

Worldwide Satellite Magazine – July / August 2015

SatMagazine

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SmallSats
SatHealth™
and more...***



SatMagazine

July / August 2015

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Koen Willems, Newtec

Authors

| | |
|-------------------|-----------------|
| Robert Bell | Jos Heyman |
| Shilpa Choudhury | Chris Hudson |
| Mark Foster | Doreet Oren |
| Roger Franklin | Tony Radford |
| Vern Fotheringham | Alvaro Sanchez |
| Kim Fesenmaier | Kartik Sephardi |
| Roger Franklin | |

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Fair Weather Ahead As Spire Closes Funding... Plans Expansion Of Weather Sats From 20 to 100+



Spire, a satellite-powered data company, announces the company has closed on a \$40 million Series B round of funding led by Promus Ventures with participation from new investors Bessemer Venture Partners and Jump Capital, as well as existing investors RRE Ventures and Lemnos Labs, among others.

To date, Spire has secured just over \$80 million through three rounds of funding.

With the new funds, the company will support further growth and expand its constellation from 20 satellites in 2015 to more than 100 by the close of 2017.

The latest round of financing comes at a time when the need for advancements in weather and maritime data is at an all-time high. With the potentially catastrophic 2016 Weather Gap right around the corner, Spire offers a solution to the \$2.4 trillion dollar global problem.

Spire is the only commercial weather data provider with scheduled launches in 2015. The company will start to deploy its satellites on a near monthly basis beginning September 2015.

"With a highly entrepreneurial San Francisco team developing a true multi-sensor, nano-sat platform, Spire is the poster child of New Space," said BVP partner David Cowan, who recently served on the board of Skybox Imaging (acquired by Google). "Spire has advanced from startup to deployment faster than any space venture we've seen—at this rate it will quickly become the largest constellation known to man."

The company's satellites employ advanced software defined radios to collect global remote sensing data with a focus on the three-quarters of the Earth that is covered by oceans or considered remote. The current generation of Spire satellites focus primarily on weather tracking, climate science, global supply chain monitoring, and broader maritime domain awareness.

With a resilient global infrastructure already in place, Spire will soon deliver five times the amount of weather data and four times more frequently updated maritime data than previously possible through other means.

"I continue to be massively impressed by the customer traction at Spire," said Mike Collett, Founder and Managing Director of Promus Ventures, who will be joining the Board of Directors. "Peter and his team have developed a clear value proposition with their approach to high frequency remote sensing data and they are adding blue chip customers, both public and private, at a notable pace. Many of those same customers never before considered purchasing this type of data, precisely because they could not do anything without the frequency and reliability that Spire is bringing to the market."

The implications of better data are immense, and range from saving lives to saving literally billions of dollars that businesses, governments and consumers lose due to unpredictable weather or maritime accidents each and every year.

By the end of 2015, Spire will have 20 satellites in orbit and 20 ground stations across the globe, providing customers with data from any point on Earth delivered every 30-minutes. From Alaska to Dubai, Spire's global ground station network is the most advanced of its kind for LEO satellite communication and data distribution.

"The last 12 months have been full of fast deliberate growth for Spire where we've opened offices in Singapore and Glasgow amongst incredibly strong customer traction", said Peter Platzer, CEO of Spire. "These funds reinforce our ability to sustain exceptional innovation and hire the world's top talent."

spire.com/

Entirely New + Colorful Visions Of Earth, Courtesy Of Sentinel-2A



On Tuesday, June 23 at 03:51:58 am CEST (June 22 at 10:51:58 pm local time), a Vega launcher took off from the spaceport in Kourou, French Guiana, carrying the satellite developed and built by Airbus Defence and Space for the European Space Agency (ESA).

After a little more than one hour, the solar panel needed to supply energy was extended and Sentinel-2A successfully reported in 'for duty.' The 1.1 tonne satellite has been designed to operate for at least 7 years and 3 months in a polar orbit approximately 780 kilometers above the Earth.

"The outstanding performance capabilities of Sentinel-2's multispectral instrument along with its rapid data transmission ability will soon be available, marking a major step forward in satellite-based Earth and environmental observation," said François Auque, Head of Space Systems at Airbus Defence and Space.

The Sentinel 2 mission will contribute to the management of food security by providing information for the agricultural sector. It will also enable the condition of and changes in land surfaces to be mapped and forests worldwide to be monitored.

The mission will also provide information about the pollution of lakes and coastal waters. Images of floods, volcanic eruptions and landslides will aid in the production of disaster maps and will also facilitate humanitarian aid activities.

The mission is based on a constellation of two identical satellites, Sentinel-2A and Sentinel-2B. Sentinel-2B will be launched in 2016 into the same orbit, but it will be 180 degrees apart. It will take both satellites five days to cover the Earth between the latitudes of 56 degrees south and 84 degrees north, thus optimizing the global coverage zone and data transmission for numerous applications.

Sentinel-2B is being worked on in the cleanrooms of Airbus Defence and Space and will be ready for launch in 2016.

The imaging instrument, which uses 13 spectral channels ranging from the visible to the infrared, delivers high-resolution multispectral images of the Earth's surface with a resolution of up to 10 meters at an image width of 290 kilometers. This extremely large scanning width results in wider coverage, while at the same time, the advanced instrument provides an unprecedented level of detail.

Sentinel-2 is also capable of using another ESA program, the European Data Relay System (EDRS). EDRS will be a network of laser communication payloads on geostationary satellites and Low Earth Orbit (LEO) satellites.

The system is also known as The SpaceDataHighway and will provide secure and fast communication services for the Sentinel-1 and Sentinel-2 satellites. It will ensure the timely availability of data particularly for time-critical applications such as environmental monitoring, emergency response and security missions.

Thanks to its ability to produce color imaging for Copernicus, Sentinel-2A perfectly complements the radar imaging provided around the clock and in all weather conditions by the first Sentinel satellite, Sentinel-1A, which was launched on April 3, 2014. Sentinel-1A carries a C-band radar instrument built by Airbus Defence and Space.

The Sentinel-2 mission has been made possible thanks to the close collaboration between ESA, the European Commission, industry, service providers and data users.

The satellite's development involved approximately 60 companies, led by Airbus Defence and Space in Germany for the satellites and Airbus Defence and Space in France for the multispectral instruments, while Airbus Defence and Space in Spain was responsible for the mechanical satellite structure.

The Knowledge Center Debuts From GVF

The GVF (www.gvf.org) now has an exciting change to the firm's award-winning training program—the GVF Knowledge Center, featuring individual and bulk monthly subscriptions, an Experts Forum for all active students, and site licenses to provide training program access to entire organizations for one monthly fee.

The monthly subscription provides unrestricted access* to the standard library of online interactive, simulator-based SATCOM training courses and certifications exam. Training paths for fixed VSAT Basic/Advanced certification courses, marine VSAT certification, mobile/SNG certification, and SatOps/ NOC certification courses are included. Subscribers have open access to the growing library, which currently stands at over 250 intensive learning hours and \$5,000 tuition value, for a monthly cost of only US\$29—or even less with developing country, NGO, and volume discounts.

Also included for subscribers, as well as current active GVF learners, is access to the new, fully-moderated Experts Forum, monitored by the SatProf instructors and guest experts, to discuss questions with fellow learners and the SATCOM community. In addition, Knowledge Center access can be provided under a site license at a flat annual rate for an entire organization. That makes it ideal not only for budget planning, but for staff development, as learners may readily engage in the specific training and certification they need to support changing responsibilities.

David Hartshorn, Secretary General of the GVF, said, “With the inauguration of the Knowledge Center program, learners stay engaged by revisiting past courses, practicing their skills with simulators, taking certification and re-certification exams, growing their expertise into new areas, and sharing questions and knowledge with colleagues and experts, all at any time, and all at a remarkably low, flat-rate subscription cost. The Knowledge Center, with the subscription and site license options, gives GVF member organizations an even easier path to Accredited Organization for Training status, which gives differentiation to the organization and reinforces the strength of the SATCOM industry, particularly in interference prevention.”

If you are a past GVF student, access to all the latest versions of your past courses, plus many more to explore, are available as is certification renewal. Current and new students are also most welcome to join. To subscribe, please visit www.gvf.org/training and click on “Subscribe.”

For a site license proposal tailored for your organization, please contact Greg Selzer at greg@satprof.com.

Orbital ATK's SKYMEXICO-1 Checks Out + Checks Off The 'To Do' List For DIRECTV



Orbital ATK, Inc. (www.orbitalatk.com/) announces that the SKY MEXICO-1 (SKYM-1) satellite, built by the company for DIRECTV, successfully completed on-orbit testing and checkout of all spacecraft systems.

The satellite was handed over to DIRECTV for full operational control after several weeks of orbit-raising activities that were conducted after the launch.

Launched on May 27, 2015, from Kourou, French Guiana, SKYM-1 will provide DTH television broadcast services to Mexico, Central America and the Caribbean for DIRECTV.

The satellite is based on Orbital ATK's flight-proven GEOSTAR-2™ platform and marks the 35th GEOSTAR spacecraft launched for customers around the world.

"We are proud to be a part of our customer's mission success by delivering

a high-quality, reliable satellite that will provide DIRECTV and its customers with state of the art broadcasting and communications services for years to come," said Chris Richmond, Vice President and General Manager of Orbital ATK's commercial satellite division. "Our ability to produce affordable technology and unprecedented rapid execution from design to launch demonstrates our commitment to build strong and lasting partnerships with our customers."

"Orbital ATK not only delivered the satellite four months early, but the satellite mission and in-orbit testing proceeded flawlessly," said Phil Goswitz, Senior Vice President of Space & Communications at DIRECTV. "We were able to begin service 22 months after the contractual program start enabling our partners at SKY MEXICO to expand their HDTV services earlier than scheduled. DIRECTV and SKY MEXICO are grateful to Orbital ATK for this exceptional performance."

Orbital ATK produced the SKYM-1 satellite in just 20 months and delivered it to the launch site four months ahead of the original baseline schedule.

Built and manufactured at its state-of-the-art manufacturing facility in Dulles, Virginia, SKYM-1 is equipped with 24 active Ku-band transponders and two active R-band transponders to provide DIRECTV's premium video broadcast services to millions of users.

The commercial communications satellite uses reflectors, solar arrays and structural components produced by Orbital ATK's Space Components Division in California and Utah. At launch, the spacecraft weighed 2,962 kg (6,530 pounds) and carried sufficient fuel on board to provide an anticipated 20-year mission life.

SKYM-1 is the first satellite built by Orbital ATK for DIRECTV. The company is currently producing the following satellites that will be delivered and launched for customers over the next several years: Thaicom-8, Al Yah 3, HYLAS 4 and SES-16/GovSat.



Rocket Lab Is A First For The Kiwis... Build + Operate An Orbital Launch Site, This Year, In New Zealand



Artistic rendition of Rocket Lab's New Zealand launch pad.

Rocket Lab announces the firm will be the first commercial company to build and operate an orbital launch site in New Zealand.

The company plans to build the launch site on Kaitorete Spit in the Canterbury region of New Zealand's South Island, which will be used to launch Rocket Lab's Electron launch vehicle designed to deliver small satellites



Robert Beck, CEO, Rocket Lab.

to Low Earth Orbit (LEO). "Creating and operating our own launch site is a necessity to meet the demands of our growing customer manifest," said Peter Beck, Rocket Lab CEO. "At present, the lead-times for satellite launches are years, and small satellite companies cannot reach orbit in timeframes that keep their businesses competitive. With the launch frequency possible from this site, Rocket Lab is one major step closer to its goal

of making space commercially accessible." Rocket Lab's customers—who have previously been unable to absorb the considerable cost of dedicated launch services—will use the launch site to launch imaging and communications satellites used for services including weather monitoring, crop optimisation, natural disaster management, maritime information, search and rescue data, GPS and Internet from space, among others.

Despite being headquartered in the United States, Rocket Lab has selected a New Zealand launch location as it offers technical, logistical and economic advantages. The location, which has been used for suborbital flights by NASA in the past, can reach a wide range of inclinations from sun-synchronous through to 45 degrees.

"New Zealand's access to high inclination and sun-synchronous orbits are ideal for small satellites," said Beck. "Operational logistics are made easier due to New Zealand's minimal air and sea traffic which enables a significantly more frequent launch rate and economies of scale."

The site is due to be completed in the fourth quarter of 2015, after which it will be ready for the first test flight of the Electron vehicle.

While Kaitorete Spit will be Rocket Lab's primary launch site, the company is also evaluating additional New Zealand sites and already established launch sites in the United States in order to meet customer demand.

Electron is an entirely carbon-composite vehicle that uses Rocket Lab's Rutherford engines for its main propulsion system. Rocket Lab recently announced that the Rutherford engine makes use of electric turbo-pumps and the majority of its components are 3D printed.

Electron is 16m in length, 1.20m diameter and has a lift-off mass of 10,500 kg. The vehicle is capable of delivering payloads of up to 100 kg. to a 500 km. sun-synchronous orbit, which is the target range for the high growth constellation-satellite market.

The carbon-composite Electron creates increased access to space by giving customers the ability to launch satellites more frequently and affordably with a dedicated launch priced at \$4.9 million.

Rocket Lab's mission is to remove commercial barriers to space. The company was founded on the belief that small payloads require dedicated launch vehicles and a flexibility not currently offered by traditional launch systems.

Rocket Lab is a privately funded company with its major investors including Khosla Ventures, K1W1, Bessemer Venture Partners and Lockheed Martin.

Founded in 2008, Rocket Lab is headquartered in Los Angeles with operations and a launch site in New Zealand.

www.rocketlabusa.com

Grace-FO Satellites Development + Design Completed By Airbus Defence and Space



The build phase of the Grace-FO climate satellites has begun with the delivery of the highly stable carbon fibre composite structure, which weighs around 200 kilograms, to the satellite integration center of Airbus Defence and Space in Friedrichshafen. Photo is courtesy of Airbus DS / Mathias Pikelj.

Airbus Defence and Space (airbusdefenceandspace.com/) has successfully completed the development and design phase of the Grace-FO (Gravity Recovery and Climate Experiment follow-on) satellites.

The build phase of the Grace-FO climate satellites has begun with the delivery of the highly stable carbon fibre composite structure, which weighs around 200 kilograms, to the satellite integration center of Airbus Defence and Space in Friedrichshafen.

Following delivery of the highly stable satellite structures, the building phase of the two NASA Jet Propulsion Laboratory (JPL) research satellites has begun.

The Grace-FO mission is based on an US-German cooperation agreement executed by JPL and the German Research Centre for Geosciences (GFZ-Potsdam).

Planned to be launched mid-2017, the Grace-FO twin satellites will take measurements to provide an updated model of the Earth's gravitational field every 30 days, for a five-year mission duration. In addition, each of the satellites will create up to 200 daily profiles of the temperature distribution and the water vapour content in the atmosphere and the ionosphere.

The Grace-FO satellites, which are around 3 x 2 x 0.8 meters and weigh around 600 kilograms, will circle the Earth in the same polar orbit, spaced 220 kilometers away from each other at an altitude of roughly 500 kilometers.

Both satellites will take continuous, very precise measurements of the distance between each other. Since this distance changes under the influence of the Earth's gravity, this enables the gravitational field to be continuously measured.

GPS receivers are used to determine the position of the satellites and the precise distance measurements between both Grace-FO satellites are made with a satellite-to-satellite microwave connection to give an extraordinarily high precision in the measurements results in the range of a few thousandths of a millimetre.

Unlike the original Grace mission, the new satellites will additionally be able to carry out high-precision distance measurements by laser—a joint German/American technological experiment developed for future generations of gravitational research satellites.

The Grace-FO satellites will follow-on the Grace satellites, also built by Airbus Defence and Space, which have been making a significant contribution to global climate research since 2002.

By observing changes in the Earth's gravitational field over time, geoscientists have been able to make new discoveries about dynamic processes beneath the Earth's surface, about deep and surface currents in the oceans and about the changes in the ice coverage at the poles, in Greenland and on mountains.

During the original Grace mission, observations were made to determine which masses—in the form of water, ice and water vapor—were moving, and even the ground water level could be monitored globally and long-term.

iDirect's Evolution With Via Direta Telecom

VT iDirect, Inc. (iDirect) announces that Via Direta Telecom, a subsidiary of TV and radio broadcast group Rede Tiradentes de Telecomunicações, has selected the iDirect Evolution® platform to enable the largest, most ambitious distance-learning program ever created in Brazil.

Limited broadband coverage in Brazil has left roughly 97 million people without access to the Internet.¹ Actively exploring a solution, the Amazon State's Secretary of Education has commissioned Rede Tiradentes to create a distance-learning program that spans Brazil. The program will use satellite to connect roughly 45,000 students situated across hundreds of municipalities along the rivers of the Amazon basin with teachers located in Manaus, the capital city of the state of Amazonas. Via Direta will operate the hub on behalf of Rede Tiradentes.

Using iDirect's Evolution platform and X1 remotes, Via Direta is able to offer Internet access, long-distance learning programs and virtual tools that provide interactivity between isolated communities. Key to the project was iDirect's Remote Commissioning Solution, Satmotion Pocket, to support the aggressive installation schedule. Upon completion, the network will consist of 1,300 VSAT stations.

Executive Comments

"Implementing a complex network in such a challenging environment as the middle of the Amazon Forest presents unique engineering issues, such as atmospheric attenuation. The use of iDirect's Remote Commissioning Solution help us overcome such challenges in order to streamline installation, while the capabilities of the iDirect Evolution platform will help us continually improve the efficiency of the network going forward," said Adriano Chagas, Director of Engineering, Via Direta Telecom.

"Government data shows that only about one-third of all children in Brazil make it to the sixth grade. This distance-learning program will be a powerful step forward in changing these dynamics, and we thank Via Direta for making us part of this program. Beyond education, access to high-speed broadband will also introduce a world of new social and economic capabilities to the residents of Brazil that will change the quality of life for generations to come," said Rob Kilroy, Regional Vice President of Sales, iDirect.

¹McKinsey & Company. (2014). Offline and falling behind: Barriers to Internet adoption. Retrieved from http://www.mckinsey.com/insights/high_tech_telecoms_internet/offline_and_falling_behind_barriers_to_internet_adoption

The Gaia Satellite Mission Benefits Asteroid Research



A total of 106 CCDs make up Gaia's focal plane. Technicians from Astrium France, the Gaia mission's prime contractor, are seen bolting and aligning the CCDs onto their support structure, at the company's facility in Toulouse. The structure (the grey plate underneath the CCDs) weighs about 20 kg and is made of silicon carbide, a material that provides remarkable thermal and mechanical stability. Gaia's CCDs are provided by e2v Technologies of Chelmsford, UK. Each CCD measures 4.7x6 cm, with a thickness of only a few tens of microns. Precisely fitted together on the support structure, the gap between adjacent CCD packages is about 1 mm. Photo is courtesy of Astrium.

Astronomical research on asteroids, i.e., minor planets, is also benefiting from the large-scale Gaia mission of the European Space Agency (ESA).

Even though the astrometry satellite's main purpose is to precisely measure nearly one billion stars in the Milky Way, Gaia has tracked down a multitude of minor dwarf planets in our solar system

To determine its current position in space and thus ensure Gaia's extremely high measurement accuracy, images are taken every day of the regions of the sky where the very faint satellite is located.

"Each night the images reveal several dozen minor planets. The data are quite valuable for our understanding of the origin of our solar system," said Dr. Martin Altmann of the Institute for Astronomical Computing (ARI), which is part of the Centre for Astronomy of Heidelberg University. Dr. Altmann heads the observation programme to determine the position of the Gaia satellite for the Data Processing and Analysis Consortium (DPAC), which is responsible for evaluating the data from Gaia.

The Gaia astrometry satellite, which has been fully operational since August 2014, measures with pinpoint accuracy the positions, movements and distances of stars in the Milky Way, thereby furnishing the basis for a three-dimensional map of our home galaxy.

