear system, will generate phase degradations (rotations).

The test is performed by applying a power swept signal at the input of the SSPA, and monitoring the phase change at the output

The desired performance is 1.5 degrees / dB. The parameter is critical when higher order modulation schemes that use both Amplitude and Phase modulation (16 APSK/QAM and higher) are used and are illustrated above.

The test results indicate that the GaN SSPA will exceed the GaAs SSPA performance by 2 dB, and by 4 dB the TWTA performance.

In other words, in terms of AM/PM performance, a 400W Ku-band GaN will be the equivalent of a 600w Ku-band GaAs, and outperform a 750W TWTA.

All the tests above indicate that GaN SSPAs exceed by far the performance of GaAs SSPAs and similar output power rated linearized TWTA.

This remarkable performance is even more interesting, considering the large reduction in size and energy consumption achieved by GaN SSPAs. Table 4 below presents the results, using the same models as tested above:

It is to be noted that a 400W Ku-band GaN is just 37 percent the weight of the 400W GaAs SSPA and 81 percent the weight of the TWTA.

In terms of energy, the 400W GaN consumes 37 percent less then the GaAs variant, and 12 percent less then the TWTA.

A remarkable 80 percent reduction in volume as compared with the GaAs variant is achieved, as well as a 60 percent reduction versus TWTA.

For the first time to our knowledge, the Solid State Technology achieved the lower weight, lower volume, has less energy consumption and can operate at 2dB higher output power, comparing to the TWTA counterpart

Adding to this impressive array of performance, is the drastic increase in reliability, the increased tolerance to high ambient operating temperatures, confers to the GaN SSPA all key indicators of a true disruptive technology. Regarding the space applications, this technology is by far better suited than both TWTA and GaAs based SSPA.

About the authors

Mr. David Gelerman founded Advantech Wireless in 1988, serving initially as President and, since March 2006, as Chief Executive Officer. Prior to founding the Company, Mr. Gelerman has held various positions at Nortel Networks, including Manager of the Transmission Networks Division, where he managed and supervised teams which developed several key Point-to-Point (P2P) radio systems. Mr. Gelerman holds a Master's of Science degree in Electrical Engineering (MSEE), specializing in Wireless Communications and Broadcasting from the Moscow Institute of Telecomm.

Mr. Damian joined Advantech Wireless in 1995 where he held various leading positions in Operations, Manufacturing, Sales, Engineering and Customer Support. Prior to Advantech Wireless, he acquired experience as a hardware engineer in various high-tech companies. Mr. Damian holds a Master's degree in Electrical Engineering from Concordia University.

SatFinder

Satellite Database & Calculation Software

DATABASE

Information on over 500 satellites (orbital location, frequencies, EIRP, G/T, SFD, bandwidth, programming etc.)

Information on 9,000 companies (address, tel, fax, web, products, services and contact names etc.)

Information on 19,000 executives in the commercial satellite industry.

800 hundred EIRP, G/T & SFD maps in color not published anywhere else.

CALCULATION

Has full up-down digital link budget calculators with input provision for uplink power control (UPC), ALC, various interferences and multiple carriers.

Finds HPA size, uplink power requirements, bandwidth and power usage per carrier.

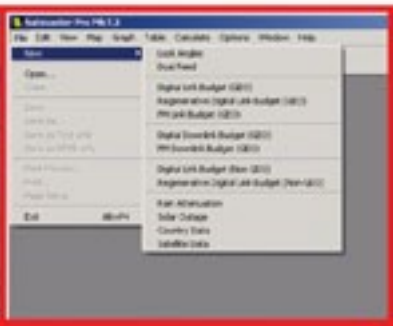
Calculates atmospheric losses and rain fade margins for any desired availability on uplink and downlink.

Handles BPSK, QPSK, M-PSK or M-QAM with any FEC code rate.

Determines power or bandwidth limited modes and calculates the power equivalent bandwidth, if appropriate.

Provision for RS codes or 'Turbo' modems. Option for rain up AND rain down scenarios where uplink and downlink are from/to the same city.

