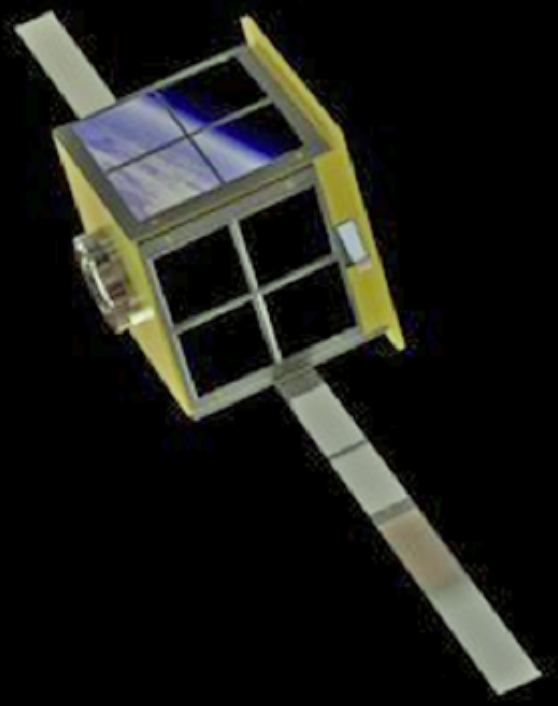
Worldwide Satellite Magazine — July / August 2016

SatMagazine



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July / August 2016

Table of Contents

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Advertiser Index

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A Pack Of Sats Impelled By India's PSLV-C43

In the thirty-sixth flight (PSLV-C34), ISRO's Polar Satellite Launch Vehicle successfully launched the 727.5 kg Cartosat-2 Series satellite along with 19 co-passenger satellites on June 22, 2016, from Satish Dhawan Space Centre SHAR, Sriharikota, India.

This is the 35th consecutively successful mission of PSLV and the 14th in the 'XL' configuration.

The total weight of the 20 satellites carried on-board PSLV-C34 was 1288 kg.

After the PSLV-C34 lift-off at 0926 hrs (9:26 am) IST from the Second Launch Pad with the ignition of the first stage, the subsequent important flight events, namely, strap-on ignitions and separations, first stage separation, second stage ignition, heat-shield separation, second stage separation, third stage ignition and separation, fourth stage ignition and cut-off, occurred as planned.

After a flight of 16 minutes 30 seconds, the satellites achieved a polar Sun Synchronous Orbit (SSO) of 508 km inclined at an angle of 97.5 degree to the Equator (close to the intended orbit).

In the succeeding 10 minutes, all 20 satellites successfully separated from the PSLV fourth stage in a predetermined sequence.

After separation, the two solar arrays of Cartosat-2 series satellite were deployed automatically and ISRO's Telemetry, Tracking and Command Network (ISTRAC) at Bangalore took over the control of the satellite.

In the ensuing days, the satellite was brought to final operational configuration following which it will begin to provide remote sensing services using its panchromatic (black and white) and multispectral (color) cameras.

The imagery sent by the Cartosat-2 series satellite will be useful for cartographic applications, urban and rural applications, coastal land use and regulation, utility management like road network monitoring, water distribution, creation of land use maps, precision study, change detection to bring out geographical and manmade features and various other Land Information System (LIS) and Geographical Information System (GIS) applications.

Of the 19 co-passenger satellites carried by PSLV-C34, two—SATHYABAMASAT weighing in at 1.5 kg—and SWAYAM—weighing 1 kg—are University Academic institute satellites.

These satellites were built with the involvement of students from Sathyabama

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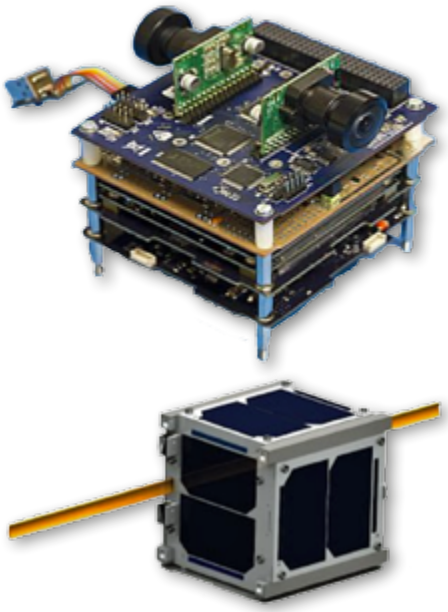


Top: SATHYABAMASAT smallsat.
Bottom: SWAYAM smallsat.