According to Dr. Altmann, it became clear during preparation for the Gaia mission that the ambitious accuracy goals required novel methods to determine the position and velocity of the satellite itself. For this purpose an observation campaign was launched to determine Gaia's position and velocity from Earth.

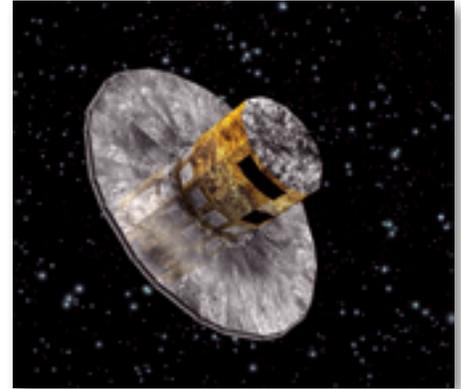
As early as 2009, Dr. Altmann of the ARI and his colleague Dr. Sebastien Bouquillon of the Observatoire de Paris (France) began planning the programme together with an international team. Among the partners for the implementation, they attracted observatories in Chile and Spain.

The Institute for Astronomical Computing is responsible for coordinating the daily observations. Since the launch of Gaia in December 2013, Gaia's ground-based position measurements are transmitted regularly to mission control, the European Space Operations Centre in Darmstadt.

Dr. Altmann explains that the astrometry satellite is at a distance of approximately 1.5 million kilometres and is always located in the region of space away from the Sun as viewed from the Earth. "For this reason Gaia's positioning images are also perfect for observing minor planets.

This so-called oppositional position brings these celestial bodies closer to Earth, making them appear brighter than at other times," continues the Heidelberg researcher. More than 2,000 small planets have been found this way since the beginning of this year, mainly on images from the VST telescope of the European Southern Observatory (ESO) in Chile.

Dr. Altmann indicates that nearly 40 percent of them are new discoveries. Moreover, these current measurements are especially interesting for already known minor planets as well,



Artistic rendition of the Gaia satellite.

precisely because Gaia and the minor planets located in the same part of space are always opposite the sun at the time of observation.

Just like with the full moon, the planets' entire earthward side is completely illuminated only at that location. This allows the researchers to measure the asteroid's reflectivity very accurately and draw conclusions as to their chemical composition. Up to now, only approximately 30 asteroids have their reflectivity sufficiently well-determined, according to Dr. Altmann.

The Gaia astrometry satellite itself will also discover and accurately measure many asteroids in its survey of the sky, but in totally different regions.

"In this respect, the observations from the Gaia mission and the ground-based measurements complement each other extremely well," says Dr. Altmann. "We hope not only to acquire new insight into the origins of our home galaxy through the Gaia satellite mission. We will certainly learn more about the origins of our solar system," stresses Prof. Dr. Stefan Jordan of the Institute for Astronomical Computing.

Editor's note: This story is based on materials provided by Heidelberg University and was originally published in Science Daily (www.sciencedaily.com/).

RigNet Keeps 'Em Connected + Enjoys A Multi-Year Deal In Southeast Asia



RigNet, Inc. (www.rig.net/) announces that it has been awarded a multi-year contract to deliver remote offshore communications services to a major operator of offshore drilling and production assets in Southeast Asia.

RigNet is a global provider of remote managed offshore communications solutions, telecoms systems integration services and collaborative applications to the oil and gas industry.

“Remote connectivity is not a commodity service in the markets we serve. The combination of higher-specification assets working in increasingly remote locations, while utilizing smarter tools and networked teams, makes secure and reliable access a critical aspect of today’s energy industry,” said Mark Slaughter, RigNet’s CEO and President.

“To meet these needs, RigNet delivers a communications architecture designed from the outset to include real-time traffic management and around-the-clock support to enable operations to flourish in the most challenging conditions.”

RigNet will provide comprehensive managed remote communications solutions on the customer’s mobile offshore production unit (“MOPU”), including telephony, network support and onboard crew WiFi service.

A fiber optic backhaul will connect the client’s headquarters to RigNet’s Singapore teleport. Network monitoring and support will be managed 24/7 from RigNet’s Global Network Operations Center, with in-country support services provided on their offshore site as required.

Hector Maytorena, RigNet’s Group Vice President, Managed Services, said, “Our combination of technical expertise and deep energy sector experience enables RigNet to provide reliable and innovative solutions worldwide.”

Hexagon Geospatial's New Smart Apps Data + Partnership



*Artistic rendition of the Pléiades satellite.
Image is courtesy of Airbus Defence & Space.*

Airbus Defense and Space and Hexagon Geospatial (www.hexagongeospatial.com/) have partnered in a new content-sharing program that will enable end-users to have access to Earth Observation data and software through smart applications offered by Hexagon Geospatial.

The content provided by Airbus Defense and Space will combine very-high and high resolution optical imagery from Pléiades and SPOT satellites with the Hexagon Geospatial offering. This partnership will fuel the creation of new smart applications, which will provide end-users with easy access to fresh data and powerful technology to transform this data into useful information across all market segments – government, commercial, utilities, natural resources, and more.

The Hexagon Geospatial Power Portfolio provides geospatial and industrial enterprise solutions to organizations across the globe. These solutions harness the power of information with tools and techniques for managing, manipulating and visualizing big data and integrate them with sensors, software, knowledge and customer workflows.

Initially, the partnership will provide users with access to content from Airbus Defense and Space's Pléiades and SPOT satellites. In the future, the plan is to make available the powerful radar data from the TerraSAR-X satellite and a range of digital elevation models for Hexagon Geospatial smart applications as well.

"Hexagon Geospatial has changed the game by offering a platform to build and deliver smart applications to our customers," said Greg Buckman, Head of Airbus Defense and Space's Geo-Intelligence Programme Line in North America.

"Today's sophisticated end-users want customized analytics that meet their dynamic and unique workflows – providing them with a quick snapshot to support faster and more effective decision-making," said Mladen Stojic, President of Hexagon Geospatial. "Our new partnership with Airbus Defense and Space satisfies this need by empowering the creation of smart applications that leverage both enhanced imagery and our software solutions."

Advantech Debuts GaN SSPA/SSPB



Advantech Wireless has released their Second Generation SapphireBlu™ GaN Technology based, 400W, C-Band SSPA/SSPB designed for broadcasting applications.

The Second Generation C-band GaN SapphireBlu™ SSPA/SSPB from Advantech Wireless offers very High Linearity in a compact single package.

These systems are designed for Ultra HD transmission broadcasting and are DVB-S2X ready.

The increased linearity comes at the same time with no additional increase in size, weight and energy consumption.

Cristi Damian, VP Business Development, Advantech Wireless, said, "We understand the challenges that broadcasters and service providers face while adopting the new bandwidth demanding Ultra HD standard.

"The Second Generation of GaN SSPAs empowers broadcasters to deliver their messages while maximizing efficiency and reducing operational cost. These units are designed for very high linearity as imposed by the heavy Ultra HD traffic, and at the same time be ready to operate under the high density modulation schemes that are now part of the DVB-S2X standard. This is a safe investment for the future."

www.advantechwireless.com/products/4-c-band-400w-hubmount-sspaspb-sapphireblu-superwideband-series-ultralinear-gan-technology/

A Stabilized Drive-Away VSAT Antenna From Cobham SATCOM

Cobham SATCOM (www.cobham.com/satcom) is launching the latest innovative antenna system in its EXPLORER portfolio for land 'Comms-On-The-Pause' users.

Developed completely in-house by Cobham SATCOM, the new one meter EXPLORER 8100 Auto-Acquire Drive-Away antenna is designed to offer unparalleled performance, ensuring high quality connectivity on any Ku- and Ka-band networks. The terminal features genuine EXPLORER design, which is already established and proven with Cobham SATCOM's highly regarded EXPLORER BGAN and GX terminals.

With EXPLORER 8100, Cobham SATCOM has focused on ultra-reliable connectivity even in situations where the vehicle is experiencing sudden movements or rocking on its suspension while the antenna is transmitting. This could be caused by high

winds or more commonly, people stepping in or out of the vehicle. Particularly important for Ka-band usage, mechanical impacts as small as 0.3 degrees may lead to an immediate loss of signal. Cobham SATCOM introduces 'Dynamic Pointing Correction' from its stabilized Maritime Antennas on this new series of Land Comms-On-The-Pause VSAT antennas. Dynamic Pointing Correction ensures uninterrupted transmission when similar antennas would experience a complete loss of signal.

A state-of-the-art RTM carbon fiber reflector combined with pointing correction technologies delivers an accurate Drive-Away VSAT antenna on the market.

EXPLORER 8100 features industry-fast satellite acquisition with pointing achieved automatically in less than two minutes. The system is available in both Ka- and Ku-band

configurations and works with all major satellite networks. A swappable feed system allows users to change frequency bands, ensuring they have full choice of what services to use throughout the lifetime of the antenna.

EXPLORER 8100 comes with built-in Wi-Fi for easy access to the terminal and the same Web-based user-interface developed for Cobham SATCOM's cutting edge Inmarsat GX series of antennas. Once connected, EXPLORER 8100 provides high performance, continuous connectivity in the field, optimally supporting high definition video streaming, high throughput data transfer and tactical and emergency communication.

First customer shipment of EXPLORER 8100 is planned for October 2015.

Satellite Industry Growth Increased During 2014 According To New SIA Report



The Satellite Industry Association (SIA) has just released its 2015 State of the Satellite Industry Report, which reveals a four percent growth rate in world satellite industry revenues in 2014, up from three percent in 2013.

Globally, 2014 revenues for the satellite industry totaled \$203 billion, up from \$195.2 billion the previous year. Industry growth was led by the satellite services segment, which saw its revenues increase by four percent to \$122.9 billion.

Satellite launch industry revenues increased significantly, rising by over nine percent in 2014. Satellite ground equipment revenues saw growth of four percent, while satellite manufacturing grew by one percent over the previous year.

"Last year was an excellent one for the satellite industry," said Tom Stroup, President of SIA. "The established parts of the industry continued to innovate and expand, while satellite entrepreneurs demonstrated the depth of new interest in satellites and the services they provide. Our industry continues to drive space-based innovation and technologies, delivering high quality services

and a level of global ubiquity that is truly unique. As recognition of the advantages offered by satellites grows, SIA and its members remain committed to supporting a policy framework which will allow the industry to continue to meet its customers' demand for innovative global satellite services, systems and solutions."

The 18th annual State of the Satellite Industry Report was prepared by The Tauri Group, an independent analytical firm.

The report is derived from proprietary surveys of satellite companies, in-depth public information, and independent analysis which are combined to assess the performance of four satellite industry sectors: satellite services, satellite manufacturing, satellite launch services, and satellite ground equipment.

The 2015 State of the Satellite Industry Report includes the following results:

- **Satellite Services revenues increased by four percent globally from 2013 to 2014, reaching \$122.9 billion, powered by continued growth in consumer satellite television plus new interest**

in satellite broadband and Earth observation services.

- **Satellite Launch Industry revenues, which include revenues for all commercially-competed launches that occurred in 2014, increased by nine percent from 2013 to 2014. The number of commercially procured launches conducted worldwide increased to 73 from 62 in 2013. In 2014, 208 satellites were launched compared with just 107 launched in 2013.**
- **Satellite Ground Equipment revenues continued to increase in 2013, rising by five percent over 2013 to reach \$58.3 billion. Satellite navigation (GNSS) equipment for both consumer and industrial customers represented approximately 53 percent of the overall ground equipment revenue.**
- **Satellite Manufacturing revenues, reflecting the value of satellites launched in 2014, grew by one percent worldwide to \$15.9 billion.**

U.S. Satellite Industry Employment, as of the third quarter of 2014, decreased by 10,055 jobs or approximately four percent since 2013.

SIA will release an updated report after full 2014 employment data is published this coming August by the U.S. Bureau of Labor Statistics.

For additional information regarding SIA's State of the Satellite Industry Report, please contact Sam Black, Sr. Director of Policy, SIA at sblack@sia.org or via telephone at 202.503.1563.

A copy of the 2015 State of the Satellite Industry Report can be accessed at...

www.sia.org/wp-content/uploads/2015/05/Mktg15-SSIR-2015-FINAL-Compressed.pdf

It's A Stampede For Harris CapRock With Hess Corporation



Harris CapRock Communications (www.harriscaprock.com/) has been selected by Hess Corporation to provide a turnkey, integrated telecommunications solution to support the Stampede offshore field development project, which is operated by Hess Corporation in the Green Canyon area of the U.S. Gulf of Mexico.

The agreement represents Harris CapRock's first large-scale integration project with Hess, a leading global independent energy company engaged in the exploration and production of crude oil and natural gas.

Harris CapRock will procure equipment and conduct factory acceptance testing, project engineering and detailed design and project management for the 22-system telecommunications project.

The integrated solution supports audio/video conferencing, satellite and wireless communication.

"Choosing Harris CapRock as a single-source telecom provider for comprehensive systems integration improves responsiveness as well as saves time and money for Hess," said Tracey Haslam, president, Harris CapRock Communications.

"Reliable customer service throughout the integration process will lead to reliable network communications for operators in the field."

Integrators play a key role in delivering products and technologies to the energy market. Harris CapRock has provided service in more than 120 countries and employs field technicians, engineers and project management personnel across a variety of IT and telecom systems specialties. Harris

CapRock recently was named the most impactful services provider in the oil and gas sector by Via Satellite's 2014 Excellence Awards Program.

Is This Any Way To Treat An Important Asset?

By Robert Bell, Executive Director, Society of Satellite Professionals International (SSPI)



“Our people,” says the CEO, “are our most important assets.”

“Yeah, right,” mumble the Important Assets.

If this sounds familiar to you, then you understand the difference between “talking the talk” and “walking the talk” when it comes to managing talent. In point of fact, people ultimately are the most important asset of the company. A motivated, skilled, painstaking and creative team with sufficient resources will almost always outplay a resource-heavy team whose heart is not in the game.

In SSPI’s recent workforce study, *Are We Winning the Talent War?*, we found some great practices in recruiting and nurturing talented people. But we also found that only a minority of companies in the satellite industry is actually implementing them today. One goal of our workforce research is to spread the wisdom farther and get more companies adopting the best practices of the savvy leaders.

Talent Attraction

The larger companies in the space already have significant talent attraction programs that are focused on youth. “We have a successful internship program,” one HR leader told us, “and we are working to enhance it with job-shadowing opportunities and more advanced co-op programs that let students combine school and work.”

“We have an associates program,” an executive at a peer company reported. “We hire younger folks in their 20’s who have recently earned a

masters degree. They have some work experience and we put them into a work-study rotation that leads to the opportunity to hire them after two years.”

Another leader has established links with four different universities and technical schools and has established internships ranging from 30 to 40 days to 90 day engagements. “Internships are a good way to identify potential employees, and we often hire interns once they have completed their studies.”

One company shared specifics about the intensive approach they take to internships. “We ask business group managers to submit requisitions for interns with specific skill sets to accomplish specific missions,” said the firm’s HR leader. “From those requests, we recruit 35 interns per year from universities and our hiring managers target the ones who do best for full-time employment.”

When you get past the largest companies in the industry, however, there is a much less of a consistent and structured approach to recruiting the next generation. A remarkable 56 percent of human resource executives reported that their companies have no formal internship or work study program.

What some of them have instead is an informal effort, typically led by a self-appointed individual with a passion for mentoring young people. “We bring in five interns on a paid basis for a couple of months over the summer

HUMAN CAPITAL

and train them," said one executive. Another noted that even this small effort is productive. "We have hired two people who interned for us over the summer in their third year of college."

Companies may consult on curriculum with local universities. They may fund scholar-ships or invite individual students to intern. When the self-appointed leader leaves or retires, however, the effort typically falls apart because it has not been institutionalized within the organization. This is a gap that clearly must be filled if the whole industry is to maintain its competitive edge.

On-Boarding

While fewer than 60 percent of respondent companies have formal internship or work-study programs, 70 percent have formalized their on-the-job training for new hires. Once we have found the right people," explained an executive, "we have a structured training program with different modules for different roles. It takes six months to one year to produce a fully-trained technical account manager in the systems engineering team. Salespeople also need to have a strong technical understanding, which takes training."

Another company outlined its intensive training program for new hires, which includes lecture sessions, formal tests and internal certification and can last as long as 12 months before an employee is considered fully trained, particularly for a sales engineering position. The program has been developed organically over several years, but the company is only now considering the hiring of a full-time training manager.

Filling the skill gaps is high on the agenda for the companies. "Universities don't tend to have the courses that would provide us with qualified prospective recruits," said one executive. "We have to teach graduates the video aspects of the job." For another, "the key issue is telecoms training. Our activities require a mix of strong software programming skills and sound knowledge of telecoms. The latter is lacking in most new graduates and we have to provide the training."

Continuing Education

The training that starts in the onboarding process continues, at many companies, throughout a career. One respondent to our study described the company's Talent Center: programs lasting two to three days that include teaching, practice and assessment. This is followed after one to two years by individual coaching to help employees prepare for a particular career path in the company. "The message is that you are important to our future," she noted, "and we want your future to be here."

One European company says it offers 70,000 hours per year of training across technical, process, compliance and management topics. Another offers internal certification programs for disciplines including operations, sales, management and dealing with customers.

One of the industry's larger players offers comprehensive training and certification programs for its employees—but has supplemented them by signing on to massively open online coursework (MOOC) from a major university and making it available to employees at no cost.

Another of the largest companies in the business operates its own university within the organization to deliver training in technology, sales, leadership and customer engagement. In addition, the company provides a Stretch program, in which teams from different areas are formed to address a specific technology or business challenge over a limited period of time. "It gives members of the team visibility across the organization," the HR leader noted, "as well as addressing problems that otherwise would be ignored."

Mentoring

Mentoring has been part of career development since people first figured out that they had to work for a living. Younger and less experienced employees learn from their older and more experienced colleagues. The learning in a mentoring relationship is not just about knowledge transfer: learning also concerns attitude, expectations and judgment and is about engaging the loyalty of younger employees and encouraging commitment to the organization's mission.

Mentoring takes place regardless of whether companies encourage such to occur. Of the HR executives interviewed in the study, 57 percent work for companies where mentoring remains an informal undertaking by people who understand the value of such work. But at 43 percent of the firms, mentoring is taken more seriously as a factor in business success.

At most of them, mentoring begins in the onboarding process. Several executives say their companies simply assign an experienced employee to help each new hire get up to speed on everything from business cards and email to where to eat lunch.

At 20 percent of the companies interviewed, however, mentoring is taken a step further. In one, mentors and mentees fill out applications and are matched by the human resources department. They work together over a yearlong program with specific goals, and assess their progress jointly with HR at the end.

The program at another company involves 100 people per year, with a 50/50 split between mentors and mentees. "We select high-potential employees globally and provide them with training on how to optimize relationships. They and their mentors have a set of goals and meet once or twice a month to carry them out."

Design an Earth station or satellite, put it into operation, and performance will generally continue with minimal maintenance. However, the really important asset of your business, the one that goes home at the end of every day, need considerably more upkeep. The good news is that the rewards for attracting and nurturing the best talent are huge.

*Robert Bell is the executive director of the Society of Satellite Professionals International (www.sspi.org) and author of **Are We Winning the Talent War?** Robert can be reached at rbell@sspi.org. The report may be downloaded at no charge by SSPI members and sponsors, and purchased by non-members at www.satelliteworkforce.com.*

Connecting LATAM In The Ways That Matter Most

By Doreet Oren, Marketing Director, Gilat Satellite Networks



In the rush to bring next-generation services to consumers whose lives are built around the premise of constant connectivity, overlooking those who have no connection at all unfortunately happens.

As LATAM residents helplessly wait for a cost-benefit analysis to determine that it is worthwhile for some form of broadband infrastructure to arrive at their village, the gap between those villagers and the connected world grows. These residents stand to gain the most from connectivity, and SATCOM has a unique role to play in reaching them.