UPDATED QUARTERLY!



http://www.satnews.com/satfinder

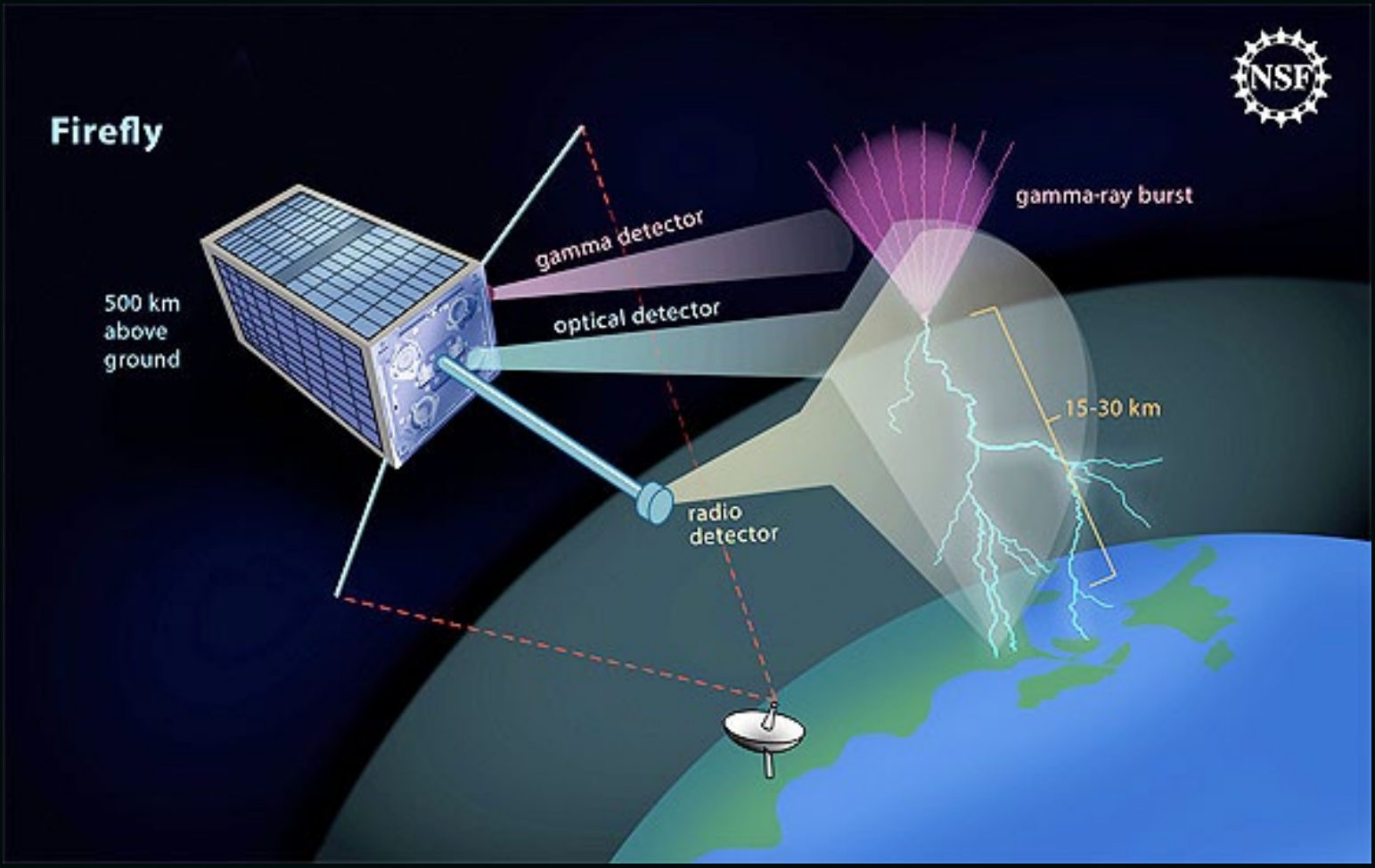
This Firefly Is Into Gamma-Rays

By Cheryl Dybas, Senior Science Writer, National Science Foundation

Imagine a fully-instrumented satellite the size of a half-gallon milk carton. Then imagine that milk carton whirling in space, catching never-before-seen glimpses of processes thought to be linked to lightning.