University, Chennai, and College Of Engineering, Pune, respectively.

The 17 co-passenger satellites were international customer satellites from Canada (2), Germany (1), Indonesia (1) and the United States (13).

With this successful launch, the total number of satellites launched by India's workhorse launch vehicle PSLV has reached 113, of which 39 are Indian and the remaining 74 are from abroad.

The Cartosat-2 series satellite (*image below*) was the primary satellite carried by PSLV-C34.

This satellite is similar to the earlier Cartosat-2, 2A and 2B.
After injection into a 505 km polar SSO by PSLV-C34, the satellite was brought to operational configuration.

India's university and academic institute satellites included...

The SATHYABAMASAT, from Sathyabama University in Channai, India, will collect data on greenhouse gases, such as water vapor, carbon monoxide, carbon dioxide, methane and hydrogen fluoride.

The SWAYAM, from the College of Engineering, Pune, will provide point-to-point messaging services for the HAM community.

Canada's Maritime Monitoring and Messaging Microsatellite (M3MSat) was a member of this successful launch by the ISRO from Sriharikota, India, along with another Canadian satellite owned by GHGSat Inc.

The M3MSat mission will improve ship detection and marine traffic management in Canadian waters by testing new technologies including an innovative antenna designed by the University of Waterloo that promises improved identification of ships and better resolution between conflicting Automatic Identification System (AIS) signals in regions with high maritime traffic.

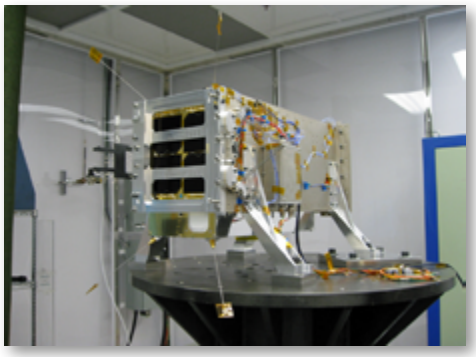
M3MSat was developed jointly by the CSA and Defence Research and Development Canada (DRDC) to meet complementary objectives.

The satellite was built by COM DEV Ltd. (now Honeywell Canada), an Ontario-based company, with support from the University of Toronto Institute for Aerospace Studies and the University of Waterloo

Once commissioned, the satellite will be owned by DRDC and operated from the Satellite Operations Centre at CSA headquarters in Longueuil, Quebec

The CSA is testing new instruments on M3MSat. One ensures data continuity on the passage of ships in remote areas when AIS receivers cannot provide live coverage, and the other will measure static energy accumulated in satellites' electronics to improve the way the health and safety of satellites is monitored.

The Honorable Navdeep Bains, Minister of Innovation, Science and Economic Development, said, "*The launch of M3MSat and GHGSat's 'Claire' will test technological advancements in important fields. While M3MSat will help our country better manage navigation in Canadian waters, Claire aims to improve our understanding of industry's impacts on our environment.*



GHGSat's Claire smallsat.

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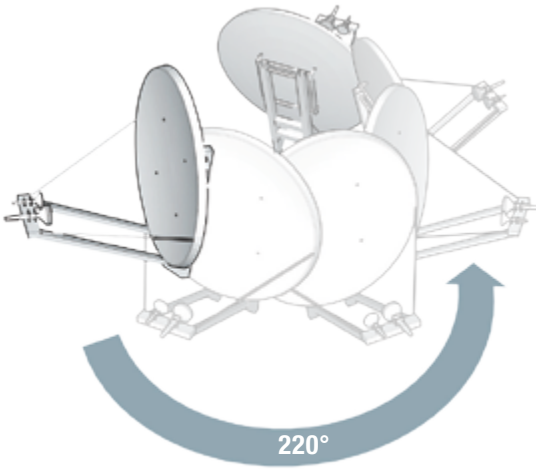

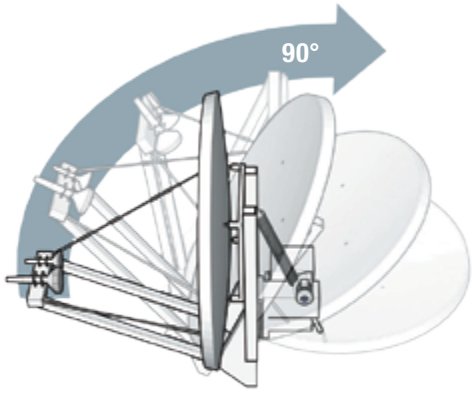

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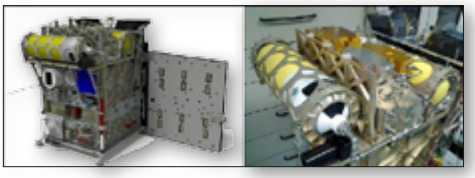
The launch also included 'Claire', the first demonstration satellite by Montreal-based GHGSat Inc. The microsatellite will test a new way to measure greenhouse gas emissions from industrial facilities.