Even those of us who grew up pre-Internet tend to take for granted the benefits our sophisticated connectivity bestows upon us. A good idea that is created in one corner of the world spreads everywhere at blinding speeds—worthy ideas, from household tips to business plans to geopolitical strategy, find a receptive audience.

Free speech finds an outlet. Markets for goods transcend boundaries. Access to skills and jobs become widespread. All the advantages that the connected world enjoys propels us to success. However, at the same time, they sharpen the distinctions between those who have and those who do not have equal access to broadband-based services.

Leveling the playing field so all may participate is what SATCOM does best. This article discusses several fundamental ways in which SATCOM is helping the unconnected join the conversation and it focuses in on real human-interest stories in LATAM.

Government

In northern Peru, a retired navy vessel streams down the Napo River—the mission: provide medical, educational and banking services to more than





7,000 people living in 30 isolated communities. In spite of the remote location, the ship is equipped with broadband, thanks to a VSAT, which provides the connection. The ship's offerings include banking and ATMs, medical and dental treatment as well as government services, including Ministry of the Interior offices.

Villagers with no hope of reaching facilities that could provide these services suddenly find themselves enjoying the benefits of modern communications. The government gains from this initiative as well; beyond registering citizens, they are able to meet this rural constituency face-to-face and better understand their needs. In the past few years, services of this type, delivered in trucks or ships, have grown increasingly common.

Another way SATCOM helps rural areas thrive is the installation of voting stations. A network of VSATs enables polling in any location, no matter how remote. In Venezuela, sites were established in remote locations with a fingerprint-based identification system; 5.5 million votes were smoothly handled.

An additional benefit occurred post-election; rather than shutter the satellite network when elections ended, the government initiated a project to use the VSATs as Wi-Fi points for Internet connectivity. The VSATs were redeployed to provide permanent broadband to remote villages. Access to these broadband services, so fundamental in the Western world, makes a tremendous impact on the villagers' quality of life. The sites were so remote and the roads so impassable that creative implementation was required. The VSAT equipment ended up being delivered by helicopters, small riverboats, and even via donkeys.

Education

When a VSAT is set up in a rural school, it represents an event far weightier than merely being a piece of equipment that transmits and receives a signal. When exposed to the wider world for the first time, the minds of students open; they recalculate the limits of what they thought possible. Exposure to a broad swath of ideas and cultures helps foster tolerance and a sense of belonging to the outside world.

Teachers reap the benefits of connectivity as well. They gain exposure to the latest education materials and methodology, enhancing their skills and broadening their students' horizons. IPTV, videoconferencing, and Internet searching all become part of the educational toolbox.

When thousands of rural schools and hundreds of thousands of classrooms are connected, the cumulative impact is millions of students learning more effectively than ever before. Bridging the digital divide is a prime benefit of SATCOM as has been successfully implemented in many LATAM countries such as: Mexico, Peru, Brazil, Colombia and Uruguay.

Disaster Relief

SATCOM is often pointed out as the most reliable connectivity delivery method. When disaster strikes, this reliability does save lives. Only SATCOM offers a guaranteed connection when terrestrial networks are compromised.

When earthquakes, tsunamis and other natural disasters wreak havoc around the world, terrestrial communications infrastructure is prone to collapse. SATCOM offers an immediate solution for the continuance of communications. From auto-pointing antennas that fit in a backpack to stations that support an entire network, SATCOM is key to rescue efforts and to restoring coverage and normalcy.

A large supermarket chain in Texas and Mexico leveraged SATCOM to bring its special brand of relief to hurricane-stricken communities. A convoy of VSAT-mounted trucks served as mobile supermarkets, ATMs, drugstores, Wi-Fi hotspots and power sources for charging cellphones—they became the centers of life and commerce for the disaster afflicted residents. Another SATCOM service was providing a feed for news teams to broadcast footage of the disaster, which, beyond its news value, serves as an important means of soliciting rescue assistance.

Healthcare

One of the greatest challenges in rural healthcare is attempting to diagnose and treat complex issues with insufficient resources. With SATCOM, local medical services can connect to central hospitals and receive the support they need, allowing them to provide quality care remotely, whether monitoring a patient's signs and symptoms, evaluating lab data, or consulting with specialists.

Another way to achieve the same quality care is to transport doctors to rural areas and allow them to work as they would in an urban hospital setting, with access to all the diagnostic information they need to succeed. From hospital ships to mobile emergency triage points, SATCOM provides the instantaneous connectivity that helps patients get well.

A decade ago, Hurricane Wilma, the most intense Atlantic storm ever recorded, struck Mexico. In response, the Mexican Ministry of Health established mobile field hospitals equipped with VSAT technology to provide reliable broadband, voice and data services during times of epidemics or disasters. These self-contained field hospitals are designed to handle different types of disasters and to operate independently for extended periods of time. They include a communication room equipped with the VSAT and all related communication equipment.

This technology provides VoIP phones for telephony services, video conferencing when doctors need the help of medical specialists, and high-speed Internet access. The link is invaluable in enabling high-speed data transfer, such as laboratory results, server synchronization, ordering supplies and other data applications.

In The Field, Making It Happen

Behind the scenes, making all of these solutions possible is a SATCOM expert with more than 25 years of experience in the delivery of connectivity solutions. Gilat Satellite Networks provides equipment, installation, project management and training, and interfaces with government and local authorities. To learn more about how Gilat continues to innovate with advanced technological solutions to meet diverse needs, please access www.gilat.com.

Together—For 50 Missions—SSL + Arianespace

By Rich Currier, Senior Vice President, Business Development, SSL



With 50 launches together over the last 30 years, for more than 20 different satellite operators, Arianespace and SSL have mastered the art of teamwork.

In July of 2015, the companies will celebrate their 50th mission together with the launch of Star One C4 for Embratel Star One, Latin America's largest satellite operator. Arianespace and SSL first worked on a launch together in 1983.

Over the years, the companies have learned the value of close collaboration at the planning stages and at the launch base.

"Arianespace makes something as incredibly complicated as launching a million pounds of explosives into space to deliver a satellite look easy," said Mr. John Celli, president of SSL. "It takes experience, capability, skill and organization to do that and they project confidence in everything they do, and work together with us and our mutual customers with the precision of clockwork."

Leading up to the 50 satellites milestone, SSL and Arianespace worked together with DIRECTV on the successful launch of DIRECTV 14 in December 2014, which was their 48th mission together. The launch of THOR-7 in April 2015 for Telenor Satellite Broadcasting (TSBC) was the 49th mission together.



SSL President John Celli at the Amazonas 3 launch in 2013. Photo is courtesy of Arianespace

Important Milestones

The relationship between Arianespace and SSL has been highlighted by many important milestones, including the first SSL-1300 satellite ever launched and the launches of two of the world's largest commercial satellites ever built, IPSTAR for Thaicom, and the EchoStar T-1 satellite, which was called Terrestar-1.

This teamwork started with Intelsat 507, which was built when SSL was owned by Ford Motor Company and was known as Ford Aerospace. This was the first time SSL and Arianespace worked together and the satellite, built for Intelsat, was delivered to orbit aboard an Ariane 1 launch vehicle in 1983. Now, 32 years later, with ever advancing performance on the satellite and launch vehicle side, the companies are highly experienced at working together and providing exceptional service for satellite operators.



Intelsat 507 being inserted into the Ariane 1 fairing. Launched in 1983, Intelsat 507 was the first SSL mission with Arianespace. Photo by Arianespace.

The First 1300

One of the most significant moments for SSL was the launch of the first SSL-1300 satellite in the summer of 1989. SUPERBIRD-A, which was launched on the Ariane 4, was built for the Space Communications Corporation (SCC) of Japan, which is now SKY Perfect JSAT Corporation.

The platform was named "1300" because, at that time, the satellite had a dry mass of about 1,300 kg. The 1300 continues, to this day, to be one of the industry's most popular platforms, due to the highly adaptable

design that continues to incrementally evolve to incorporate advances in technology. Now, satellites designed on the 1300 platform can have a dry mass of as much as 4,200 kg. The heritage of the 1300 is maintained, all the while allowing careful insertion of new developments, such as electric propulsion in 2004 and a highly advanced data handling system in 2013.

Over the years, the 1300 earned a reputation for high reliability while providing the flexibility for a broad range of applications and technology advances. SUPERBIRD-A, for example, was a powerful satellite in 1989, with a game-changing 3 kW power level and an intended life of 10 years. Now the 1300 provides power levels of up to 25 kW and on orbit life of 15 years... or more.



The first SSL 1300 satellite, SUPERBIRD-A, is prepared for enclosure in the Ariane 4 fairing. The satellite was successfully launched on June 5, 1989. Photo is courtesy of Arianespace.

The Ariane 4

While SUPERBIRD-A was a historic first, the rocket that delivered the satellite to orbit, the Ariane 4, already had a championship pedigree. The Ariane 4 launch vehicle was extremely popular, capturing roughly 50 percent of the commercial satellite launch market during its lifetime with 113 successful launches.

One reason the Ariane 4 launcher was popular revolved around the rocket's flexibility—each launch could be customized to include either solid strap on boosters, liquid strap on boosters, or a combination of both, depending on the lift requirements of the mission.

In addition to this flexibility, the Ariane 4 launcher was a dual manifest launch vehicle, which meant the rocket could launch two satellites on the same flight. However, although the Ariane 4 launcher had the benefit of being customizable for each mission, the sheer power necessary to carry some of the higher mass satellites that were starting to emerge as technologies advanced was lacking.

Heavier Payloads

With the mass of commercial GEO satellites on the rise to accommodate more capable and complex payloads, there was demand for a launcher with the power to haul these satellites into orbit. This led to the development of the powerful Ariane 5 launch vehicle, which was also designed for dual launch capability. The first SSL-built satellite to launch on the Ariane 5G was Optus C1, which was built for Australian operator, Optus. Optus C1 is a commercial satellite that also hosts multiple military payloads for the Australian Defence Force, launched on an Ariane 5 in 2003.

Breaking the record for the largest commercial satellite ever launched, the Ariane 5G+ was able to accommodate the launch of SSL-built THAICOM 4 (also known as IPSTAR) in 2005. With a launch mass approaching 6,500 kg., IPSTAR was the world's first High Throughput Satellite (HTS) and was built for Thai satellite operator, Thaicom, and the satellite currently provides broadband service throughout the Asia Pacific (APAC) region.

In 2009, TerreStar-1, an S-band mobile satellite services (MSS) satellite now known as EchoStar T-1, broke another record for launch mass, which required a dedicated Ariane 5 ECA launch vehicle. The satellite was featured in the 2011 edition of "The Guinness Book of World Records" as the heaviest commercial satellite ever launched at 6,903.8 kg. (15,220.27 lb). The European Space Agency (ESA) used this flight to demonstrate the Ariane 5 ECA qualification for large single spacecraft launches.

32 Years Of Success

SSL had satellites launched on each of the successive Ariane launch vehicles, Ariane 1 through Ariane 5. Coming in 2016, the companies will collaborate regarding a launch on the smaller Vega launch vehicle, which first entered into service in 2012. Last March, at Satellite 2015 in Washington, D.C., Arianespace announced that the company was awarded a contract to launch four innovative Earth observation LEO satellites that SSL is building for Google's Skybox Imaging on its Vega launcher. This will be the first Vega launch for a U.S.-based satellite manufacturer and will mark yet another milestone in the long term SSL and Arianespace relationship.

Professionalism + Teamwork

John Celli, president of SSL, has worked at SSL throughout the company's history with Arianespace. He said there is always a strong sense of satisfaction when a satellite, which takes 20 to 30 months to build, gets

launched into space. He particularly looks forward to every Arianespace mission with an SSL-built satellite because he knows that the launch teams bring a long history of professionalism and teamwork and he can expect a close collaboration and a well-coordinated mission, as the launch teams work side by side during the month long preparation that leads up to each launch.

"The SSL and Arianespace launch teams work very well together, sharing a focus on exceptional service and uncompromising quality," said Mr. Celli. "I'm proud of our long history together and look forward to seeing launches on the Vega and eventually on the Ariane 6."

Stephane Israel, Arianespace CEO, said that SSL is an excellent partner at launch base and that the two companies are committed to the success of their mutual customers, the satellite operators.

"The 50 missions that Arianespace and SSL have performed together over the last three decades are an extraordinary achievement, and provide overwhelming proof we have a remarkable relationship for the benefit of our customers. It is based on mutual respect and a shared culture of excellence" he said. "We continue to expect great things from this admirable partnership."

"SSL has a great working relationship with Arianespace," said Grant Gould, Launch Systems Manager at SSL. "We know each other's requirements and capabilities so well that when changes are required by one side or the other, we are usually able to achieve our mutual goals without an issue. Arianespace shares in our vision and goals, while at the same time providing an environment which, I'm glad to say, is often a lot of fun."

Now, after a partnership thirty years in the making, SSL and Arianespace are celebrating their 50th mission together with the launch of the Star One C4 satellite in July 2015. There is nothing more gratifying than a successful launch and the two companies have shared so many of those. "The future of the SSL and Arianespace partnership looks very bright," said Mr. Celli. "I expect it to continue and flourish for many years to come as satellites and launch vehicles continue to evolve."

www.sslmda.com

Rich Currier is the Senior Vice President of Business Development for SSL.



The shipping container with Star One C4 was loaded into the Antonov for transport to launch base in May 2015. Star One C4 is the 50th SSL mission with Arianespace. Photo by SSL.

A Case In Point: Helping To Close Mexico's Digital Divide

By Kartik Seshadri, Senior Director, International Products Division, Hughes, and Alvaro Sanchez, Sales & Marketing Manager, Integrasys



Earlier this year, Hughes Network Systems (Hughes) announced that the company had been selected by Grupo Pegaso to supply its JUPITER™ System to help close the “digital divide” for communities in rural Mexico.

To assist the government in reaching the goal of Internet provisioning for 100 percent of the country's schools and municipalities, Pegaso Banda Ancha (a Grupo Pegaso company) will deliver services over the Bicentenario satellite. The satellite is owned by Mexico's Secretariat of Communications and Transportation (SCT), which operates a Hughes JUPITER Gateway and more than 5,000 remote terminals. Grupo Pegaso chose JUPITER for its efficient use of bandwidth and ability to support 20 percent more sites than its competitors.

This project required Pegaso to deploy more than 5,000 Hughes HT terminals in extremely remote locations during a four-month period of time. In order to meet such an aggressive schedule, Hughes partnered with Integrasys to incorporate their award-winning and innovative Satmotion product into the installation process. Integrasys, a company that provides carrier monitoring systems and VSAT commissioning tools, customized the Satmotion system to enable rapid and high-quality installations over the JUPITER platform.

The Satmotion system installation was completed at Pegaso's Toluca Facility, with the full system installed and ready to use in just two days. The Satmotion Pocket system enables rapid VSAT commissioning by providing the installers a real-time view of the satellite spectrum to adjust for pointing and cross polarization isolation. The Satmotion Pocket configuration at the Toluca facility also allows for six simultaneous installers performing pure carrier lineups without any interference between users.

The system used the same Ku- frequencies in both linear polarizations for delivering its services on the Bicentenario satellite, mandating at least 30dB of isolation on the installation to provide quality service. The Satmotion Pocket technology enabled Pegaso to deploy the network quickly while maintaining accurate installation.

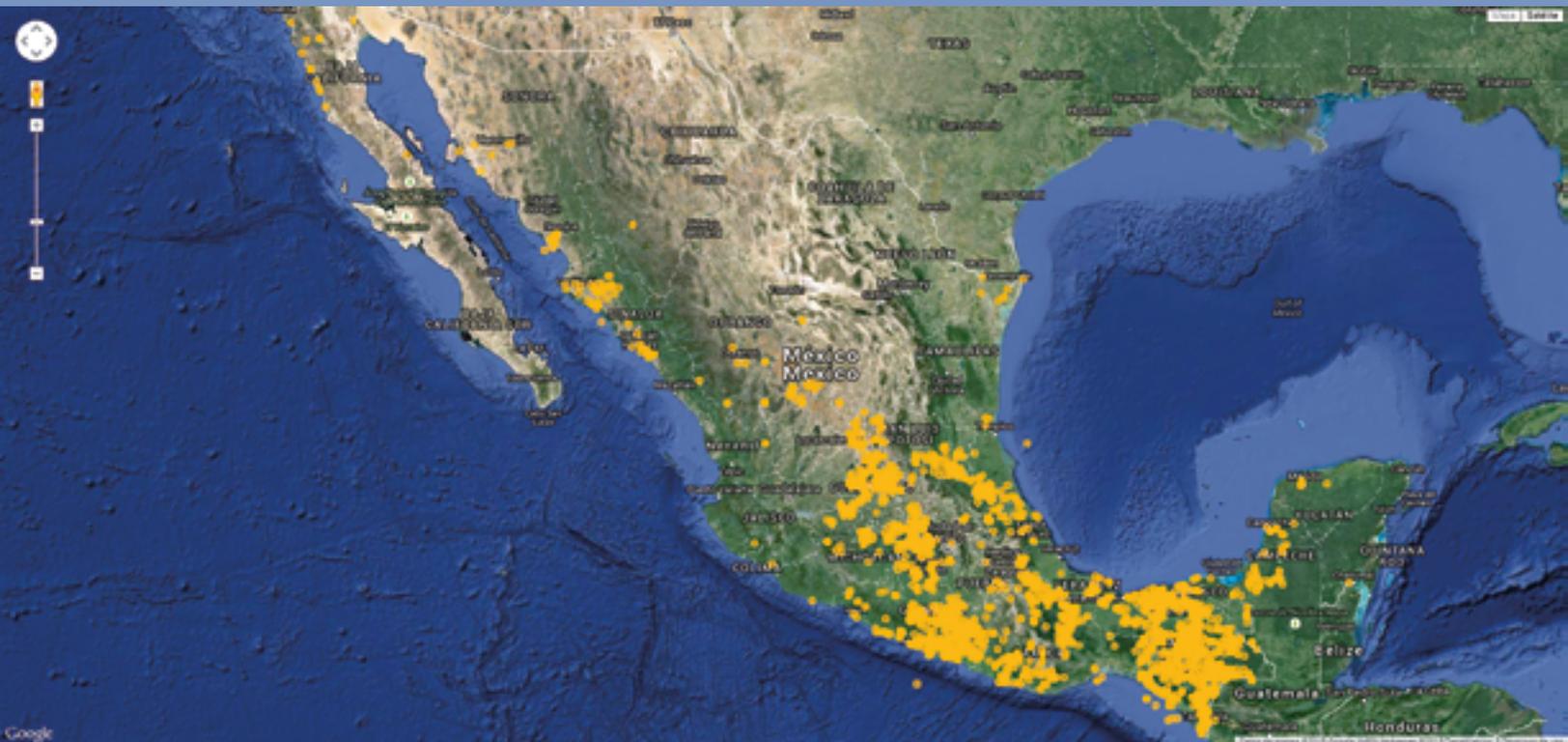
Satmotion Pocket automates the HT1100 and HT1200 terminals commissioning by simplifying the lineup. This allows the installer in the field to adjust the antenna for peak performance while ensuring cross polarization isolation without NOC (Network Operations Center) coordination.

The entire network was deployed with 10 teams of installers around Mexico who visited sites that possessed limited or no existing connectivity. Not having to coordinate with the NOC to check for cross polarization isolation was a key advantage, as all the communications during installation was managed over the VSAT.

Once the installers had performed the line-up and minimized CrossPol Interference better than 30dB, the system automatically generated a report that was sent to the hub using the same VSAT link. This process was found to require between three to five minutes to complete, in most cases, as compared to the more traditional method that could take hours.

By analyzing the installation process, within a couple of weeks of using the Satmotion Pocket system the installation teams were able to reach and exceed the goals set for the required number of installations per day. The Satmotion system allowed the customer and Hughes to better track the progress and the quality of installation on a daily basis. During the first month, more than 1000 VSATs were installed with the help of the Satmotion Pocket.