This little satellite that could is a CubeSat called Firefly, and it's on a countdown to launch next year. CubeSats, named for the roughly four-inch-cubed dimensions of their basic building elements, are stacked with modern, smartphone-like electronics and tiny scientific instruments.

Built mainly by students and hitching rides into orbit on NASA and U.S. Department of Defense launch vehicles, the small, low-cost satellites recently have been making history. Many herald their successes as a space revolution.



Firefly, a milk-carton-sized satellite, will study gamma-ray bursts that accompany lightning.
Credit: Zina Deretsky, National Science Foundation

Several CubeSat projects funded by the National Science Foundation (NSF) are currently in orbit, making first-of-their-kind experiments in space and providing new measurements that help researchers understand Earth's upper atmosphere.

Firefly is designed to help solve the mystery of a phenomenon that's linked with lightning: *terrestrial gamma rays*, or *TGFs*.

Bursts Discovered

Bursts of gamma rays usually occur far out in space, near black holes and other high-energy cosmic phenomena. Scientists were surprised when, in the mid-1990s, they found powerful gamma-ray flashes happening in the skies over Earth.

Powerful natural particle accelerators in the atmosphere are behind the processes that create lightning. TGFs result from this particle acceleration.

Individual particles in a TGF contain a huge amount of energy, sometimes more than 20 mega-electron volts. The aurora borealis, for example, is powered by particles with less than one-thousandth as much energy as a TGF.

But what causes a TGF's high-energy flashes? Does it trigger lightning—or does lightning trigger it? Could it be responsible for some of the high-energy particles in the Van Allen radiation belts, which can damage satellites?

Firefly soon will be on the job, finding out.

Atmospheric Accounting

The CubeSat will look specifically for gamma-ray flashes coming from the atmosphere, not space, conducting the first focused study of TGF activity.

The Firefly team is comprised of scientists and students at Siena College in Loudonville, New York; NASA Goddard Space Flight Center in Greenbelt, Maryland; the Universities Space Research Association in Columbia, Maryland; the Hawk Institute for Space Science, Pocomoke City, Maryland; and the University of Maryland Eastern Shore, Princess Anne, also in Maryland.

Students are involved in all aspects of the mission, from design and development, through fabrication and testing, to operations and data analysis.

Firefly will carry a gamma-ray detector along with a suite of instruments to detect lightning, says Therese Moretto Jorgensen, program director in NSF's Division of Atmospheric and Geospace Sciences, which funds Firefly and its CubeSat companions in space.

The CubeSat will return the first simultaneous measurements of TGFs and lightning.

Target: T-Storms

When thunderstorms happen, powerful electric fields stretch upward for miles, into the upper atmosphere. These electric fields accelerate free electrons, whirling them to speeds that are close to the speed of light.

When these ultra-high-speed electrons collide with molecules in the air, they release high-energy gamma rays as well as more electrons, starting a cascade of electrons and TGFs.

"Gamma rays are thought to be emitted by electrons traveling at or near the speed of light when they're slowed down by interactions with atoms in the upper atmosphere," says Moretto Jorgensen. "TGFs are among our atmosphere's most interesting phenomena."

Atmospheric scientists think TGFs occur more often than anyone realized and are linked with the 60 lightning flashes per second that happen worldwide, says scientist Allan Weatherwax of Siena College, a lead scientist, along with Doug Rowland of NASA's Goddard Space Flight Center, on the Firefly project.

Build-up of electric charges at the tops of thunderclouds from lightning discharges can create a large electric field between clouds and the ionosphere, the outer layer of Earth's atmosphere. But how this might lead to TGFs is unknown.

"Firefly will provide the first direct evidence for a relationship between lightning and TGFs," says Weatherwax. "Identifying the source of terrestrial gamma-ray flashes will be a huge step toward understanding the physics of lightning and its effect on Earth's atmosphere."