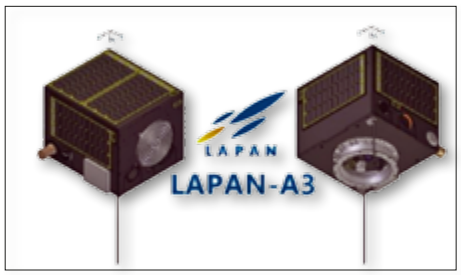
Other satellites on this journey included...



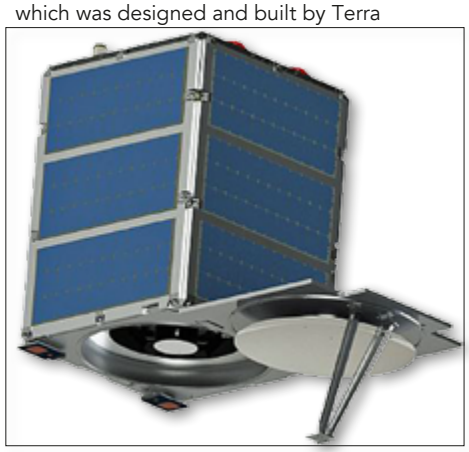
DLR's BIROS smallsat.

BIROS (Berlin Infrared Optical System) is a small scientific satellite from the German Aerospace Center (DLR). The main mission objective is the remote sensing of high temperature events.

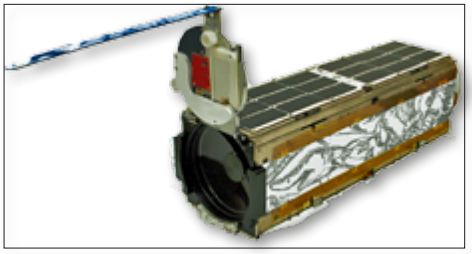
LAPAN-A3, an Indonesian microsatellite for EO (multi-spectral remote sensing) for land use, natural resource and environment monitoring was also sent skywards.



Then there was the SkySat Gem2-1, which was designed and built by Terra Bella, a Google company—this satellite will be capable of capturing sub-meter resolution imagery as well as HD video.



Terra Bella's SkySat Gem2-1.



A Planet Lab Dove smallsat.

And 12 Planet Labs' Dove satellites, that comprised Flock-2P, all Earth imaging craft, all of which were carried inside three QuadPack dispensers.

The ISRO's record setting PSLV-C34 launch of 20 smallsats.
Photo courtesy of ISRO.

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NewSpace Systems and Oakman Aerospace Plan Smallsat Platform

A South African small satellite component manufacturer just improved their standing and export capabilities to world markets in a pact signed with a US counterpart.

Newspace Systems Pty. Ltd., from Cape Town, South Africa, signed with Oakman Aerospace, Inc., of Colorado, USA, during the 4S Symposium for small Earth observations (EO) satellites which was recently held in Malta. This deal will give the company a competitive edge in the smallsat market.

Both companies are specialists in various fields of the smallsat industry and the partnership will enable them to establish a unique technical platform for the manufacture and operation of small satellites with interchangeable modular components sourced from different suppliers. This will help to extend a satellite's service lifetime and ultimately reduce costs.

Their products will be available to government, commercial, and academic customers across the globe.

This first MoU paves the way for a Master Service Agreement after which they will pursue a Technical Assistance Agreement through the United States Department of State Directorate of Defense Trade Controls (DDTC).

"*This pact is not only about extending our business and increasing exports for our country but also recognition of African capability in the sophisticated high-tech small satellite market,*" said James Barrington-Brown, CEO of NewSpace Systems (NSS), which has already secured some 30 contracts from 11 different countries.