"Integrating the Satmotion Pocket system in our JUPITER product portfolio allowed our customer to meet the aggressive installation goals mandated as part of this project," said Kartik Seshadri, senior product director at Hughes.

"From the remote end, Satmotion Pocket brings a key advantage as the installer is able to perform the crosspol check without communicating with the NOC, which drives on an important time saving for the installers and operators. Also Satmotion Pocket follows the rules of the satellite operators to pass the crosspol check," said Ulises Quintana, Pegaso Field Manager.

"In general terms, I note a very intelligent Satmotion solution, and I believe that it is a success due to the levels of cost savings achieved," said Leonardo Tovar, Director of Operations.

"At Integrasys, we believe that this project shows the potential of Satmotion Pocket to automate the commissioning in order to deploy a high-speed broadband network that is interference free," said Alvaro Sanchez, Integrasys Sales & Marketing Manager.

The current Pegaso deployed network allows a visualization of the coverage of the Mexico Conectado project, which connects the rural areas of Mexico from Baja California (northwest area) to Tapachula (southeast area).

This project has been a huge success and rural communities are now connected to high-speed broadband Internet using next-generation Hughes JUPITER terminals.

www.integrasys-sa.com/
www.hughes.com/

Kartik Seshadri is the Senior Director, International Products Division at Hughes. He is responsible for international product development of Hughes' broadband products and services.

Alvaro Sanchez is the Sales & Marketing Manager, at Integrasys. He is responsible for Satellite Carrier Monitoring at Integrasys providing the most innovative solution to satellite operators and service providers.

Pictured below is Integrasys' Satmotion product.



The Continued Rise Of CubeSats

By Jos Heyman, Contributing Editor



Since the launch of the first batch of CubeSats, on June 30, 2003, a total of 277 of these tiny satellites have been placed in orbit, either via a launch vehicle or deployed from the International Space Station (ISS).

At the time of this writing, 16 CubeSats were aboard the ISS awaiting deployment.

To promote, and to a certain extent, coordinate the development and launch of CubeSats in the United States, NASA introduced the CubeSat Launch initiative (CSLI) program in 2010. Satellites developed as part of this endeavor were eventually launched through the complementary Educational Launch of Nanosatellite (ELaNa) Program.

| Year | Launched | ISS deployed | Failed |
|--------------|------------|--------------|-----------|
| 2003 | 6 | | |
| 2004 | 0 | | |
| 2005 | 2 | | 1 |
| 2006 | 4 | | 15 |
| 2007 | 7 | | |
| 2008 | 6 | | 2 |
| 2009 | 9 | | |
| 2010 | 16 | | |
| 2011 | 7 | | 3 |
| 2012 | 18 | 5 | |
| 2013 | 80 | 4 | |
| 2014 | 36 | 46 | 30 |
| 2015* | 14 | 17 | 6 |
| Total | 205 | 72 | 57 |

Number of CubeSats launched/deployed (as of May 1, 2015)*

| Year | Selected | Launched to date |
|--------------|------------|------------------|
| 2010 | 14 | 13 |
| 2011 | 22 | 10 |
| 2012 | 35 | 10 |
| 2013 | 27 | 2 |
| 2014 | 16 | 1 |
| 2015 | 14 | 0 |
| Total | 128 | 36 |

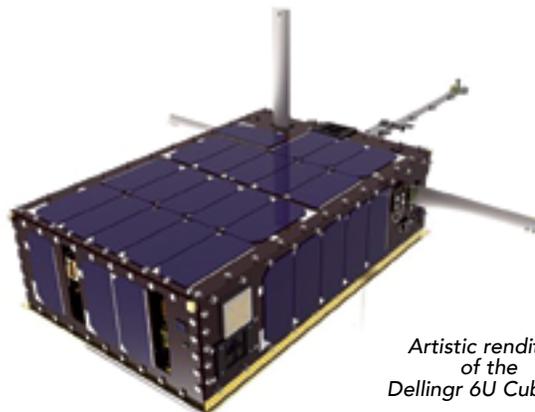
CSLI program

The CubeSat, sometimes also referred to as 'nanosatellite,' was, however, a concept that also captured attention beyond the academic world. These satellites provide excellent platforms and can be used to test technological concepts in space.

We are now at the start of the commercial use of CubeSats for communications, Earth Observation (EO) and for various meteorological purposes. There are also early proposals being introduced to use CubeSats for interplanetary missions.

There is also currently a move toward 6U units, comprised of two 3U units next to one another, as well as 12U units.

NASA hopes to send the first 6U CubeSat, named Dellingr, to the International Space Station (ISS) later in 2015 for deployment from that space platform in January of 2016.



Artistic rendition of the Dellingr 6U CubeSat.

These 10x10x10 cm structures (or multiples thereof) were first advanced in 1999 by California Polytechnic State University (Cal Poly) in San Luis Obispo, California, and by Stanford University. They were seen as an instructive method of teaching science and engineering in a multi-disciplinary environment.

The objective was to build a satellite within a two- to four-year academic career period using Commercial Off-The-Shelf (COTS) components. Such was possible through the miniaturization of electronic components—a trend that continues unabated.

The early CubeSats were primarily built for educational purposes. In fact, if the small satellite was actually launched, such was considered to be a real bonus. While the early CubeSats were just that, 10x10x10 cm cubical structures referred to as 1U, before long various combinations were introduced, such as 2U and 3U as well as 1.5 U and 0.5 U. These variously sized units provided scientists with a structure that was optimized for the payload volume required for a specific project.

There are now various commercial suppliers in the market for CubeSat components, such as Innovative Solutions In Space (ISIS) of Delft, The Netherlands, who operates the on-line **CubeSatShop.com** as a one-stop-shop for CubeSat and nanosat systems. Clyde Space of Glasgow, Britain, also provides a similar service.



Clyde Space 2U frame.

United Kingdom-based Alba Orbital markets the PocketQube Kit, which consists of the Alba Orbital Skeletonized structure that comes in 1p, 2p or 3p sizes. The 1p version is 5x5x5 cm and has a structural mass of 0.069 kg.

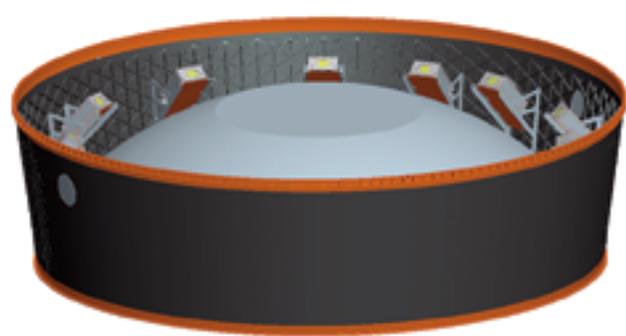
Pumpkin, a San Francisco based company, offers the CubeSat Kit, an affordable, off-the-shelf hardware and software development and deployment solution that includes complete, finished and ready-for-launch CubeSat structures in 0.5U, 1U, 1.5U, 2U or 3U size.

But these projected large numbers of satellites, coupled to the readily available components, as well as their increasing size, possess certain problems that have to be overcome.

Launching The CubeSat

The earliest CubeSats were launched as additional payloads with a larger primary payload, that occupied some spare space in a rocket's payload bay. Then with a random release, resulted into an orbit somewhat similar to the primary payload. This is expected to continue.

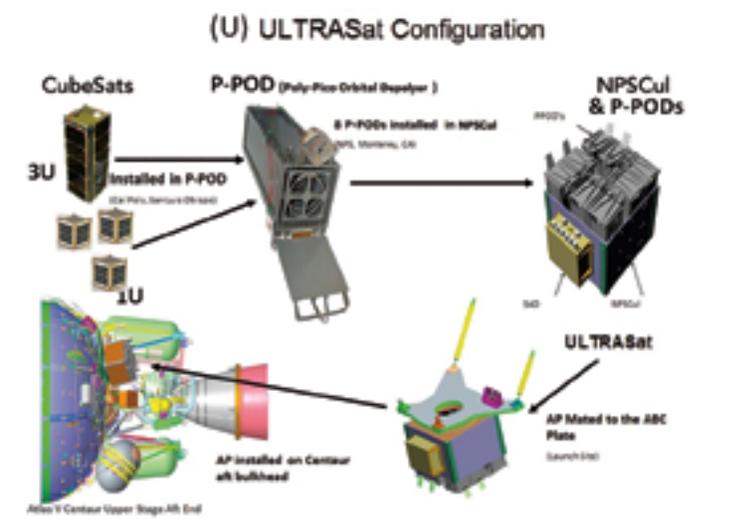
Proposed launch vehicles, such as NASA's Space launch System (SLS), will most likely be fitted to accommodate future deployment of CubeSats. In the case of SLS, these CubeSats will be placed inside the upper stage adapter, where they will be exposed once the main payload, the Orion spacecraft, has been released 10 minutes after the launch. When the Orion is at a safe distance, the CubeSats will then be deployed.



SLS CubeSat Deployer.

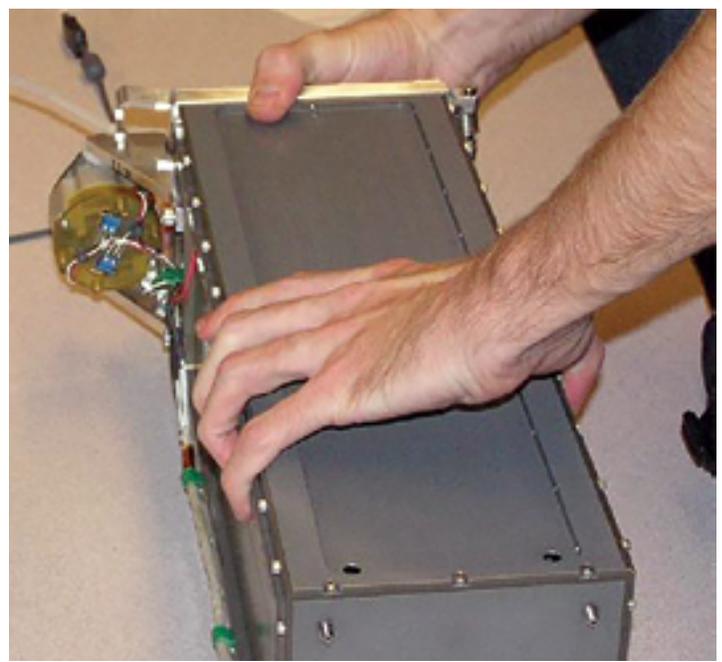
To gain some control over the release of these small satellites, devices such as the Poly-Picosatellite Orbital Deployer (P-POD) were developed as a means to deploy CubeSats from a range of launch vehicles.

The P-PODs can be mounted in the small, empty space of a launch vehicle. In example, a recent Atlas V launch managed 10 CubeSats of varying sizes, which were fitted into eight P-PODs. The P-PODS themselves were mounted in the Ultra Lightweight Technology and Research Auxiliary Satellite (ULTRASat), which was positioned at the aft end of the upper stage of the launch vehicle.



ULTRASat configuration.

However, the P-POD only has the volume to hold 10x10x30 cm payloads. These means the P-POD can only deploy three 1U CubeSats, a 1U and 2U combination, or a single 3U CubeSat—the proposed 6U and 12U combinations could not be accommodated.



P-POD

A large number of deployments have taken place with the JEM-Small Satellite Orbital Deployer (J-SSOD), such as in the Kibo module of ISS. In these instances, the CubeSats are brought up to ISS on one of the cargo spacecraft and are then deployed in a more or less controllable orbit.

However, with the number of nanosats or CubeSats to be launched in the coming years, a dedicated launch vehicle is certainly going to be required. Such a launch vehicle should be able to place a large quantity of CubeSats, perhaps 50 or more at a time, in orbit, to make such cost effective and into orbits better suited for their payload.



Nanorack Deployer (J-SSOD).

One launch vehicle that, in the past, deployed large numbers of satellites on a single launch is the Russian/Ukrainian Dnepr 1, although this launch vehicle may not be available much longer. Apart from the fact that the Dnepr 1 is a converted missile, political situations could be a barrier to this vehicle's use.

Although not a launch vehicle in its own right, Spaceflight Inc. is developing the SHERPA space tug, which allows secondary payloads, such as CubeSats, to be accommodated on a range of launch vehicles and, rather than being placed in the same orbit as the primary payload, they are into different orbits. The space tug offers five ports and a series of adapters to attach the various payloads, with a maximum capacity of 1,500 kg. The SHERPA will also have a propulsion system.

SHERPA will be built in two versions. The first one, the SHERPA 400, will accelerate a payload to a 400 m/s change in velocity, whereas the second and larger version, known as SHERPA 2200, will accelerate to 2,200 m/s. The SHERPA 400 is optimized for Low Earth Orbits (LEOs), whereas the SHERPA



Artistic rendition of SHERPA.

2200 will bring small satellites from a LEO to a geostationary orbit. The first use of the SHERPA is scheduled for 2015 when eight, as yet unnamed, CubeSats will be attached to a SHERPA vehicle that will be launched as a secondary payload on the Japanese Astro H mission. The company plans to provide two SHERPA mission each year, one being the SHERPA 400 and another the SHERPA 2200.

Closer to actually being a dedicated CubeSat launcher is the LauncherOne proposal that is being advanced by Virgin Galactic. Using the same infrastructure as their SpaceShipTwo, the company's WhiteKnightTwo can carry the LauncherOne to altitudes of up to 15 km., the altitude at which the LauncherOne is released. Briefly free-falling before the first stage ignition, the two-stages vehicle will deliver payloads into LEO.



Virgin Galactic's WhiteKnightTwo.

In May 2015, NASA requested industry proposals for the agency's Venture Class Launch Services (VCLS) program, which seeks to launch 60 kg. of CubeSats simultaneously at a fixed price. The expectations are that a contract will be granted by September 30, 2015, and that the launch will occur before April 15, 2018.

Only time will tell if any of the above launch proposals will be selected, or if a new contender in this increasingly important market niche will be selected.

Applications

As stated before, applications being devised for CubeSats are becoming more and more varied.

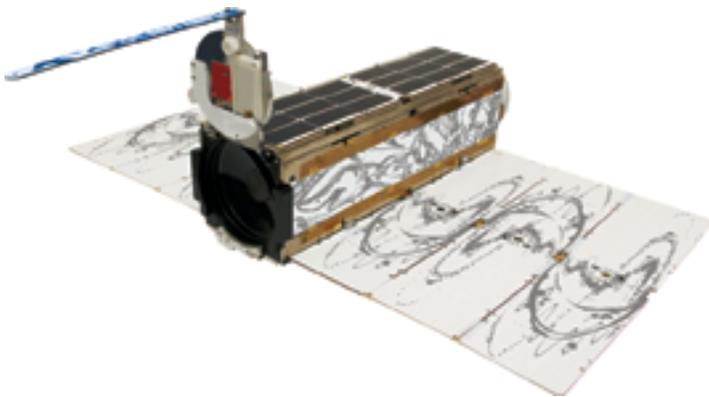
Planetary scientists have already proposed that a number of CubeSats of varying size be carried on missions to the Moon, asteroids, comets or other planets. Once the main spacecraft is in the vicinity of a celestial body, a number of nanosatellites will be deployed to take part in a wide range of exploratory objectives. Deployment could be as individual satellites or as constellations. The low cost and the large number of CubeSats would reduce the risk of mission failure, while also allowing exploration of a much greater area. NASA has already started the Cube Quest Challenge, a competition for the development of CubeSats to fly to the Moon and beyond on the first Orion flight, which will be launched by the SLS rocket.

NanoSwarm is a proposal from University of California at Santa Cruz for a swarm of more than 30 CubeSats around the Moon. They will observe the body's interaction with the solar wind, study strange localized magnetic swirls, and track the movement of water across the airless lunar surface. If accepted, this 10 month mission could be launched in February of 2020.

The European Space Agency (ESA) has announced they will accommodate two 3U CubeSats on the proposed Asteroid Impact Mission (AIM), which is scheduled for launch in October 2020. Once the CubeSats have eventually been selected, they will boost and complement the main mission. In addition, the intention is to use the CubeSats to test intersatellite communications networking. In a similar manner, NASA's Europa Clipper, scheduled for launch in 2022, may carry a number of CubeSats that will be deployed in orbit around the Jovian moon.

Within the EO environs, Planet Labs has taken the lead with its Flock series of satellites, a constellation of 28 EO CubeSats. These 5 kg, 3U satellites will provide 3 to 5 m resolution images of the Earth from the equator to 52 degrees latitude. To date, 63 of these satellites have been deployed—11 were launched on a Dnepr 1 launch vehicle, the remainder from facilities aboard ISS. Fourteen satellites remain on ISS to still be deployed, while a batch of 26 satellites did not orbit as a result of the failure of the Antares launch vehicle on October 28, 2014.

One of the problems with the Flock series is, however, that these small satellites do not remain in orbit for extended periods of time. As of this writing, 40 Flock satellites have experienced an average on orbit time of 135 days. To maintain this constellation, many more launches will be required.



Spire's Flock CubeSat.

San Francisco based company Spire, formerly known as NanoSatsifi Inc., intends to establish a constellation consisting of as many as 100 CubeSats to provide data on weather and climate changes on a global basis. The satellites will be fitted with High Resolution Sensors that measure the GPS signals through Earth's atmosphere to calculate temperature, pressure, and humidity with a high accuracy and resolution. The expectation is that this satellite constellation will have to be upgraded every two years in order to maintain pace with changing technology. Once operational, the system is expected to provide, by the end of 2015, five times more data than current systems, 10 times the amount of data by the end of 2016, and more than 100 times the data by the end of 2017.

The space communications industry has also advanced some proposals for the commercial use of CubeSats. The U.S. company Outernet has teamed with Clyde Space of Scotland to develop a 200 1U CubeSat telecommunications constellation to provide low-cost broadband to remote regions of the world. This project is sponsored by the UK Space Agency, with funding provided through its International Partnership Space Program (IPSP) that funds British companies to work with international partners developing satellite technology.

Additionally, Dunvegan Space Systems (DSS) has signed a contract with Deep Space Industries (DSI) for the construction of 24 3U CubeSats for a communications constellation.

Specific mention should be made of the QB50 project proposed by the von Karman Institute for Fluid Dynamics (VKI) in Belgium. The QB50 project consists of 50 2U and 3U CubeSats in a worldwide program for long-duration measurements in the lower thermosphere that is intended to greatly increase the knowledge and understanding of the E and F layers of the ionosphere. In addition, the satellites will carry out research experiments on re-entry and perform in-orbit demonstration of the newly developed technologies. The project was officially kicked off in November of 2011.

The CubeSats are to be constructed by universities all over the world. The plan is that all 50 satellites will be launched in 2015 via a single launch vehicle and be placed in circular orbit of between 350 and 380 km. altitude, with an inclination of 98.6 degrees. The satellites will be separated in orbit by natural atmospheric drag forces and they will form a uniform network around Earth within about three weeks. The vision is that 34 CubeSats would be provided by European universities in 19 countries, 11 by universities in the U.S., two by universities in Canada and three by Japanese universities. After the call for proposals was made in February 2012, the VKI Project received proposals for 81 CubeSats from 41 countries.

CubeSats and pocket-cubes, with their relatively low cost, provide opportunities to institutions and individuals that, without them, would not be able to develop satellites. For instance, the Superior Institute of Technologies and Applied Sciences (InSTEC) and of the Polytechnic Superior Institute José Antonio Echeverría (Cujae), Havana, Cuba, has started with the construction of the CubaSat-1 satellite. In Australia, a single individual is developing the OzQube-1 satellite. Unfortunately, due to the limited availability and the high cost of launch opportunities, these projects remain Earthbound.