Unlike lightning, a TGF's energy is released as invisible gamma rays, not visible light. TGFs therefore don't produce colorful bursts of light like many lightning-related phenomena. But these unseen eruptions could help explain why brilliant lightning strikes happen.

Following *Firefly* is *FireStation*, a set of miniaturized detectors for optical, radio and other lightning measurements.

Editor's Note:

This article is courtesy of the ***National Science Foundation's Discovery website. Contact the author @ cdybas@nsf.gov***

Firefly, as it will look once launched high into the atmosphere above Earth. Credit: NASA

Firefly catching a terrestrial gamma ray, or TGF, in action. Credit: NASA

Junkyard Dogs Or Outhouse Rats?

OpEd by Elliot Holokauahi Pulham, CEO, Space Foundation

I fear the Republic no longer functions, but we *must* keep our faith.

I generally try to be as upbeat and positive as possible. I'm no Pollyanna, but I subscribe to Thomas Jefferson's theory that more gets accomplished through generosity than meanness.

Yet, our Republic has arrived at a point where it is difficult to find anything generous to say about Congress or the White House, who have abrogated all responsibility to govern in favor of pursuing a course of economic chaos and mutually assured political destruction. What I can't figure out is: are these people just meaner than junkyard dogs, or are they crazier than outhouse rats?

Here are some of the navigational waypoints on the egregiously irresponsible course that Congress and the White House, Democrats and Republicans, collectively, have set the country on:

Sequestration

In order to force themselves to compromise and act collaboratively in the interests of the nation, our elected officials planted a bomb in the federal budget. "Fix the deficit and fix the budget," they said to themselves, "or we'll blow ourselves to kingdom come!" Well, Congress doesn't respond well to threats, even from itself, and of course no agreement was reached and, as per usual, nothing was done. However, the bomb—$500 billion in mindless budget cuts - is still ticking. If it goes off when the timer runs down to zero on January 2, it could plunge the nation into the worst economic collapse it has ever seen.

The unemployment rate will climb above 9 percent, pushing the economy toward recession and reducing projected growth in 2013 by two-thirds. An already weak economy will be undercut as the paychecks of thousands of workers across the economy will be affected from teachers, nurses, construction workers to key federal employees such as border patrol and FBI agents, food inspectors and others. - Dr. *Stephen S. Fuller*, Dwight Schar Faculty Chair and university professor and director for regional analysis at George Mason University.

The automatic spending cuts mandated in the Budget Control Act of 2011 . . . in just the first year of implementation will reduce the nation's GDP by $215 billion; decrease personal earnings of the workforce by $109.4 billion and cost the U.S. economy 2.14 million jobs. -- *Aerospace Industries Association* study

These cuts will not just impact a few large companies. These cuts will flow down the supply chain and through the broader economy. They will impact companies, like mine and threaten the jobs of thousands of skilled workers. In fact, a report released last month by the National Association of Manufacturers concludes that by 2014, the cuts in defense spending enacted last year combined with the cuts set for Jan. 1, 2013, will result in the loss of more than one million jobs, increasing the unemployment rate by almost 1 percent. - Della Williams, president and chief executive officer, Williams-Pyro

> The very prospect of sequestration is already having a chilling effect on the industry. We're not going to hire. We're not going to make speculative investments. We're not going to lean forward. We're not going to invest in incremental training because the uncertainty associated with $53 billion more of reductions in our first fiscal quarter next year is a huge disruption to our businesses.—Robert Stevens, chairman and chief executive officer, Lockheed Martin

The media is just beginning to catch on to what is happening here. Sadly, we probably won't see any real urgency on the part of Congress or the White House until the first week in October. At that time, the federal Worker Adjustment and Retraining Notification Act (WARN) will be triggered and hundreds of thousands—perhaps millions—of workers across the country will begin getting pink slips from companies that do business with the federal government. Not only is this grotesquely irresponsible government, but, triggering mass layoff notices one month before the general election has to go down as one of the most politically stupid moves of all time.