Stanley Kennedy, President and Chief Systems Engineer for Oakman Aerospace, Inc (OAI), commented on the MoU—"*Oakman Aerospace is enthusiastic for this opportunity to work with NewSpace Systems in developing and advancing modular, open-systems architecture and leveraging the competitive advantage this agreement brings to the United States and world markets.*"

James Barrington-Brown, NewSpace Systems CEO, added, "*With NewSpace's product solutions for the smallsat market, the next logical next step is to focus more directly on the US, which is currently the most significant smallsat community—OAI makes the perfect partner for our next stage of company investment and growth.*"

Oakman Aerospace, Inc., is a veteran, woman-owned business focused on space mission engineering and simulation; mission analysis; orbit design and orbit constellation design; spacecraft design, analysis and simulation; payload design and analysis; and flight software development.

NewSpace Systems, which has their main facility in South Africa and a subsidiary in the UK, has as shareholders Space Commercial Services Aerospace Group, South Africa's largest private satellite company as well as a Dutch investor.

NewSpace Systems operates their own European Space Agency standard Clean Room facility, which is the only one in Africa.

newspacesystems.com
oak-aero.com

Smallsat Surveillance Network Planned By Asian Nations and Universities

The Nikkei Asian Review is reporting that eight Asian nations will team with two Japanese universities to build a network of microsatellites aimed at monitoring the region for natural disasters and other developments.

Hokkaido University and Tohoku University will lead the creation of up to 50 microsatellites by 2020. The devices are 50cm cubes, and weigh around 50kg each—roughly 5 percent of a traditional satellite. Each unit costs around 300 million yen ($2.54 million) to make. The satellites will be launched using Japanese rockets, or released from the International Space Station.

The Philippines, Vietnam, Indonesia, Malaysia, Myanmar, Bangladesh, Thailand and Mongolia will join in the project. The two Japanese universities will pursue memorandum of understanding with government authorities, universities and other organizations in each nation.

The capabilities of any one microsatellite are limited. Each participating country will have a role in launching a number of the devices into orbit between 300 km and 500 km above the Earth's surface, and share the data each collects. Around 25 units are reportedly required to monitor all of Asia.

The devices will be used to photograph the occurrence and aftermath of flooding and other natural disasters, giving a boost to recovery efforts. The satellites' parts were designed by a team including Hokkaido University, and manufactured by small-to-midsize Japanese companies. Two were commissioned from the Philippines, which will contribute 800 million yen to the project.

Those satellites have already been built by a team involving the country's Department of Science and Technology and public university system. They are set to be transported to the International Space Station by this summer and launched from the Japanese-made experiment module, known as Kibo. Each unit is equipped with a camera capable of photographing the Earth's surface with a resolution of 3 meters to 5 meters.

Participating in the plan is a chance for other Asian nations to learn from Japan's relatively developed space industry. Around 10 Philippine technicians were sent to study at the two Japanese universities. Japanese companies can also expect involvement in the project to yield further business in the future.

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No Fooling — Refueling An On Orbit Satellite Is A Chinese First

A major thrust of ongoing interest and development within the satellite industry has been focused on the ability to refuel on orbit satellites as their propulsion fuels are depleted.

China's National University of Defense Technology has now reported that the nation has successfully completed an on orbit refueling of an orbital satellite.

This success enhances both the maneuvering and the functional life of the satellite and was accomplished via the recently launched Tianyuan-1 refueling system.

Tianyuan-1 was built by the aforementioned university and was launched via a Long March-7 launch vehicle on Saturday, July 2, 2016.

China's Wenchang launch center.

The launch occurred on the Wenchang launch center located in South China's Hainan Province.

Wenchang was built in 1970 and was the second such launch center built by China.

As proof of this accomplishment, various processes were tested and then examined to fully validate the complex satellite instruction sets and the resultant data—videos recording the entire process were then beamed back to Earth, according to a university spokesperson.

China is now among the first nations to triumph in the area of satellite refueling and repurposement.

Though an area of great interest, the process is complicated and only a few countries have began on orbit satellite refueling and repurposing experiments.