However, the increasing number of CubeSats has also raised concern about the increase of space debris in frequently used orbits, such as the polar orbits and the ISS orbit. As these secondary payloads are being placed in the same orbit as the primary payload and cannot be removed from those orbits, they pose, at the end of their missions, a threat to the primary payloads in similar orbits. Indeed, some CubeSats are now testing de-orbit devices that will reduce their orbital parameters.

Small satellites, such as CubeSats and pocket CubeSats, are here to stay and they can be expected to increase in number. In fact, there are some estimates that as many as 2,750 CubeSats could be built and launched over the next five years.

*Jos Heyman is the Managing Director of Tiros Space Information, a Western Australian consultancy specializing in the dissemination of information on the scientific exploration and commercial application of space for use by educational as well as commercial organizations. An accountant by profession, Jos is the editor of the **TSI News Bulletin**.*

The SSPA Vs. TWTA Debate Continues... A Teledyne Paradise Perspective

By Tony Radford, Vice President, Sales and Marketing, Teledyne Paradise Datacom

The seemingly endless, albeit occasionally entertaining, debate over which technology is best suited for slinging bits into space pits the benefits of Solid State Power Amplifiers (SSPAs) against those of Traveling Wave-Tube Amplifiers (TWTAs)—which one is the best choice for any given application?

For some, 'application' seems to be relegated to a delineating threshold of output power somewhere south of 200 watts—i.e., SSPAs are good for low power and tubes are best for high-power. The rationale for this delineation is explained with charts and graphs that compare the latest Gallium Nitride (GaN) SSPAs with the latest TWTA and Klystron products on the issues of size, weight, output-power and efficiency.

The assumption of course—that all tubes are identical for a given band and power level, and that all SSPAs are identical, regardless of transistor line-up, how they're combined and the amount of linearization employed. Seldom are references made to such benefits as soft-fail redundancy, hot-swap modularity and cold standby—features that are unique to SSPAs.

Some manufacturers tout themselves as being "technology-agnostic" because their portfolios include products on both sides of the 'tube/transistor divide. However, I've yet to see one that has a balanced offering that includes both technologies. The respective recipes are different enough to require design skills that are unique to each technology. Even the power supplies that drive them are as different as 'night and day.' To date, the few companies that produce SSPAs in the thousands of watts remain exclusively dedicated to their solid-state heritage.

Over the years, both camps have generated countless ads, editorials and white papers, rife with subjective attributes designed to "help" customers make an "informed decision." But it seems to me that customers have already made their decision, as is indicated by a market trend set into motion years ago—a wave of transition not unlike evolutions of technology in other industries. That's not to say that tube technology is dead, but there is a new kid on the block that offers a value proposition that only solid state technology can provide. You don't have to take my word for it, nor does an inordinate amount of analysis have to be completed to see where the industry is headed.

Admittedly, I work for one of the largest SSPA manufacturers in the business, but before you accuse me of being unfairly biased towards solid-state amplifiers, let's take the following little quiz...

- | | | |
|--|-----------------|---------------------------------------|
| 1. How many TWTA manufacturers have added SSPAs to their product portfolios? | | |
| a) 1-5 | b) 6-10 | c) All of them |
| 2. How many SSPA manufacturers have added TWTAs to their product portfolios? | | |
| a) 1-2 | b) 3-4 | c) None of them |
| 3. How many customers have replaced TWTAs with SSPAs? | | |
| a) 500-1,000 | b) 1,000-10,000 | c) Just about everyone I can think of |
| 4. How many customers have replaced SSPAs with TWTAs? | | |
| a) 1-2 | b) 3-4 | c) None that I can think of |
| 5. Which of the following items is least likely to pass gas? | | |
| a) Corn-fed dairy cow | b) Spare TWT | c) Spare SSPA module |



Okay, I'll concede that there are physical elements of tube technology that render them ultimately suitable for some applications, at least for the time being.

For example, TWTs have had a choke-hold on wideband and pulsed-amplifiers used for electronic warfare. But to say that "the TWTA is obviously the best choice" for high-power and that the decision to choose GaN-based SSPAs over TWTAs is "not rational" suggests that the multitude of operators that have adopted GaN to facilitate their need for high power are irrational and incapable of weighing the tradeoffs.

One shouldn't ignore the fact that the proliferation of GaN devices has clearly been a game-changer for the industry, particularly at the upper frequencies and higher power levels. Transistors are now available to address just about every slice of the frequency spectrum from L- to Ka-band—at efficiencies that were unachievable just a few years ago.

Modular-redundancy, the ability to instantaneously activate hibernating amps and the low MTTR values associated with hot-swappable components alone can dwarf any benefits offered by tube amps. Thanks to the latest device technology, those benefits are continuously shrinking. Higher power densities and increased tolerance of extreme ambient temperatures have now allowed us to shrink footprints to the point that even outdoor installations of systems can generate thousands of watts and make perfect sense.

Steve Turner, the company's Vice President of Engineering and Chief Architect, has been dedicated to the advancement of solid state power amplification for decades. He is a renowned expert on the subject and has gone to great lengths to characterize SSPAs across the frequency and power spectrum.

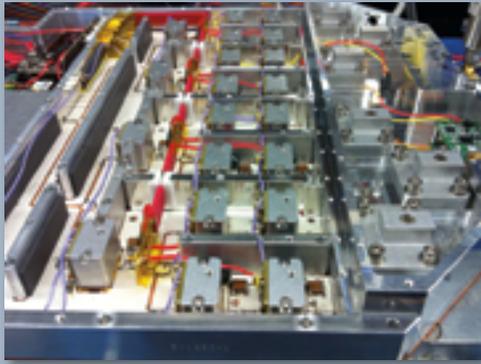
High Power Density

Steve Turner: "Some of our customers require amplifier systems that can generate very high levels of RF output power in a relatively small footprint. In many cases, our solid state systems are replacing existing TWTA or Klystron products, so the available floor-space is already defined. Gallium Nitride technology provides us with the ability to achieve tremendous power density in our RF module architectures. By using our own proprietary linearization circuits and combining networks, our module designs push the limits of efficiency. We can cascade modules with a variety of combining schemes to reach power levels in excess of 10 kW with switchless redundancy and hot-swap serviceability. A good example of this is our PowerMAX system."



PowerMAX

Steve Turner: "Paradise Datacom has been deploying PowerMAX systems for several years to commercial customers and government agencies alike. PowerMAX was designed for applications that require a lot of reliable RF power and system redundancy that maintains constant output power even after the failure of a major component.



850W Linearized GaN X-Band SSPA Module

The modular construction of the amplifiers and power supplies is designed to allow the replacement of modules while the system is in service without interrupting traffic, resulting in the lowest Mean-Time-Between-Failure (MTBF) values available today.

"PowerMAX systems are currently in service around the world, providing Ku-band power for DTH uplinks, TWTA replacements for high-power X-band gateways, C-band for deep space exploration and are delivering thousands of watts in S-band for TT&C and Troposcatter systems.

A single PowerMAX rack can generate power levels of 6 kW+, but they can also be phase-combined to deliver levels in excess of 10 kW."



A pair of phase-combined PowerMAX rack assemblies.

Outdoor PowerMAX

Steve Turner: "We've encountered some instances where customers need to generate thousands of watts of power at the antenna pedestal and don't wish to invest in a dedicated equipment shelter and all the bells and whistles that go with it.

They want the benefits of PowerMAX, such as 1:N soft-fail redundancy, modular-architecture and the ability to generate high levels of reliable RF-power, but they need it to be installed outdoors. So we introduced our 'Outdoor PowerMAX' product-line with the same GaAs and GaN-based SSPA modules that comprise PowerMAX, only they're packaged in weather-proof enclosures with their own individual forced-air cooling systems.

Just like the indoor version, Outdoor PowerMAX is built on a fully-parallel architecture, which means that there is no single point of failure in the system.

"Outdoor PowerMAX comes factory-integrated in an open frame that allows the amplifiers to be easily removable while in service. The frame



Redundant system controllers for Outdoor PowerMAX

baseplates can easily be secured to an antenna foundation in close proximity to the feed in order to minimize signal loss.

For applications that require an L-band interface, Outdoor PowerMAX can be supplied with a redundant L-band to RF converter subsystem that includes an optional fiber optic transceiver for lossless IFL runs over long distances."

SSPA Confidence

Paradise Datacom offers a wide range of switching and combining schemes that allows users to take full advantage of our SSPA products to address virtually any application that competing technologies can provide, but with superior MTBF and MTTR values. Plus, the wide (and growing) availability of solid state devices allows us to address non-mainstream frequencies with minimal lead times. We developed our own linearization circuits and even produce many of the passive components that we use in our designs.

Ultimately, the customer must weigh the benefits of tube amps versus SSPAs to determine which technology best suits his or her needs. However, we're pretty confident that somewhere in our broad portfolio of GaAs and GaN-based solid state power amplifiers lies the optimum solution, be such for indoors or outdoors.

Tony has served the satellite communications industry for 35 years, under a range of banners that include Scientific Atlanta, VertexRSI, STM Wireless, Paradise Datacom and Teledyne Technologies. His knowledge of the industry stems largely from the practical experience he acquired as a Field Engineer installing and commissioning satellite Earth stations around the world. His first book, Satcom Guide for the Technically Challenged, has more than 1,000 copies fielded and is used by large brands throughout the industry as a primer for new hires. He presently holds the title of Vice President of Sales & Marketing for Teledyne Paradise Datacom.

Stephen Turner is the Vice President of Engineering for Teledyne Paradise Datacom in State College, Pennsylvania, USA. He has been involved in the design of microwave components including: oscillators, amplifiers, and converters for more than 30 years. He has introduced many innovative RF combining and thermal design techniques to solid state power amplifier design. Turner is a member of the IEEE Microwave Theory and Techniques Society. He can be reached at Stephen.Turner@Teledyne.com.

SMAP: Advancing Earth Science With Soil Moisture Data

By Mark Foster, Northrop Grumman Astro Aerospace



On May 14, mission managers at NASA's Jet Propulsion Laboratory, Pasadena, California, declared the space agency's new Soil Moisture Active Passive (SMAP) observatory ready to start its minimum three-year science mission.

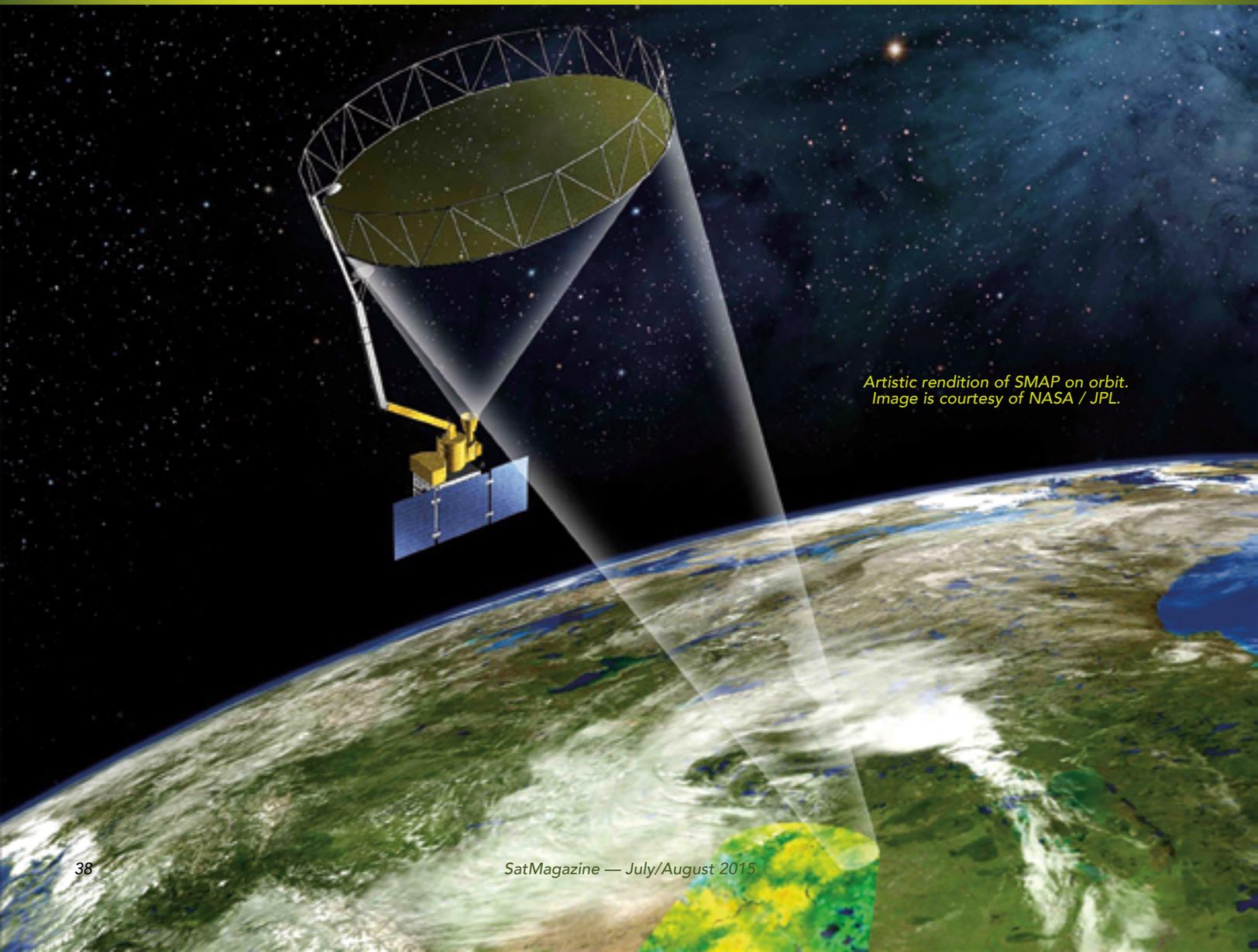
Scientists now have accurate, frequent mapping of soil moisture levels around the world. This information will potentially impact every person on Earth, affording better flood predictions and drought monitoring as well as improved weather and growing season forecasts. Mapping the entire land surface of Earth, every two to three days, SMAP will also assist scientists in better understanding the links between our planet's water, energy and carbon cycles.

SMAP was launched from California's Vandenberg Air Force Base January 31, 2015, aboard a United Launch Alliance Delta II rocket. In late April, ground controllers completed all planned on orbit deployments and spacecraft instrument checkouts. During SMAP's critical first three months in orbit, referred to as the "commissioning" phase, the spacecraft and its two instruments, the active radar and passive radiometer, were first exposed

to the space environment. The solar array and reflector boom assembly, containing SMAP's 20-foot (6 meter) reflector antenna, were unfurled and deployed, and the antenna and instruments were spun up to their full speed of approximately 15 revolutions per minute.

The commissioning phase was also used to ensure that SMAP science data would reliably flow from the instruments through the spacecraft and ground network to science data processing facilities at JPL (Jet Propulsion Laboratory) and NASA's Goddard Space Flight Center, which is located in Greenbelt, Maryland.

Prior to SMAP, the importance of soil moisture levels on weather and climate was not well known, gathering accurate data on a global scale was difficult to obtain. "From current climate models that produce widely differing estimates of how much water will be available regionally in the future, to inaccurate local weather forecasts, the value of high-resolution



Artistic rendition of SMAP on orbit. Image is courtesy of NASA / JPL.

measurements of soil moisture has been recognized for decades. Existing ground-based measurements are too sparse to show detailed variations,” said Dara Entekhabi of the Massachusetts Institute of Technology in Cambridge and SMAP’s Science Team leader, who has worked on the program since inception. “We knew that better data could have a hugely positive impact, but didn’t have the technology to make it work in a cost-effective way.”

Since 2001, NASA scientists have been working on a way to get better soil moisture data from space, starting with the Hydrosphere State (Hydros) soil moisture and freeze/thaw mission project that was proposed to NASA’s Earth System Science Pathfinder Competed Missions Program in 2001. Entekhabi, who served as the mission’s principal investigator, led Hydros.

Hydros completed a series of risk reduction studies before being canceled in 2005 due to NASA budget constraints. In 2007, SMAP was named the successor mission and slated as one of four Tier 1 missions recommended by the National Research Council’s Committee on Earth Science and Applications from Space.

The SMAP mission stays true to many of Hydros’ objectives, including instrument and performance requirements. Plus, the lead and supporting NASA centers and key science personnel are the same. Following a successful mission concept review in June 2008, SMAP entered the formulation phase in September of that year. In July of 2012, the project completed the critical design review and proceeded into system integration and test in May 2013.

Now successfully in orbit, SMAP offers global mapping of soil moisture from space with about a 5.6-mile (9 kilometer) resolution. Among other data, the mission will allow scientists to better understand the processes that link Earth’s water, energy and carbon cycles. For example, soil moisture controls the evaporation and transfer of water and heat from Earth’s land surface and plants to the atmosphere. Just as perspiration helps maintain human body temperature, soil moisture and its evaporation help regulate Earth’s surface temperature.

With the high data resolution SMAP brings to Earth science, the satellite will also help with the creation of more accurate climate model estimates, increasing overall confidence in projections of regional future water availability, local weather events and more.

SMAP’s unmatched data capabilities are enabled, in part, by the largest spinning mesh reflector ever deployed in space. Engineered by Astro Aerospace, a Northrop Grumman company, the 20-foot (6 meter) deployable reflector and boom spins atop the spacecraft at about 15 revolutions per minute (rpm), which allows the spacecraft to continually image a swath of Earth approximately 620 miles (1,000 kilometers) wide. The spacecraft’s orbit allows for coverage of the entire planet every three days.

“A big challenge for this mission was getting accurate data quickly,” said Entekhabi. “Satellites that just stare at the ground under them aren’t practical for mapping the entire Earth, and so we knew that we needed to spin the reflector, and also to have a very large one to capture the entire planet’s surface.”

Adding to the challenge, the reflector could not be dynamically tested in advance. The gravity environment the reflector and boom would experience in space could not accurately be replicated on Earth, and all of the components needed to be precisely manufactured.

To build the reflector and boom for JPL, Astro Aerospace drew on the company’s long history of on orbit success for space deployables and hardware. “No one has ever tried this with such a large reflector before, so we had some significant challenges in regard to design, fabrication and assembly,” said Astro Aerospace’s Chuck Dollison, production supervisor for assembly and fabrication.

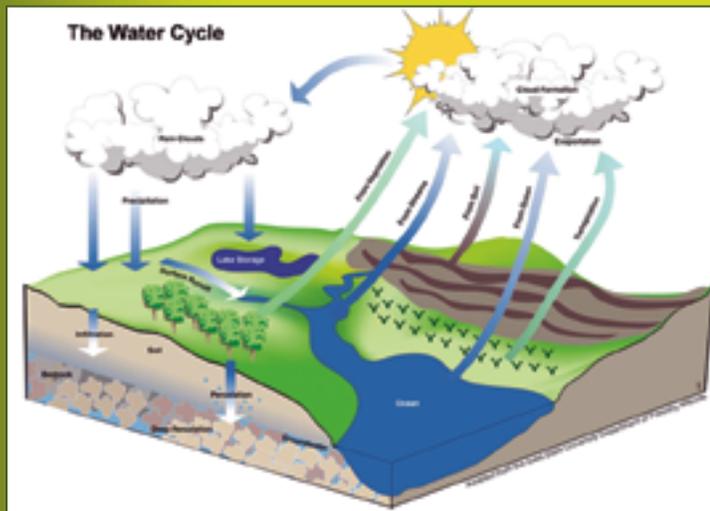
To ensure proper rotation without testing, the Astro Aerospace team measured the mass properties of the reflector with unprecedented accuracy. Astro engineers even invented new methods to achieve the extremely precise mass measurements they needed. For certain tests, Astro also brought in machines typically used to balance airplane engine blades.