Which returns us to my original question: Are these people just meaner than junkyard dogs or are they crazier than outhouse rats?

Debt Ceiling Vote

Intertwined with sequestration is the issue of dealing with the U.S. federal debt ceiling. Should we raise it? Lower it? Leave it alone? While we can argue about whether the debt ceiling is where it should be, the fact is that it is there. Statutorily, you cannot exceed it, yet we'll almost certainly need to if we are to deal with the federal budget responsibly. But by how much? And for how long? As economist Edgar R. Fiedler said, "Ask five economists and you'll get five different answers—six if one went to Harvard."

One actually sympathizes with members of Congress on this point. After all, for the past two decades we've heard nothing but how bad it is for the U.S. dollar to lag behind the Euro, yet, now that the currencies are nearing parity, we're being told how bad that is! Well, which is it? I can't believe I'm quoting Rupert Murdoch, but there's something to his observation that "we all know economists were created to make weather forecasters look good."

The problem is that Congress sometimes relies upon experts to advise them. In this case, the experts are economists and, as George Bernard Shaw said, "If all the economists were laid end to end, they'd never reach a conclusion."

Still, Congress does need to act. But it is showing no signs of doing so.

Continuing Resolution/FY13

All this inaction is almost certain to result in government operating under yet another continuing resolution in FY13. What this means is that only the Department of Defense is likely to have a congressionally authorized budget. So, at the end of the day, government continues on, with no changes, guidance or direction from Congress. Urgently needed program changes cannot be made. Wise and prudent budget reallocations cannot happen. Proper prioritization of services and programs cannot take place, neither within agencies nor among them. Rather, Congress institutionalizes the status quo, which has brought us to the brink of economic disaster.

About the author

Elliott H. Pulham is the CEO of the Space Foundation, based in Colorado Springs, Colorado. For more information on the organization, head over to their website.

A Builder's Guide To Inexpensive Space Access

By Randa Relich Milliron, CEO, Interorbital Systems

If you're planning to start your own space transportation company, you'll need a few things. First and foremost is positive attitude and faith in your own abilities. A close second requirement is developing a simple, robust rocket design that actually can be built using mass production techniques. You must take the sage advice of the Apple ad campaign "Think Different" and, simultaneously, grasp how to think like a member of the established space dinosauria as they exercise majority control of the gravity-well escape business. These skills are required for both a competitive edge and your own survival.

Your goal is to be nimble enough to keep the cash flow from freezing up while your team develops the ultimate killer app in rocket technology and/or spacecraft design. To facilitate that entire process, one driving question should be blazing in your forebrain—"*Can we actually afford to build this?*" If not, the next question is, "*How do we modify the design to make a rocket buildable on our budget?*"

To create a path to success that will take you from your garage workshop to elsewhere in the Solar System, the vital move at the start of your project is to embark on a design campaign that will yield a launch vehicle that embodies a majority of the principles comprising *Arthur Schnitt's* mid-1960s *Minimum Cost Design* (**MCD**) studies, conducted for **The Aerospace Corporation**; the art world and architectural industry's methods of Subtractive Design; and, of course, low-cost LEO guru J*ohn London* III's solid tome, "*Leo on the Cheap*"—the literary spark that ignited the commercial space movement in America.

If you take this most fundamental and basic step, and follow the core values of these philosophies through your entire rocket development program, there is a slim possibility that you just might triumph and actually move from the drawing board into the Black Skies…

So, Space Entrepreneurs, (with deep reverence for and reference to the three sources above), here's how this can be accomplished...

"Just Say No!" To Using Aerospace Practices
Borrow from other industries; shipbuilding; automotive; construction, and so on. There's always another way to do things outside the bloated and artificially inflated standard aerospace price structure.

When you call for quotes, never use the "**A**" word—anything from the '*aerospace*' collection will cost at least three or four times more than the same perfectly serviceable commercial item. Always search for less expensive alternatives and, always bargain.