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The Philippines Diwata Smallsat Driven To The ISS

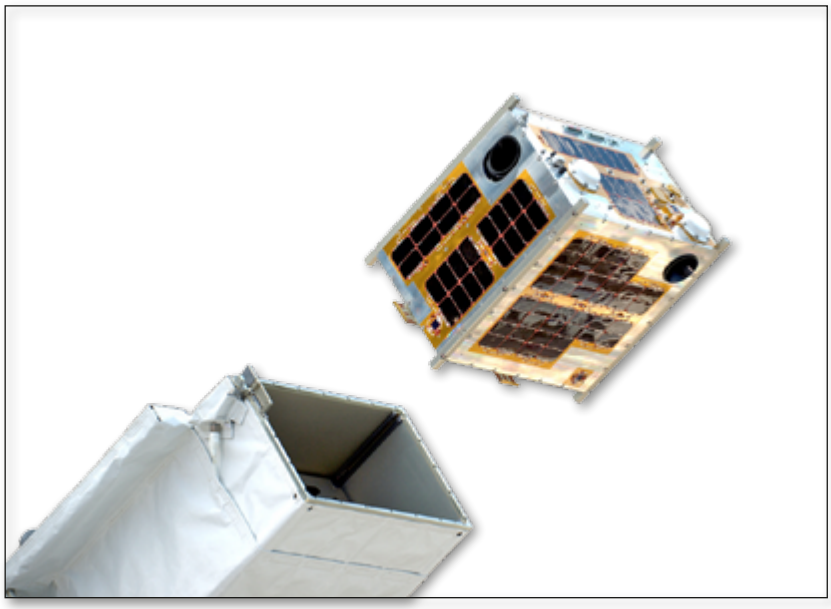
Inquirer.net has reported that the Philippines have sent their third satellite into space.

Diwata, the first Filipino-made and co-developed microsatellite, officially called the Philippine Scientific Earth Observation Microsatellite (Phil-Microsat), was launched from Cape Canaveral Air Force Station in Florida onboard the Orbital ATK Cygnus spacecraft, all part of NASA's fifth resupply mission to the International Space Station.

Philippines Science Secretary Mario Montejo said the launch of the microsatellite further cements the belief that that nation's scientists and engineers can be on par with their foreign counterparts.

The Philippines first had a satellite in space, the privately owned Agila 1, in 1996, which was acquired from Indonesia and was launched from Cape Canaveral in 1991.

The second Philippine satellite was Agila 2, also for communications, privately owned and launched from Sichuan, China, in 1997 and is now called ABS-3 after Mabuhay Satellite Communications, a subsidiary of Philippine Long Distance Telephone Co., sold it to Bermuda-based Asia Broadcast Satellite Holdings Ltd. for P400 million in 2009.



The Diwata smallsat being released from the ISS. Image is courtesy of NASA / ESA.

Carlos Primo David, executive director of the Philippine Council for Industry, Energy and Emerging Technology Research and Development, said that Diwata was housed in the Japanese Experiment Module before the smallsats was released into orbit in early April.

"*By the time Diwata has been released into orbit, we will have full control of it. Initially, this will be controlled by our Filipino engineers who are stationed at Tohoku, Japan*," David told reporters.

He added that control of Diwata will be transferred to the Philippine Earth Data Resources Observation (Pedro) in Subic, Zambales province, which will receive and store data sent by the satellite.

The expectation is that Diwata will remain in orbit for about 20 months and will capture an average of 3,600 high-resolution images of the Philippines daily using its four cameras.

Phil-Microsat program head Joel Marciano Jr. explained that Diwata is equipped with a high-precision telescope that is capable of determining the extent of damage from disasters; a space-borne multispectral imager with liquid crystal tunable filter that could monitor changes in vegetation and ocean productivity; a wide-field camera that could observe cloud patterns and weather disturbances; and a middle-field camera, an engineering payload that would be used to assist in determining the location of each image captured by the other optics.

Diwata's launch came after Filipino scientists and DOST officials turned over the microsatellite to their counterparts at the Japan Aerospace Exploration Agency, who sent the device to NASA after conducting final tests on the craft's space worthiness.

SCIENTISTS from the University of the Philippines and Department of Science and Technology officials turn over Diwata, the first Filipino co-developed microsatellite, to their counterparts at the Japan Aerospace Exploration Agency in Tsukuba City, Japan.

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Blue Canyon Technologies Provides Smallsat Precision

In its first flight, the XACT attitude control system from Blue Canyon Technologies (BCT) is providing high-performance guidance, navigation, and control to the orbiting Miniature X-ray Solar Spectrometer (MinXSS) smallsat.

A 3U CubeSat funded by NASA and led by the University of Colorado's Laboratory for Atmospheric and Space Physics, MinXSS requires precision pointing to carry out its scientific objectives.

Integrating an array of high-performance miniaturized space sensors and actuators, including BCT's Nano Star Tracker and Micro Reaction Wheels, the XACT unit provides state-of-the-art attitude control for small spacecraft like MinXSS.