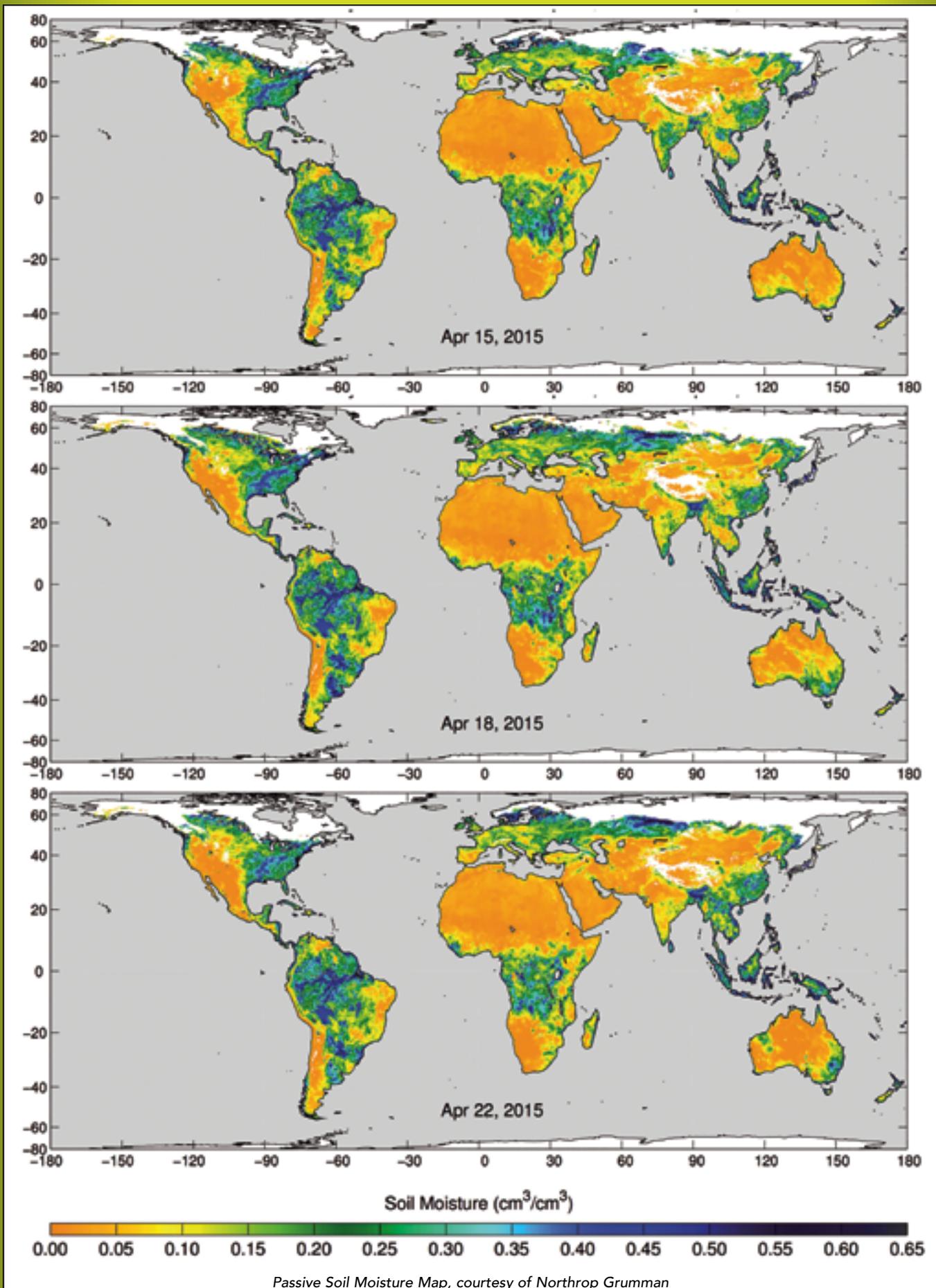
“These machines are so sensitive that breathing near the equipment during measurements skewed the results,” recalled Dollison. These techniques allowed Astro Aerospace engineers to keep the reflector and boom mass to within a 3.5-ounce window (the weight of approximately 39 pennies) and the center of mass within a half-inch (1.3 centimeter) window. The 20-foot reflector successfully deployed on February 24 and was spinning at a full 15 rpms by March 26.

Deploying large, low-mass structures in space is never easy. This is one of the larger engineering challenges NASA missions must confront in development. Another huge challenge was in getting such a large reflector into the rocket—something akin to technical origami. The successful unfurling, deployment and spin-up culminated the more than six years of challenging reflector and boom assembly development, system engineering and an extensive test campaign.

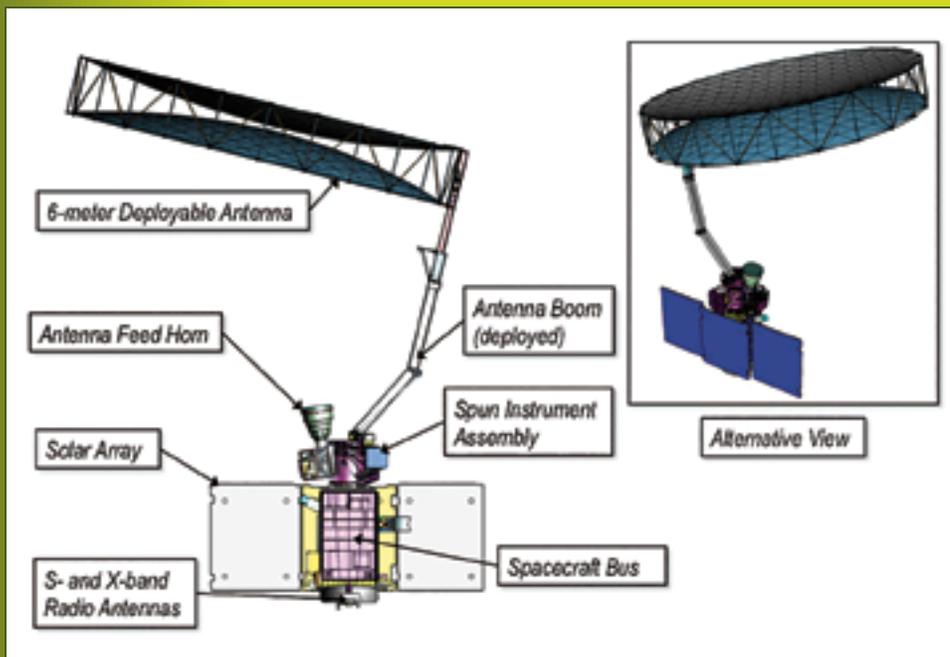
In spite of the challenges of the mission, the SMAP reflector weighs only 56 pounds (25.4 kilograms). The extremely stiff boom, which deployed the reflector into position and reduces deflections caused by the spin rate, weighs 55 pounds (25 kilograms). With the remaining launch restraint equipment weighing approximately 15 pounds (6.8 kilograms), the entire system totals a mere 127 pounds (57.6 kilograms).

The remainder of the spacecraft is dedicated to support SMAP’s two instruments: the radar and radiometer. The radar transmits L-band microwave pulses to the ground and measures the strength of the signals





Passive Soil Moisture Map, courtesy of Northrop Grumman



The SMAP mission is designed to produce high-resolution maps of global soil moisture and also detect whether soils are frozen or thawed. SMAP's radar has two data acquisition functions: one for synthetic aperture radar (SAR) processing to produce radar measurements at a spatial resolution of 0.6 to 1.9 miles (1 to 3 kilometers), and another for low-resolution processing to produce radar measurements at a spatial resolution of 19 miles (30 kilometers). The SAR function will be used over land surfaces and coastal oceans during routine science operations, while low-resolution processing will be exercised over land as well as over global ocean areas.

Scientists will combine measurements from SMAP's radar and radiometer sensors through advanced data processing to achieve high data accuracy and a resolution of 5.6 miles (9 kilometers). Once fully calibrated, SMAP will offer the individual radar and radiometer data, among other data products.

that bounce back from Earth to the reflector, while the radiometer measures the L-band microwaves that are naturally emitted from Earth's surface.

The instruments can peer into the top 2 inches (5 centimeters) of the soil, through clouds and moderate vegetation cover, day and night. The "Active Passive" in the mission name refers to the radar actively emitting microwave pulse, and the radiometer passively measuring the microwaves naturally emitted by Earth.

Together, SMAP's two instruments produce the highest-resolution, most accurate soil moisture maps ever obtained from space. To obtain this resolution and accuracy, the data from the two instruments is combined in a way that takes advantage of the best features of each, while working around their individual limitations.

SMAP's radar, operating at 1.2 gigahertz, transmits microwave pulses to the ground and then, using the spinning reflector, receives and measures the strength of the signals that bounce back from Earth, called backscatter. Water—including water in soil—responds differently than dry soil does to microwaves.

Water changes the strength of backscatter and microwaves' polarization (the orientation of the electrical field of the microwaves). Therefore, backscatter from soil containing more moisture is stronger and is polarized differently than backscatter from drier soil. The extent of this difference allows scientists to distinguish the amount of moisture present in the soil. SMAP's radar emits pulses with two different polarizations, horizontal and vertical, to make a more complete measurement of this effect.

Like the radar, SMAP's radiometer detects differences in microwaves caused by water in soil; but it measures Earth's natural microwave emissions at the frequency of 1.4 gigahertz. Around the globe, the most striking difference in these natural emissions is between water and land surfaces. A desert emits microwaves at about three times the rate a lake does. Because the difference is so large, even a small amount of moisture in soil causes a change that a radiometer can accurately measure.

Over the next year, SMAP data will be calibrated and validated through comparison against actual ground measurements of soil moisture and freeze/thaw state at sites around the world that represent a broad spectrum of soil types, topography, vegetation and ground cover. SMAP data will also be compared with data from existing aircraft-mounted instruments and other satellites that collect soil moisture data.

NASA scientists are now beginning the calibration and validation process for SMAP, using the lowest level data products (maps of backscatter and brightness temperature). Preliminary-level, or "beta," calibrated data will be available in August at designated public-access data archives. These will include the National Snow and Ice Data Center in Boulder, Colorado, and the Alaska Satellite Facility in Fairbanks. Preliminary soil moisture and freeze/thaw products will be available in November, with validated measurements scheduled to be available for use by the general science community in the summer of 2016.

"SMAP data have implications for the entire world," said Entekhabi. "From local weather forecasts to disaster planning to agriculture cycles, we are happy to make these data available to anyone who is interested."

With this key milestone—the start of science operations—in their rear-view mirror, the SMAP team now looks forward to completing its calibration activities and releasing the data from this important mission, which offers broad applications for science and society.

www.northropgrumman.com/BusinessVentures/AstroAerospace/Pages/default.aspx

Mark A. Foster is an INCOSE certified Expert Systems Engineering Professional (ESEP) and is currently serving as the Director of Engineering for Astro Aerospace, a Northrop Grumman company. In this role, Foster supports Astro Aerospace's advanced development efforts and serves as Astro's Chief Systems Engineer on the various NASA, commercial, and government programs, including the James Webb Space Telescope and the SMAP satellite.

Throughout his career, Foster has had the privilege of working on many of the major space programs in recent history, including the Antares, Delta IV and Atlas V launch vehicles, the X-37 Reusable Space Vehicle, the Space Shuttle, and the International Space Station.

A published author, Foster holds a BS in Electronics Engineering from California Polytechnic University (summa cum laude 1983), and Masters in Systems Engineering (2011) from the Missouri University of Science and Technology, as well as several professional certifications. Foster is currently pursuing his PhD in Systems Engineering at the Stevens Institute of Technology.

India Uses SATCOM To Bridge Medical Education Gaps

By Shilpa Choudhury, Marketing Manager, Hughes Communications India Ltd.



The International Monetary Fund predicts that India will eclipse China as the world's fastest-growing major economy in 2016.

With the growth and modernization of India's economy has also come a higher demand for medical care and the physicians to provide these crucial health services.

India has more medical colleges than any country in the world—381 public and private institutions. However; the country's size and the medical needs of the nation's one billion people are outstripping available services.

Government and private medical schools are responding by creating 10,000 more medical college seats, but that doesn't address the short-term need for more specialists in vital areas, such as gerontology and endocrinology. In particular, there is a critical need for practitioners in rural India, where 70 percent of the specialist posts at rural health centers, which provide basic medical services to villagers, are vacant.

That problem is rooted in a reality of India's medical education system. Many medical school graduates cannot get into their desired post-graduate specialist programs because they haven't received the necessary training to pass entrance exams. As a result, the country's medical coaching industry emerged to help

provide young doctors with the additional training they need to get into desired specialties.

Until recently, access to medical coaching schools was largely restricted to doctors who lived and worked near sizable cities and towns. Interactive remote learning was limited by the extent of India's landline Internet infrastructure, which does not extend to many of the country's vast rural areas. Over the last few years, many of India's coaching schools have extended their services through remote learning systems that use satellite broadband service to reach locations with limited or no landline Internet access.

Coaching Across Distances

Satellite broadband gives India's coaching schools a high-performance connectivity platform for qualified faculty to reach doctors who want to attend prestigious post-graduate programs. The systems help India to obtain a better return on the investment in educating young doctors.

With medical services in such high demand in India, every medical school graduate is a valuable asset to the country. The satellite-based distance learning systems give doctors living in remote areas access to learning resources once available only to doctors in urban areas.



The interactive services provide young doctors with live instruction and a portfolio of self-paced learning resources to help them pass exams and close India's medical skills gap. Satellite broadband economically spans India's vast distances without the expense of building landline infrastructure, especially to rural areas where the need for doctors is high.

Broadband satellite network solutions provide a virtual face-to-face experience with high-quality, high-clarity media that enables direct eye contact, two-way voice interaction, and chat-based queries. With high-definition and 3D-quality images, the educational experience simulates the in-person training available at labs and classrooms.

In the past, satellite connectivity was typically thought to be too expensive, too slow, and unreliable to support such a demanding application. With the advent of high-performance satellite broadband and advances in radio technology, the cost and reliability of satellite connectivity has made satellite systems a viable option for medical coaching companies trying to span India's long distances.

Satellite Medical Coaching At Work

Two coaching schools, the Delhi Academy of Medical Sciences (DAMS) and the Dr. Bhatia Medical Institute (DBMI), have implemented satellite-based distance learning systems.

DAMS deployed a Hughes tele-education network in more than 82 coaching centers across 25 states. Once primarily serving large cities, the Hughes network is significantly extending DAMS' reach into rural areas.

"The Hughes technology and learning software have helped us take our students to a new level," said Dr. Sumer Sethi, director, DAMS. "The beauty of it is that we can create mass delivery of this education, yet keep it individualistic. This will be the future of medical education in India."

DBMI has more than 95 medical coaching centers across the Indian subcontinent linked by a Hughes network. Hughes expects the total number of medical coaching networks powered by its satellite services to grow to 200 in 2015.

The schools' satellite networks are set up very similarly to broadcast networks. The primary difference is that they are communicating interactively with a limited number of endpoints instead of to mass audiences.

Training originates in centrally located broadcasting studios where specialist doctors teach on camera. The satellite network transmits their words and images to remote classrooms and coaching centers throughout the country.

Students in the remote classrooms can ask questions and receive responses from their instructors in real time. Instructors can engage students in multi-party video communication, with an option for audio-only communication.

Instruction options include chat and application sharing, video sharing with presenter voice overs, public and private chat, and one-to-one private interaction. Tools, such as hand raise, polls and quizzes, also make learning more interactive. Auto scanning all of the remote classrooms enables instructors to read students' reactions and determine how well they comprehend the presented material.



The Next Wave

The current generation of satellite networks supports capabilities that will extend the coaching schools' portfolios of educational resources.

Multicasting, for example, is an inherent satellite capability. Medical coaching schools can use multicasting to provide students with electronic textbooks, presentations, documents, and so on. Textbooks, especially, are expensive to purchase, maintain, and deliver. Digital delivery solves this issue when coupled with e-readers, such as tablets.

Schools can also multicast live learning to several locations at once and distribute self-paced learning programs. Pre-recorded content such as lectures, documentaries, and other video content may be delivered in a "forward and store model" so that the material can be viewed when needed.

Recognizing that students can learn as much from each other as from their instructors, coaching schools can implement on-demand video conferencing over satellite to connect students in different regions. Videoconferencing is more engaging than conference calls or testing and leads to more productive exchanges between students.

Satellite also gives coaching schools the option of expanding beyond their current education delivery model to new self-service models. Computer-based training or self-paced learning is common in higher education and trade-oriented learning. Kiosks or terminals to support this may be located close to underserved areas where people already work.

Remote test administration is another important function that can be improved with satellite. In some countries, standardized tests are used to evaluate students on a level playing field. These tests must be delivered securely and on time to meet testing schedules. In Indonesia, for example, this is a daunting task simply because of geography and population size. Digital delivery could be the solution.

These are just some of the options that satellite offers India's medical education community. India's size and population are challenges to extending healthcare delivery to more areas of the country. Medical coaching schools have demonstrated how satellite technology can span those obstacles and broaden the pool of qualified applicants for post-graduate education in vital specialties.

Shilpa Choudhury is Marketing Manager at Hughes Communications India Ltd.

SatBroadcasting™: Metadata Matters—What You Need To Know...

By Roger Franklin, President and Chief Executive Officer, Crystal

Metadata-rich streams enable additional advertising revenue as consumers' viewing habits change.

This new advertising revenue is needed to offset losses from traditional advertising that are the result of declining, traditional TV viewership.

Crystal, in concert with *Satnews Publishers* and Paul Woidke, an industry veteran and award winning SCTE expert, recently conducted a webinar on that inclusion of SCTE messages into the video stream (crystalcc.com/metadata-matters/). As a result, several questions were asked that are addressed here:

Today—using a sports metaphor as an example—the information about the content in each program segment is contained in the play-out automation system. In the future, additional information about the content will be generated at the cameras. This additional metadata describes such attributes as players on the field, where the ball is, who is in the field of view of each camera, and how many yards are left to the next down.

Managing and distributing a growing world of metadata will be challenging and involves moving information about program segments from automation systems into compressed transport streams that are distributed to cable head-ends, DTH providers, and web streaming content delivery networks (CDNs).

To discuss the methods by which you should insert metadata, the discussion will focus on the differences between live video and pre-recorded content.

Inserting Metadata Into Prerecorded Content

For non-live programs, the automation playlist can be parsed and the program segment descriptive information that must be inserted is known. The programmer must decide to build a splice schedule that delineates the beginning and end of each segment, and deliver that schedule using splice schedule SCTE-35 messages, and mark the end points of program segments using splice immediate or splice insert messages. Regardless of the method chosen, the programmer must use splice insert messages to embed splice descriptors for each segment.

Inserting Metadata Into Live Events

Precise prediction as to where segments will start or end during a live event is impossible, which means that the splice schedule method doesn't work well for adding metadata to mark up program segments. For live events, the play-out automation system must send out triggers that can be used to insert the correct metadata. These triggers initiate the insertion of metadata that define the beginning and end of each segment, as well as metadata that describes the segment.

To meet the standard, a splice descriptor message describing the segment must occur at least four seconds prior to the start of a segment, which is possible for live events. If an encoder cannot properly translate splice descriptor SCTE-104 into SCTE-35 messages, then the descriptors and the beginning and end splice messages may be inserted through different methods (*described later in this article.*)

In that situation, the exact splice point can be identified with a separate SCTE-104 splice message that only identifies the beginning of a segment. Then, a different SCTE-35 message containing the segment descriptor can be inserted into the Mux, bypassing the encoder.

Handling Programs Going To Different Destinations

Many programmers must overcome the fact that some distribution streams need more, or different, metadata than others. A programmer's traditional distribution transport stream sent via satellite to cable head-ends may not need complete metadata to describe the details of each program segment. However, a new transport stream that is sent to two other super head-ends may.

Relying on the automation playout system to send triggers to an external insertion system provides flexibility on how and where metadata is inserted. The external insertion system can generate SCTE-104 splice messages marking the beginning and end of segments for insertion into one pre-encoder stream, but not another and the insertion system can generate SCTE-35 splice insert messages with segment descriptors into another post-encoder stream. An external insertion system is effective with older play-out automation systems that are not capable of generating SCTE-104 messages.