Just Say No To Using Standard Spaceports
Become your own spaceport. How can you begin to lower space-access costs for yourself and others when using a majority of these launch locations anywhere in the world will add several million dollars to the cost of your mission—***not*** what you want to do if you're trying to produce a rocket that will lower space launch costs—probably ***not*** even in the realm of possibility if you're a rogue team of spaceflight idealists with just enough cash for the build only—and not for the high-roller niceties…

No To Turbopumps + Other Expensive Systems
Use blowdown pressurization ala **OTRAG** (world's first commercial rocket company established in the 1970s by *Lutz Kayser*). A lower part- and system-count equals less parts to fail and, therefore ,a greater margin of safety. Blowdown is ultra-cheap and relatively uncomplicated; turbopumps are expensive and failure-prone.

No To Exotics
Don't use costly propellants-—select your mix from standard industrial sources. Pay pennies for your go-juice, not hundreds of dollars per pound. Remember—you're dealing with tons of the stuff and it all adds up.

No To Extortionate Launch Costs
Pass on the savings generated by the low-cost rocket, Spartan launch infrastructure, and affordable spacecraft to the long lines of new customers who will be ready and waiting for a disruptive technology to slash launch-cost prices.

Don't Forget The Giants Upon Whose Shoulders We Stand
We acknowledge *Lutz Kayser* (***OTRAG***) and *Wernher von Braun* (***Apollo***) as the chief sources of our rocket design and production inspiration.

Finally, Don't Take No For An Answer
When it comes to dealing with the dreaded regulatory hurdles: Licenses, permits, insurance, alphabet agencies and bureaus—**don't take no for answer**. If you are denied a request that you feel is legitimate, persist! Curling up in a corner is not allowed if you consider yourself a true spacer.

In the Trenches…
The perks are many for those who engage in a creating a viable program of launch cost reduction:

- *Enjoying Nature*—bask in the 105+ degree temperatures of the white-hot Mojave Desert and feel convinced that there must be some unreported and deadly solar flare activity occurring as you check for leaks in the rocket engine test stand pressure lines…
- *Gain Recognition* from one's peers and customers! Collaborative partnerships and sales skyrocket; blogs become more vicious…
- *Creating Jobs* because of your new income stream, you can afford to pay your team of volunteers and interns—and, perhaps, *even yourself*.
- *Enabling Space Science*—injecting adventure and excitement into space experimentation by creating a system that will allow students to actually fly the experiments that would normally go straight to the lab storage shelf.
- *Orbital, Interplanetary, and Celestial Body Space Enterprise and Tourism*—plan a flight on your own rocket to your own Moon Base, Titan Time-Share, or the personal Platinum mine on that Asteroid you claimed last year. You've earned it.

The CPM Flight Test Vehicle On Mobile Launch Unit, Mojave Spaceport. Photo courtesy of IOS

The Big Pay-Off

The gallows humor that permeates the industry simply goes with the territory—we laugh when we can because what we do is somewhere well above serious. Potential injury and death lurk at every turn, and the dangers are built-in; all who tread here must be completely aware of the brutal truth of these facts. Make it safe. Live to fly in your own launch vehicles—and that's an order!

Interorbital Systems has adhered to the rules of *Minimum Cost Design* and has achieved success in designing and developing propulsion systems and launch vehicles capable of orbital and interplanetary missions. We've put a thriving and expanding space company on the map. Founded with an $1,800 budget in 1996 in a borrowed garage, the company has followed MCD principles from its inception.

From those humble beginnings, **IOS** has evolved to its current level of completing a **NASA SBIR Phase I** contract that furthers the development of the company's ***NEPTUNE*** rocket series, and is readying its rockets for flight tests. IOS has invented cylindrical form-factor (***TubeSat***) satellite kits that are sold with a launch on a NEPTUNE rocket included in the ultra-low cost.

The $8,000 ***Personal Satellite Kit and Launch Program*** serves universities, private citizens, military, and government entities throughout the world. The key to the company's success has been Interorbital's choice to build a rocket that can be configured for any type of mission requirements simply by adding additional identical common propulsion modules or CPMs (individual rockets that serve as construction elements or modules of a larger bundled launch vehicle).