Generating SCTE-104 messages that are inserted directly into the uncompressed video is no small undertaking—the encoder will be able to turn those into the correctly formatted SCTE-35 messages. The first consideration must be what type of SCTE-104 can be generated. Some items to consider:

Can any field in SCTE-104 messages be modified to properly describe a splice point or a segment?

In order to insert a clean splice point, your encoder must be capable of translating a SCTE-104 splice point message into a SCTE-35 message and inserting an IDR frame for all PIDs (video, audio, etc.) associated with that program. Some systems do not allow for full manipulation of a the data fields in a SCTE-104 message.

Are pre-formatted SCTE-104 messages simply triggered by a relay?

This can be done, but the method is very limited and makes it difficult to generate segment descriptors with different content identification values or descriptive data in each message.

If your system is able to generate the right SCTE-104 messages, will your encoders properly translate them into SCTE-35 messages? Private or proprietary messaging may prevent the encoder from working as expected. If you want to do more than an Avail or DTMF descriptor, your encoder may have issues interpreting and translating SCTE-104 message into a SCTE-35 message.

As the presence of a segmentation descriptor does not have to correspond to an IDR frame, it is possible and reasonable to inject a properly formatted SCTE-35 message into the post-encoder multiplexer, bypassing the video encoding function altogether. This method enables content identification signaling for older encoding systems that don't support the SCTE-104 to SCTE-35 translation for segmentation descriptors.

This method may be used for proprietary data. To successfully implement, a middleware solution is needed to receive the triggers from the play-out automation system and generate the SCTE-35 messages that are delivered to the Mux. Also possible is for this same middleware system to generate the SCTE-104 splice messages and insert them into the uncompressed video stream ahead of the encoder.

During this evolution of consumer's video consumption, content originators and distributors must keep the current distribution systems working and add new distribution systems that can generate additional revenue. It is imperative to become more operationally efficient and find ways to do more with less.

The push to support new revenue models—targeted advertising, services that enable toys to interact with video content, product placement and replacement, consumer credits for sharing video segments and endorsing products will increase.

Companies that plan today to manage content smartly will reap the rewards of participating in new revenue streams wherever their content flows.

Eric Holtzclaw is the Chief Marketing Officer at Crystal. He may be reached at eric.holtzclaw@crystalcc.com.

Fast, Secure Broadband Connectivity Via “Fiber In The Sky”

By Vern Fotheringham, CEO and Chairman, LeoSat, Inc.

With the ever-increasing demand for fast, uninterrupted coverage and connectivity worldwide, this is an exciting time to be active in the satellite broadband market.

In particular, technological and economical improvements in recent months have led to the rise of Low Earth Orbit (LEO) satellite constellations. The big names are all vying for a piece of this lucrative market. As demand for data transport and products continues to increase, and the size and cost of satellites continues to fall, now is the correct time for a unified LEO broadband network that spans all corners of the globe.

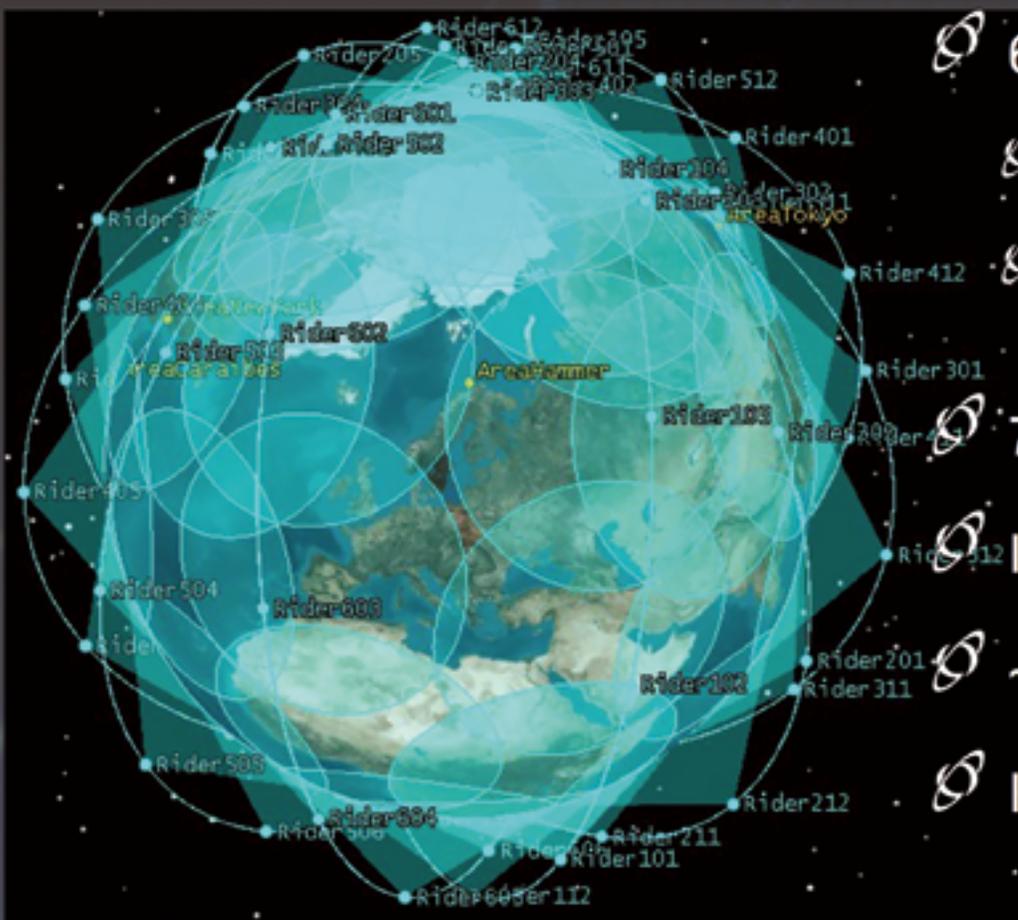
I joined LeoSat to deliver on this promise of global connectivity and to advance the future of non-geosynchronous orbit (NGSO) satellite broadband systems. Founded by former Schlumberger executives Cliff Anders and Phil Marlar, LeoSat is focused on developing a LEO constellation that will provide extremely high-speed, low-latency, cost-effective broadband coverage anywhere on the planet.

The company is harnessing the latest advances in satellite communication technologies for this constellation as well as for our mobile, fixed and portable ground-segment equipment and services, with the vision of providing the most reliable solution with the highest capacity. However, LeoSat isn't just another initiative to bring Internet to the masses. The company is focused on the top 3,000—not the three billion unconnected—uniquely and deliberately aimed at addressing the unmet, critical need for fast coverage specifically within the business and government markets.

What sets LeoSat apart is an incredibly advanced system for high-end users to solve essential communications issues in key markets such as maritime, mobility, oil & gas exploration and production, enterprise VSAT and telecom backhaul and trunking of all types. As an alternate to the Internet, LeoSat will provide the fastest network for global data transfer by launching 80 to 120 high-powered Ka-band satellites into LEO.



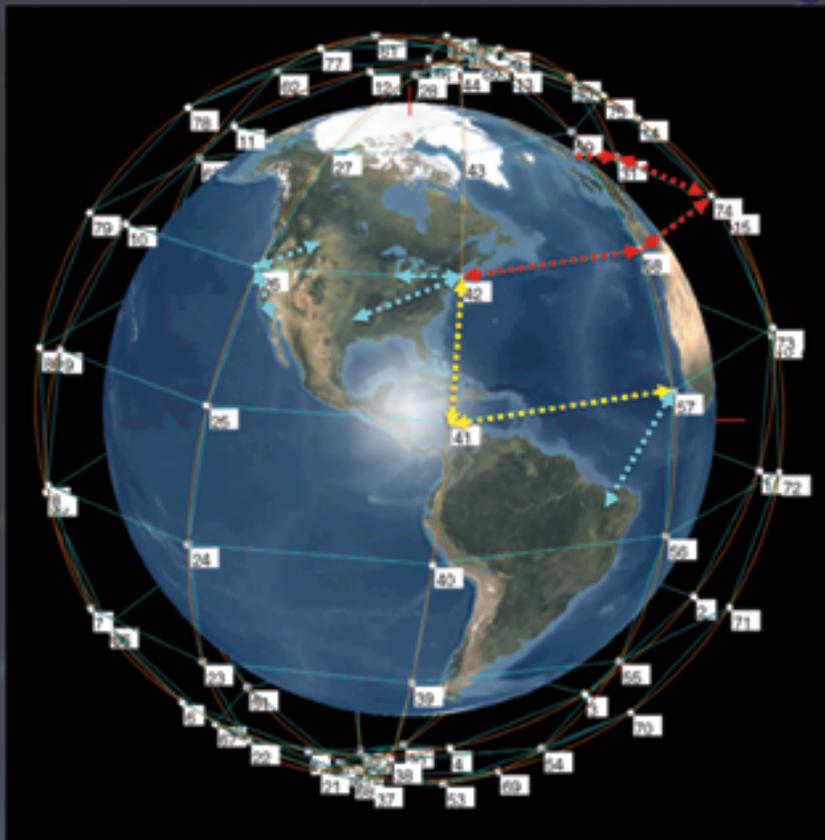
LeoSat Constellation



- 6 planes each with:
- 1-2 gateways each
- 12 primary on-orbit satellites + spares
- 72+ total satellites
- Inclined Polar Orbit
- ~1,400 km altitude
- Inter-Satellite Links



ISL Routing Examples



ISL Routing

Regional



Global



Customer Links



LEOSAT

In line with this focus on businesses and governments, a key component is that LeoSat's network will be highly secure to meet the sensitive needs of these markets. Acting as a connected, continuous, "fiber in the sky," LeoSat will provide a global, private data network with autonomous routing of secure traffic.

This system will offer point-to-point data connections to and from anywhere worldwide, all without the need for interstitial terrestrial landings or transport. The data will be able to travel in its native form, but is encrypted and secure from end-to-end.

In this way, the system is perfectly suited for large corporations, communications service providers, or governments that need to move huge, sensitive amounts of data around the world at very high-speed. LeoSat satellites will be able to provide 4G backhaul while seamlessly complying with LTE switching protocol standards, and the terminals will receive and forward data to multiple satellites to hasten delivery. LeoSat is considering the use of optical inter-satellite links (ISLs) to maximize capacity and minimize system-wide latency.

LeoSat's low-orbiting constellation of High Throughput Satellites (HTS) will provide high-speed data transfers across the constellation using RF or optical ISLs. Compared to "fixed" geosynchronous communications satellites, low-orbiting satellites enjoy dramatically reduced latency.

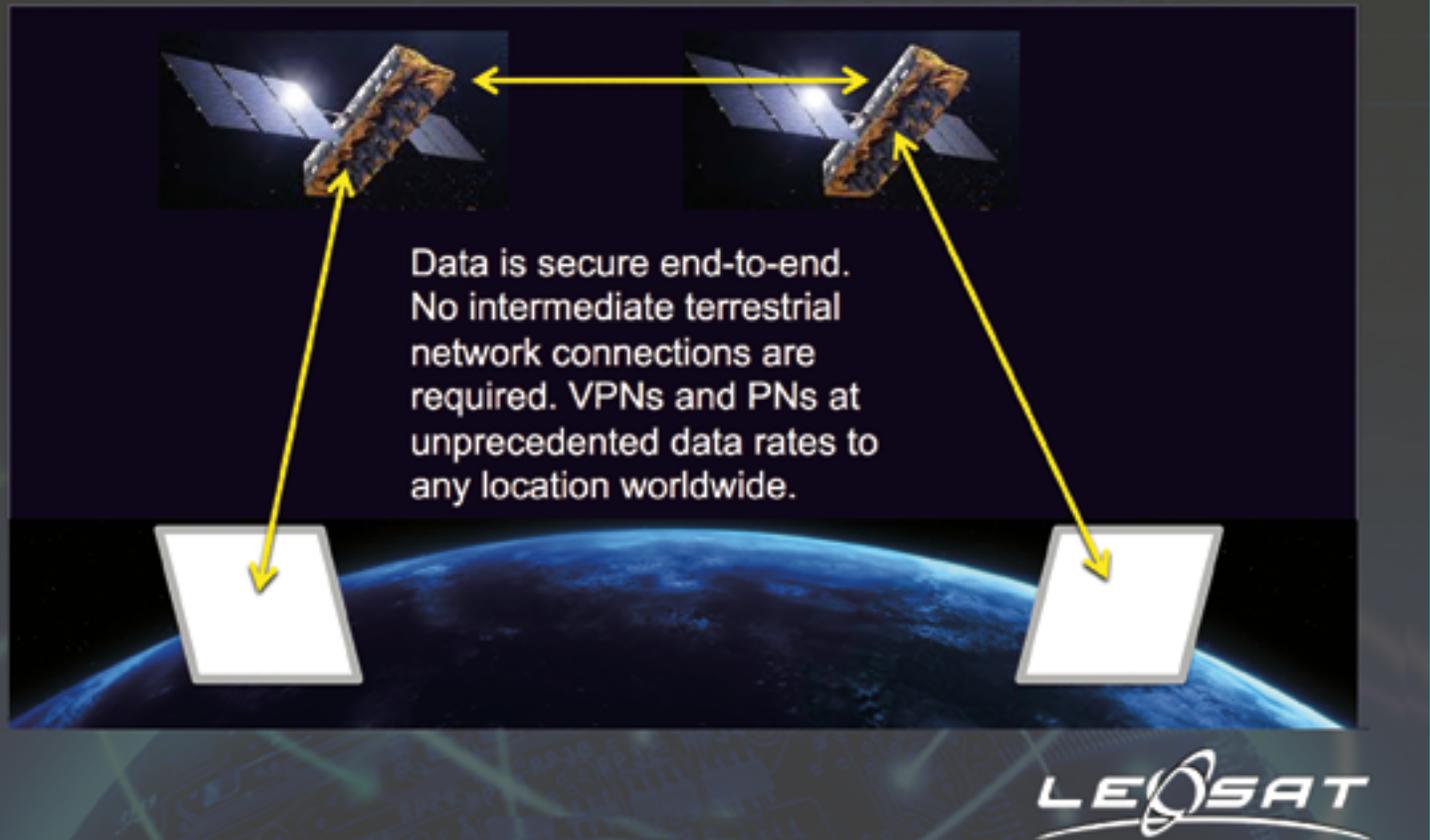
LeoSat's system is expected to provide 1.2 gigabytes of synchronous connections worldwide for business and government customers. Thanks to the constellations extremely low latency, even time-sensitive applications, such as voice services, become feasible.

Many other factors differentiate LeoSat from other mega constellations announced by major players such as Google, OneWeb and SpaceX. Generally aimed at providing connectivity to the consumer level, these constellations are comprised of hundreds to thousands of small satellites— they have relatively low onboard power with the resultant capacity constraints. In contrast, LeoSat's extremely high-capacity constellation will alleviate the most difficult communications issues for organizations that cannot be solved by the new LEO or legacy geosynchronous systems. LeoSat is complementary to existing fixed satellite service (FSS) operators by offering new services that start where the legacy FSS services end in terms of capacity, latency and coverage.

Other key differentiators of LeoSat's constellation include low-delay, multiple satellite redundancy, extremely high-speed ISLs, and interconnected satellites with intelligent routing. These satellites will use a patent-pending integrated network linked via our ISLs to transport client data transmissions worldwide.

LeoSat will also implement a new generation of client Earth stations that use electronic beam steering, have no moving parts, are self-initializing, and which can simultaneously handle multiple beams. Incorporating all of these

Private Network Connectivity



qualities, LeoSat will stand alone as the ultimate complementary satellite system to the existing satellite and terrestrial service providers.

To date, the company has achieved significant milestones at a relatively early stage and the satellite platform concept is proving to be well received by the technical community and the market. LeoSat has been developing the network architecture, spectrum planning and satellite payload, all in conjunction with many leading aerospace contractors and equipment manufacturers.

This progress has created a solid foundation for building out global operators and market reach in the coming months—some extremely significant industry alignments and service delivery partnerships will be announced shortly. Contracts for satellite development should be initiated within a year.

Recently, LeoSat retained Axiom Capital Management to coordinate an initial Series A round of financing to see the firm through our preliminary design phase, with work on a much larger Series B round expected in Q3 to support the initial satellite supply contract. Through these strategic objectives, the focus is on reaching the next phase of our development and building LeoSat into a world-class organization.

Not long ago, successfully deploying a large-scale LEO satellite constellation would have seemed out of reach. Back in the 1990s, companies such as Teledesic failed to launch massive spacecraft constellations, resulting in waning hopes for the future feasibility of such systems. However, the

industry has reached a tipping point in recent years, where advancements in materials science and electronics, unique LEO manufacturing methods and improved economics have made this type of constellation not only possible, but an imminent reality.

The key ingredient here is the emergence of low-cost, electronic beam-forming antennas, such as those Phasor Solutions and Kymeta are developing that enable tracking and signal hand-off with no moving parts. Combine this technology with developments in interlinking satellites and ground segments, new business opportunities and growing demand for fast data transport, and a new wave of lucrative market growth and technological development is nigh.

With a highly efficient, easily deployable, cost-effective and secure LEO constellation, LeoSat's "fiber in the sky" is well positioned to forge this next phase and bring fast, unlimited broadband connectivity for the world's most data-intensive and mission-critical markets.

www.leosat.com

Vern Fotheringham, chairman and CEO of LeoSat, has been a serial entrepreneur in the broadband wireless and satellite communications industry for more than 30 years. He has created and built numerous successful ventures and contributed to large-scale projects for major service providers, system vendors and software solution suppliers. He has also been a public policy and regulatory advocate for new telecommunications' service rules and standards, and an inventor and creator of now globally adopted standards and innovative new products and services. Contact the author at vern.f@leosat.com.

Using Radar Satellites To Study Icelandic Volcanoes + Glaciers

By Kimm Fesenmaier, Senior Science Writer, California Institute of Technology

On August 16 of last year, Mark Simons, a professor of geophysics at Caltech, landed in Reykjavik with 15 students and two other faculty members to begin leading a tour of the volcanic, tectonic, and glaciological highlights of Iceland.

That same day, a swarm of earthquakes began shaking the island nation—seismicity that was related to one of Iceland’s many volcanoes, Bárðarbunga caldera, which lies beneath Vatnajökull ice cap.

As the trip proceeded, it became clear to scientists studying the event that magma beneath the caldera was feeding a dyke, a vertical sheet of magma slicing through the crust in a northeasterly direction. On August 29, as the

Caltech group departed Iceland, the dike triggered an eruption in a lava field called Holuhraun, about 40 kilometers (roughly 25 miles) from the caldera just beyond the northern limit of the ice cap.

Although the timing of the volcanic activity necessitated some shuffling of the trip’s activities, such as canceling planned overnight visits near what was soon to become the eruption zone, it was also scientifically fortuitous. Simons is one of the leaders of a Caltech/JPL project known as the Advanced Rapid Imaging and Analysis (ARIA) program (*additional information at the close of this article*), which aims to use a growing constellation of international imaging radar satellites that will improve situational awareness, and thus response, following natural disasters.



This Landsat 8 image, acquired on September 6, 2014, is a false-color view of the Holuhraun lava field north of Vatnajökull glacier in Iceland. The image combines shortwave infrared, near infrared, and green light to distinguish between cooler ice and steam and hot extruded lava. The Bárðarbunga caldera, visible in the lower left of the image under the ice cap, experienced a large-scale collapse starting in mid-August. Image credit: USGS

Under the ARIA umbrella, Caltech and JPL/NASA had already formed a collaboration with the Italian Space Agency (ASI) to use its COSMO-SkyMed (CSK) constellation (consisting of four orbiting X-Band radar satellites) following such events.

Through the ASI/ARIA collaboration, the managers of CSK agreed to target the activity at Bárðarbunga for imaging using a technique called interferometric synthetic aperture radar (InSAR). As two CSK satellites flew over, separated by just one day, they bounced signals off the ground to create images of the surface of the glacier above the caldera.

By comparing those two images in what is called an interferogram, the scientists could see how the glacier surface had moved during that intervening day. By the evening of August 28, Simons was able to pull up that first interferogram on his cell phone. The interferogram revealed that the ice above the caldera was subsiding at a rate of 50 centimeters (more than a foot and a half) a day—a clear indication that the magma chamber below Bárðarbunga caldera was deflating.

The next morning, before his return flight to the United States, Simons took the data to researchers at the University of Iceland who were tracking Bárðarbunga's activity.

"At that point, there had been no recognition that the caldera was collapsing. Naturally, they were focused on the dyke and all the earthquakes to the north," said Simons. "Our goal was just to let them know about the activity at the caldera because we were really worried about the possibility of triggering a subglacial melt event that would generate a catastrophic flood."

Luckily, that flood never happened, but the researchers at the University of Iceland did ramp up observations of the caldera with radar altimetry flights and installed a continuous GPS station on the ice overlying the center of the caldera.

Last December, Icelandic researchers published a paper in *Nature* about the Bárðarbunga event, largely focusing on the dyke and eruption. Now, completing the picture, Simons and his colleagues have developed a model to describe the collapsing caldera and the earthquakes produced by that action. The new findings appear in the journal *Geophysical Journal International* (gji.oxfordjournals.org/).

"Over a span of two months, there were more than 50 magnitude-5 earthquakes in this area. But they didn't look like regular faulting—like shearing a crack," said Simons. "Instead, the earthquakes looked like they resulted from movement inward along a vertical axis and horizontally outward in a radial direction—like an aluminum can when it's being crushed."

To try to determine what was actually generating the unusual earthquakes, Bryan Riel, a graduate student in Simons's group and lead author on the paper, used the original one-day interferogram of the Bárðarbunga area along with four others collected by CSK in September and October. Most of those one-day pairs spanned at least one of the earthquakes, but in a couple of cases, they did not.

That allowed Riel to isolate the effect of the earthquakes and determine that most of the subsidence of the ice was due to what is called aseismic activity—the kind that does not produce big earthquakes. Thus, Riel was able to show that the earthquakes were not the primary cause of the surface deformation inferred from the satellite radar data.

"What we know for sure is that the magma chamber was deflating as the magma was feeding the dyke going northward," said Riel. "We have come up with two different models to explain what was actually generating the earthquakes."

In the first scenario, because the magma chamber deflated, pressure from the overlying rock and ice caused the caldera to collapse, producing the unusual earthquakes. This mechanism has been observed in cases of collapsing mines (e.g., the Crandall Canyon Mine in Utah).

The second model hypothesizes that there is a ring fault arcing around a significant portion of the caldera. As the magma chamber deflated, the large block of rock above it dropped but periodically got stuck on portions of the ring fault. As the block became unstuck, it caused rapid slip on the curved fault, producing the unusual earthquakes.

"Because we had access to these satellite images as well as GPS data, we have been able to produce two potential interpretations for the collapse of a caldera—a rare event that occurs maybe once every 50 to 100 years," says Simons. "To be able to see this documented as it's happening is truly phenomenal."

Additional authors on the paper, *The collapse of Bárðarbunga caldera, Iceland*, are Hiroo Kanamori, John E. and Hazel S. Smits Professor of Geophysics, Emeritus, at Caltech; Pietro Milillo of the University of Basilicata in Potenza, Italy; Paul Lundgren of JPL; and Sergey Samsonov of the Canada Centre for Mapping and Earth Observation.

The work was supported by a NASA Earth and Space Science Fellowship and by the Caltech/JPL President's and Director's Fund.

About ARIA

ARIA is a collaboration between JPL and Caltech to exploit radar and optical remote sensing, GPS, and seismic observations for hazard science and response.

ARIA investigates the processes and impacts of earthquakes, volcanoes, landslides, fires, subsurface fluid movement and other natural hazards by applying modern geodesy, merged with ground-based observations, to improve society's resilience.

ARIA develops state-of-the-art ground deformation measurements, change detection methods and physical models using GPS and synthetic aperture radar observations, automating the required large scale processing, and producing basic data products for the science community. Additional information is available at aria.jpl.nasa.gov/.

An Intelsat General Perspective: Open Or Closed HTS Architecture?

By Chris Hudson, Senior Technical Advisor, Intelsat General Corporation

The new high throughput satellite (HTS) systems that have been announced or deployed have created great anticipation among satellite customers for major performance improvements.

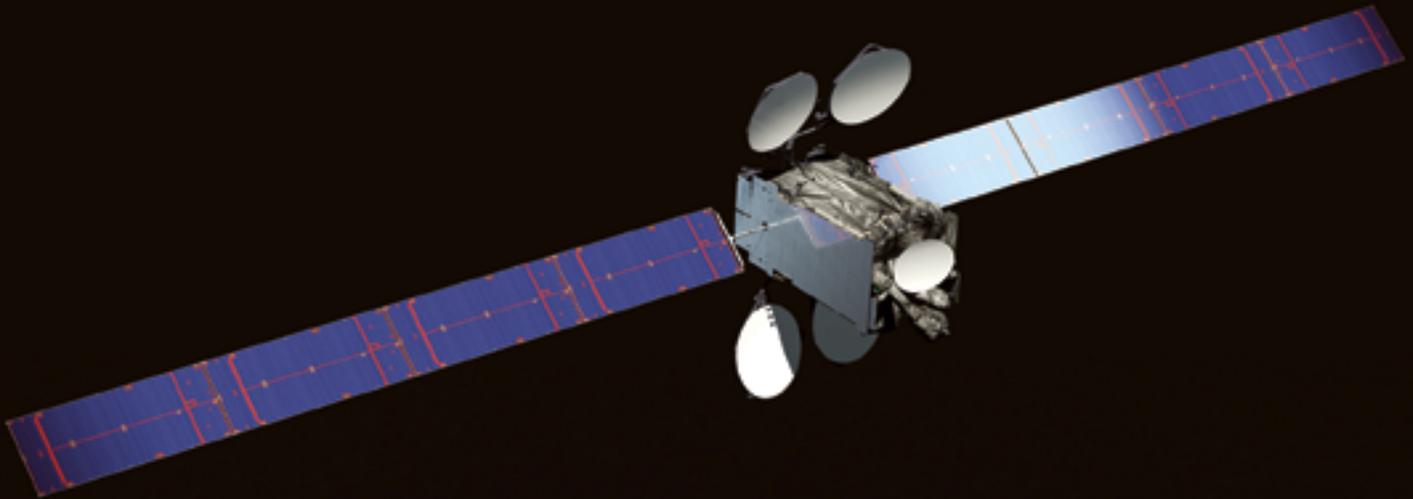
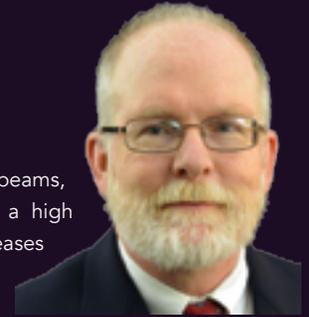
While the messaging has often focused on a satellite's aggregate gigabits per second (Gbps), there is more to these HTS systems than raw capacity. Customers also need to examine the architectures underlying the service offerings to ensure they match their specific communication needs. This architectural review should include the topologies, ground technologies, and service level agreements (SLAs) supported.

HTS satellites are indeed throughput game changers, positioning large amounts of capacity in space at only an incremental cost increase over widebeam satellites. Both Ku- and Ka-band HTS systems offer these significant increases in Gbps per satellite.

HTS satellites do this by using small spot beams, which improve bits/Hertz efficiency, and a high factor of frequency re-use, which increases the aggregate amount of Hertz. This is a win-win for satellite operators and their customers.

Beyond this, customers need to understand how those Gbps can be accessed and utilized. A critical question to answer is whether an HTS offering is 'open' or 'closed.' Each type has common characteristics in terms of topologies, technologies and services supported.

Closed HTS architectures include ViaSat, Inmarsat Global Xpress, Hughes Network Systems Jupiter, and Eutelsat KA-SAT.



Artistic rendition of the Intelsat 29e, the first of the company's Intelsat Epic^{NG} satellites. Image is courtesy of Intelsat.

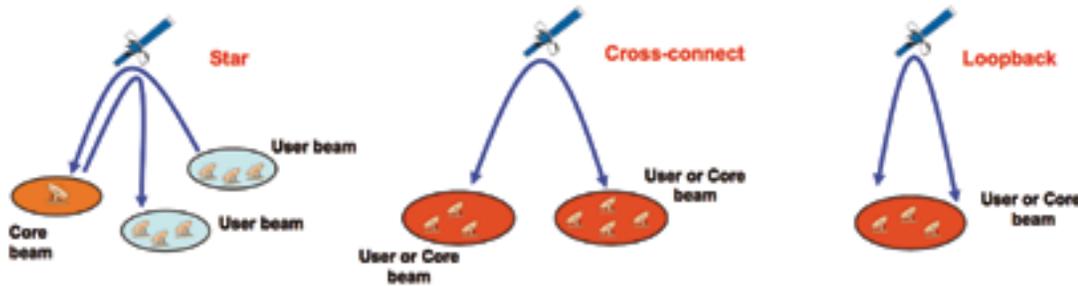
Technical Element: Architecture

HTS designs may allow for **closed** or **open** network architectures.

Intelsat Epic^{NG} is **open** architecture

Ground technology / platform is **open**

Intelsat Epic^{NG} supports many **beam** topologies



...and within that, supports **star** and **mesh** network topologies

Intelsat is working with a variety of service providers who are using Epic^{NG} to provide a **variety of end user solutions.**

As such, closed HTS services have to limit what can be guaranteed. Limits may include no guarantee of achieving the maximum throughput (it is best effort) or no guarantee of the availability of a circuit (e.g., a voice line or a 512 kbps duplex link).

In open HTS architectures, users can purchase dedicated capacity for their terminal or group of terminals. The throughput of that capacity is dedicated and available to only the user's terminals. As such, maximum throughput capabilities can be guaranteed.

This is analogous to residential versus enterprise terrestrial broadband service. With a residential cable connection, a

Open HTS architectures include Intelsat Epic^{NG}, Telesat VANTAGE and Inmarsat High Capacity Overlay (HCO).

A closed HTS architecture requires a star topology. This means all remote terminal traffic must route via one of a limited number of gateways or access stations. This is similar to commercial airline travel, where one must travel through an airline's hub to reach a certain city even if that is not the shortest distance to your final destination. Closed architectures do not allow loopback within a satellite beam or customer beam-to-customer beam topologies.

Open architectures, such as Intelsat Epic^{NG}TM, support multiple connection topologies. Traffic from a user beam can be routed loopback to the same user beam, cross-connect to another user beam, or reach back to a core beam.

Inmarsat HCO supports loopback and reach-back topologies. Within these beam connections, both star and mesh traffic topologies are supported. Please see *Figure 1* above.

On the ground, closed architecture HTS systems require that all terminals use common equipment. Each closed HTS service is based upon a single platform and all terminals must use that platform.

Open HTS systems differentiate themselves by allowing users to select their preferred ground equipment, be that an installed base or a newly selected deployment. The ability to use existing ground equipment in open systems can lead to substantial cost savings for the customer.

These ground equipment differences also influence what service level agreements can be supported. Closed architecture HTS are shared services. Terminals from multiple independent users, or user groups, share a common pool of satellite resources. Those same terminals however, demand throughput in their own, independent, ways.

group of houses share one hub and its bandwidth.

Throughput to a specific house is dependent upon how heavily the other houses are using the shared connection. The open alternative is analogous to enterprise broadband which is provided via a direct connection, not shared, and can guarantee throughput levels.

In summary, customers evaluating HTS options should understand not only a system's capacity but also how those Gbps can be used to meet specific needs. Here's a list of potential questions to consider:

- **To where must the remote terminals connect? In theater? Reach back? Both?**
- **Can the HTS provide all required connectivities in a single satellite hop?**
- **What ground hardware must be used to access the HTS?**
- **Is the ground hardware appropriate for the needs?**
- **Can existing assets be leveraged or will new investment be required?**
- **Can the HTS Gbps be purchased and utilized in a manner that provides the guaranteed throughputs and availabilities required by the mission?**

For those interested in maximum flexibility in connectivities, ground equipment and SLAs, open systems such as Intelsat Epic^{NG} truly deliver the solutions in a most complimentary manner.

www.intelsatgeneral.com/

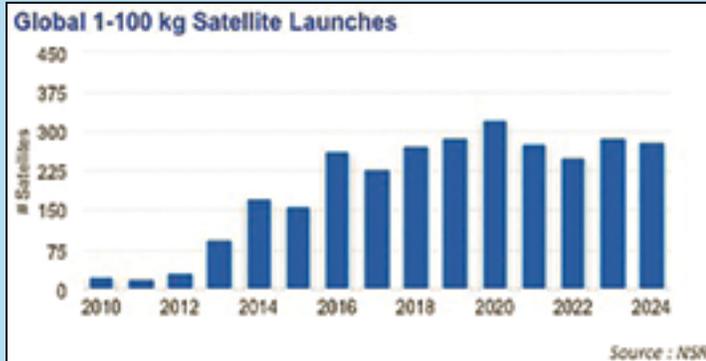
Editor's Note: Our thanks to Intelsat General for allowing us to republish this article from their SatCom Frontier blog.

Nano + Microsatellite Size Belies Magnitude Of Impact

By Carolyn Belle, Analyst, NSR

Nano and microsatellite launches have increased at a 61 percent compound annual growth rate since 2010; the number of unique operators launching these satellites has increased at a 31 percent CAGR over the same period.

With these unprecedented growth rates, nano and microsatellites from 1 to 100 kg. have become a central talking point of the space sector. However, even if the size of the platforms may be smaller, their impact on the industry could be large.



Originally used as the world's first satellites in the 1950s and 1960s, government agencies, militaries, and, most recently, commercial players have once again begun to leverage these small platforms for operational missions. During the next decade, NSR forecasts the launch of more than 2,500 such satellites.



What does this high volume market signify for the satellite industry at large?

As explored in NSR's Nano and Microsatellite Markets, 2nd Edition report (<http://www.nsr.com/research-reports/commercial-space/nano-and-microsatellite-markets-2nd-edition/>), operators are taking novel approaches at all stages across the satellite project value chain. The effects of these, from rapid design iterations to higher risk tolerance and the cultivation of new end-users, have already begun to be felt. The ultimate impact of nano and microsatellites will stem not only from the unique capabilities and processes associated with the form factor itself, but from the ecosystem of new players that are engaged in creating these satellites.



Reassessing Manufacturing + Launch Operations

More than 80 percent of nano and microsatellites launched since 2010 were manufactured in-house. Comparatively, only 5 percent of traditional, >100 kg. satellites launched over the same period were manufactured in-house (excluding Chinese and Indian state-run industries).

Inherent characteristics resulting from nano and microsatellites' small size, including; an often simpler design, short lifetime, use of COTS components/commercial software, and limited pre-launch testing, enable this in-house construction. When combined with the greater risk acceptance, CAPEX limitations, and rapid build cycle goals of new operators, in-house manufacturing in many cases becomes the most viable practice. Operators thereby enhance control of their system architecture and gain previously inconceivable agility in satellite redesign to adjust capabilities based on performance or evolving market demand.

However, given the short on-orbit lifetimes and rapidly evolving state-of-the-art, this trend towards fast development time and incremental design improvements is characteristic of the nano/microsatellite market as a whole. Replacement on the order of years instead of decades means that nano/microsatellites consistently leverage more up-to-date technology than their larger counterparts.

The popularity of constellations and standardized platforms (CubeSats) within this mass range has prompted a shift towards volume manufacturing facilities and assembly line production that is more pronounced than what has emerged for constellations of larger satellites, such as Iridium,

Orbcomm, and Globalstar. Again, the short lifetime and sustained replenishment demand compounds this trend.

Demand for launch services has stimulated the development of a new class of launch vehicle that is optimized for low mass satellites. For instance, Bessemer Venture Partners has explicitly linked its motivation for investing in Rocket Labs directly to the challenge of obtaining launch slots for the ~120 kg. Skybox satellites. A secondary, more immediate impact of rising nano/microsatellite launch demand is the emergence of third party launch brokerage services to coordinate rideshare capacity on traditional vehicles.

Expanding The Addressable Market

The low cost and short lifetime of small satellites, particularly when operated individually, significantly decrease the required scope of a sustainable business plan. This widens their applicable field of use from more traditional satellite applications like Earth imaging, data relay, or AIS signal detection to such areas as marketing or cultural enrichment—just search for images of the Hello Kitty figurine launched in 2014 on a Japanese microsatellite to stimulate national interest in space, or for opera broadcasts from an American CubeSat launched the same year, or the establishment of an artist-in-residence program at PlanetLabs to witness the more intangible stamp of the innovation behind this emerging market.

Even within traditional applications and services, the lower price points, simplified customer ease-of-use, and the improved coverage rates all enable commercial nano/microsatellite operators to cater to untouched markets and to expand the space services industry.

Entities previously priced out of the satellite market, or whose requirements were not fully addressed by existing capabilities, have become customers of nano/microsatellite projects—such as non-profits researching natural resource depletion, or energy companies requiring daily pipeline monitoring.

Alongside greater potential for diverse applications, low barriers to entry facilitate a broader operator base that has included players without prior space sector experience. This new community of operators brings creativity and, as has been notable with Silicon Valley space firms, can make the space sector more approachable to both new potential customers and investors. This effect is compounded by the short development times of these platforms that enable a new idea to be brought to market on the order of months rather than the requisite years for their larger counterparts.

Globalizing Access To Space

Small satellite projects are sufficiently limited in scope and risk to be particularly suited to the development of space capabilities. Not only a trend noted today, more than 15 leading space economies including the United States and Russia (as USSR) have leveraged this form factor for their first domestically built satellites.

This can be undertaken through government-led programs or support for university projects, both of which develop a workforce with hands-on space mission experience that forms the basis for domestic industry.

Developing space regions (Latin America, Middle East & Africa, and Southeast Asia) have successfully launched 22 nano/microsatellite missions since 2010, though not all have achieved nominal operations in orbit.

Ten developing space economies in these regions have utilized nano/microsatellites as their first domestically built platform. The rate at which this has increased since 2010 indicates that additional countries will pursue similar capacity building models moving forward. The Latin America and Middle East & Africa regions are expected to boost activity to 17 percent of the global market by 2024.

Whether the motivation for cultivating domestic space capabilities is institutional, economic, or strategic, the opportunities provided by nano/microsatellites are growing the number of countries that see space within their reach. Once the initial capabilities are established, these nations are expected to continue developing expertise and engaging in the space economy, potentially domesticating or regionalizing a satellite manufacturing and operations market currently dominated by few foreign players.

Bottom Line

The new players and processes tied to nano and microsatellites have already made a mark on today's space industry. New manufacturing practices, target markets, and regional skill development stemming from these small platforms have shown the potential for nano and microsatellites to affect space sector dynamics at a magnitude beyond their size.

Yet the duration and significance of their impact remain to be seen, and whether these will transition into industry norms or merely become a passing trend, depends on the success of current ventures and applicability to broader use.

In the meantime, interest in smallsats such as nanos and micros continues to develop as the community is challenged to establish their role in the space sector and the economy at large.

Ms. Belle joined NSR as an analyst with several years of experience in the space industry, ranging from atmospheric chemistry to education outreach and market research. Her main focus is satellite manufacturing and launch markets, and in particular the trends surrounding creation of diversified space architectures. She also contributes to research in government and military communications markets in addition to participating in the diverse tailored consulting projects undertaken at NSR.