Analysis during IOS' recent NASA SBIR study confirmed a seven-module rocket as the best choice for a first orbital launch vehicle configuration—a ***NEPTUNE 7*** (N7) using completely identical CPMs. This rocket is capable of lifting approximately 40kg to LEO—or 30 small TubeSats and CubeSats per launch. The first launch is sold out and the second is rapidly closing. Earlier this year, Interorbital began its series of preflight engine tests.

Successful test firing of the IOS CPM vernier rocket engine

Successful Test Firing

Two of these small vernier rocket engines in the photo provide roll control for a stand-alone *Common Propulsion Module* (**CPM**) stage. CPMs are the basic building blocks for IOS' multi-stage bundled modular rockets—as in the N7, a seven-module, three-stage orbital rocket. IOS rocket engines are the first US rocket engines using storable high-density nitric acid and turpentine as propellants.

In addition to the vernier rocket engine, the series of tests included the verification of the CPM controller. This unit is the interface between the CPM and the user or the guidance software. The test series also verified IOS' rocket launch control software developed to control the launch of the NEPTUNE series rockets. This software allows the use of a laptop computer or tablet computer for simple low-cost launch control. Launch crew training and key ground support equipment were also verified in this series of tests. These field trials were precursors to the 7,500-lb-thrust CPM main engine hot-firings, which will begin soon at the IOS test facilities, located at the **Mojave Air and Space Port**.

The Satellite Showcase

Payloads on the current N7 launch manifest for the first two missions range from academic, to arts, military, pure space science, music, and even to projects that are destined for the Moon!

CubeSats

UC Irvine, UCISAT1

FPT University, Vietnam, F-1 CubeSat

Nanyang Technological University, Singapore VELOX-P CubeSat

Google Lunar X PRIZE(GLXP) Team PLAN B (Canada)

GLXP Team EuroLuna, Romit 1 (2-Unit CubeSat from Denmark)

NASA Independent Verification and Validation (IV&V) Facility, 1 CubeSat & 2TubeSats

King Abdullah University, Saudi Arabia (KAUST) (2 IOS CubeSats;1TubeSat; 1 suborbital payload)

The Golden iPod: Voyager revisited; Earth to Sky, spaceweather.com, Bishop, CA,

Pakistan's I CUBE-1 Islamabad Institute of Science and Technology

Just Added! Taiwan's National Cheng Kung University, 2U

TubeSats

Morehead State University (Kentucky Space) (TubeSat and 2 suborbital payloads)

InterAmerican University of Puerto Rico

University of Sydney (Australia) (2) i-INSPIRE (initial-INtegrated SPectrograph, Imager & Radiation Explorer)

Aslan Academy (Private LA High School) STEM Program

Project Calliope (Space Music Project)

Project Calliope TubeSat Stack vs. CubeSat Frame. Image courtesy of Sandy Antunes

Photo of a Common Propulsion Module Test Vehicle (CPM TV) on its Mobile Launch Trailer (MTA), photo courtesty of IOS.

Universidad de Puerto Rico / Marcelino Canino Canino Middle School, STEM micro-meteoroid impact study

GLXP Team SYNERGY MOON Space-Qualifying Rover Team Astronomska Udruga

Vidulini's (AUV) Comms

GLXP Team Part-Time Scientists / Fluid & Reason Software (2) (US/Germany) FRETS1

Naval Postgraduate School (3) (TubeSats as ad-hoc orbital communication nodes) and 2 suborbital payloads

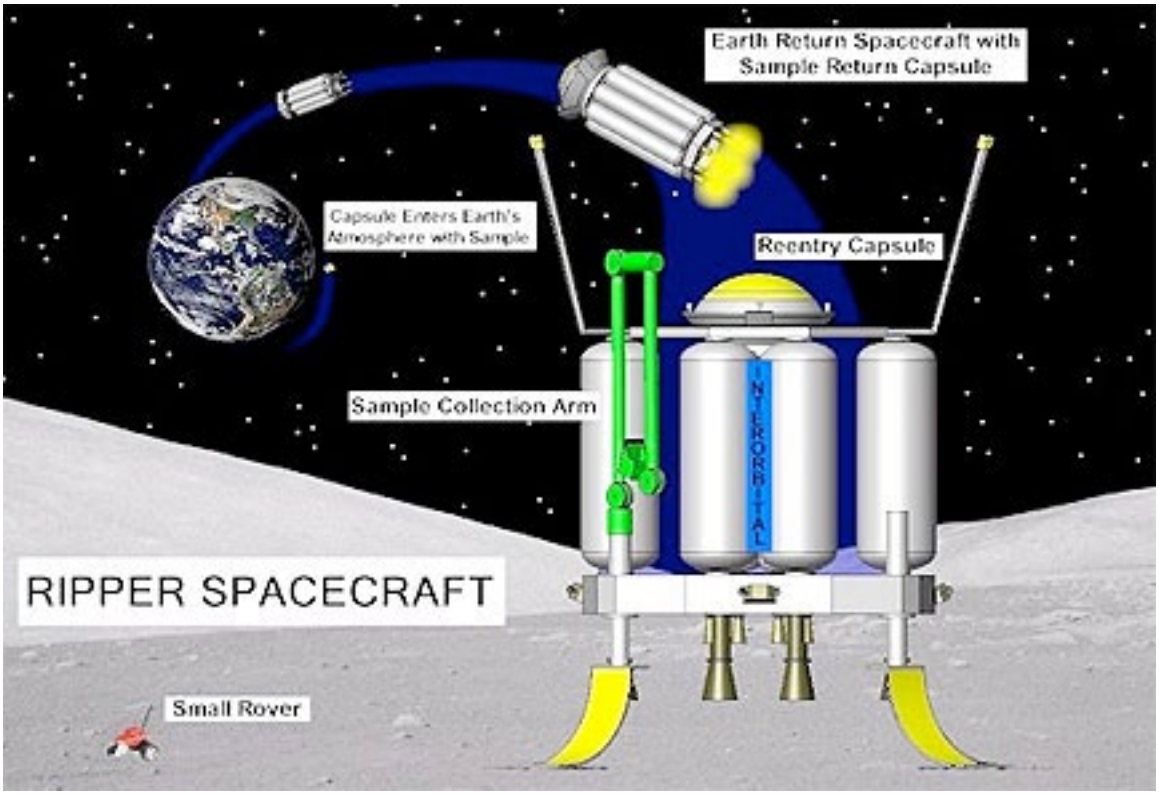
Defense Science and Technology Lab (DSTL) United Kingdom

Austrian Arts Group mur.at with MURSAT 1: Earth-as-Art Project

The Call to Action

Engines roaring—rockets flying—citizen-science projects destined for LEO, and the Moon—reveling in and learning to respect the power of the pillar of fire that carries your personal launch vehicle and payload into space.

After settling on an orbital launch vehicle design that you and your team have systematically reduced to a set of robust essentials, by adopting the required radical shift in mindset, and by doing away with the old methods of creating a standard aerospace company by saying ***no*** to the dead-ends that have killed other start-ups, it's time to focus and move ahead—time to take the all-important first step—time to do the hard thing: time to ***start***. Check ***www.interorbital.com*** for updates on the main engine test series, suborbital test flights, and satellite programs.



A lunar sample return mission is currently in development at Interorbital Systems (IOS). The mission's primary hardware component is the Robotic Interplanetary Prospector Excavator and Retriever, or the RIPPER. RIPPER is an autonomous system, designed to soft-land on the Moon or any other body in the Solar System, select surface samples, and then excavate and retrieve them for return to Earth. These off-world samples will be the rarest minerals on Earth, and will be made available to research institutions and private collectors at a fair price. Only a small quantity of lunar material (12-lbs or 5.4-Kg) will be brought back to Earth by the RIPPER Spacecraft. The demand for this extremely rare material will be enormous, even at its estimated value of more than $4.5 million per pound ($10,000 per gram).