Blue Canyon's XACT Attitude Determination Control System.

On orbit telemetry from the XACT unit and independent spacecraft instrumentation indicates 1-sigma cross-axis pointing error better than 8 arcseconds, which is less than the width of the Empire State Building as viewed from Los Angeles.

MinXSS was deployed from the International Space Station on May 16th and is designed to collect soft X-ray emissions from the sun that will help scientists better understand space weather in which solar storms impact our space-based technology such as communication and navigation systems.

The mission exemplifies the increasing capability of low-cost CubeSat missions, which have proliferated as enabling technology has developed.

Over the coming years, BCT's XACT attitude control system and XB-1 spacecraft bus are slated for dozens of flights in support of a wide array of scientific, commercial, and defense missions.

bluecanyontech.com/

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Optical Communications To Be Developed For Smallsats

LGS Innovations has been awarded a contract to develop a prototype pair of lightweight, low-power optical communication terminals that will allow for light-based communication between smallsats in Low Earth Orbit (LEO).

Under the terms of the contract, LGS will be responsible for developing a pair of laser communication terminals to be launched on two Defense Advanced Research Projects Agency (DARPA) small satellites.

The terminals are to be extremely lightweight, weighing less than two pounds each, and will operate on less than three watts of power.

This is the second DARPA contract announced by LGS in recent weeks and is in support of the Inter-Satellite Communication Link project, which seeks to enable direct communication within constellations of small satellites (weighing less than 100 pounds each).

Once completed and deployed, the terminals will allow for jam-resistant, high-data-rate, low-latency communication within a network of hundreds of small satellites.

Kevin Kelly, the CEO of LGS Innovations, indicated that small satellites represent the next generation of global communication technologies, with a constellation of smallsats that can communicate with one another able to improve the armed forces' ability to send and receive data quickly, safely, securely and at the lowest cost.

According to Dr. Linda Braun, the Vice President of LGS Innovations Photonics Applications & Development, the feasibility of high-bandwidth, laser communications between satellites will be demonstrated through this project.

"This is increasingly viewed as an essential part of the DoD's communication network, because of their lower cost and higher survivability," she added.

lgsinnovations.com/

Dawn — Mission Completed

Orbital ATK, Inc. is celebrating the achievements of NASA's Dawn as the deep space exploration spacecraft's primary mission is successfully completed.

Designed and built by Orbital ATK, Dawn is in the ninth year of this historic journey, which is advancing human understanding of planetary formation and revealing new mysteries of the solar system. Dawn is the first mission of its kind, relying on solar electric ion propulsion, the world's most advanced and efficient space propulsion technology, to travel to and orbit two interplanetary bodies in the main asteroid belt between Mars and Jupiter.

Orbital ATK's Space Systems Group designed and built Dawn at the company's facilities in Dulles, Virginia. Launched from Cape Canaveral, Florida in September 2007, Dawn embarked on a two-stop, interplanetary mission. During its nearly decade-long journey, Dawn traveled more than 3.5 billion miles or the equivalent of 140,000 trips around Earth's equator. The spacecraft delivered troves of important data to scientists worldwide with the first-ever, up-close look at two planetary bodies that date back to the formation of the solar system. In recognition of these achievements, the Dawn Project Team received prestigious awards, including the 2015 Robert J. Collier Trophy and the 2016 National Space Club's Nelson P. Jackson Award.

In July 2011, Dawn reached its first destination, Vesta, the second most massive object in the main asteroid belt. It spent nearly 14 months orbiting and mapping Vesta, returning more than 30,000 images and other measurements of the protoplanet. In September 2012, Dawn departed Vesta in pursuit of its second destination, the dwarf planet Ceres, previously known as the largest unexplored world of the inner solar system. Dawn entered orbit around Ceres in March 2015.

Since then, Dawn has returned nearly 40,000 images of intriguing topographical features, including the now-famous bright areas believed to be salt concentrations on the surface of Ceres. The quality of all images collected from both Vesta and Ceres substantially exceeded resolution previously available from the ground-based W.M. Keck Observatory and NASA's Hubble Space Telescope. In fact, many of the images Dawn returned are more than 800 times the resolution available from Hubble observations.

Dawn's mission is managed by the Jet Propulsion Laboratory for NASA's Science Mission Directorate in Washington and is a project of the directorate's Discovery Program, which is managed by NASA's Marshall Space Flight Center in Huntsville, Alabama. The University of California at Los Angeles (UCLA) is responsible for overall Dawn mission science.


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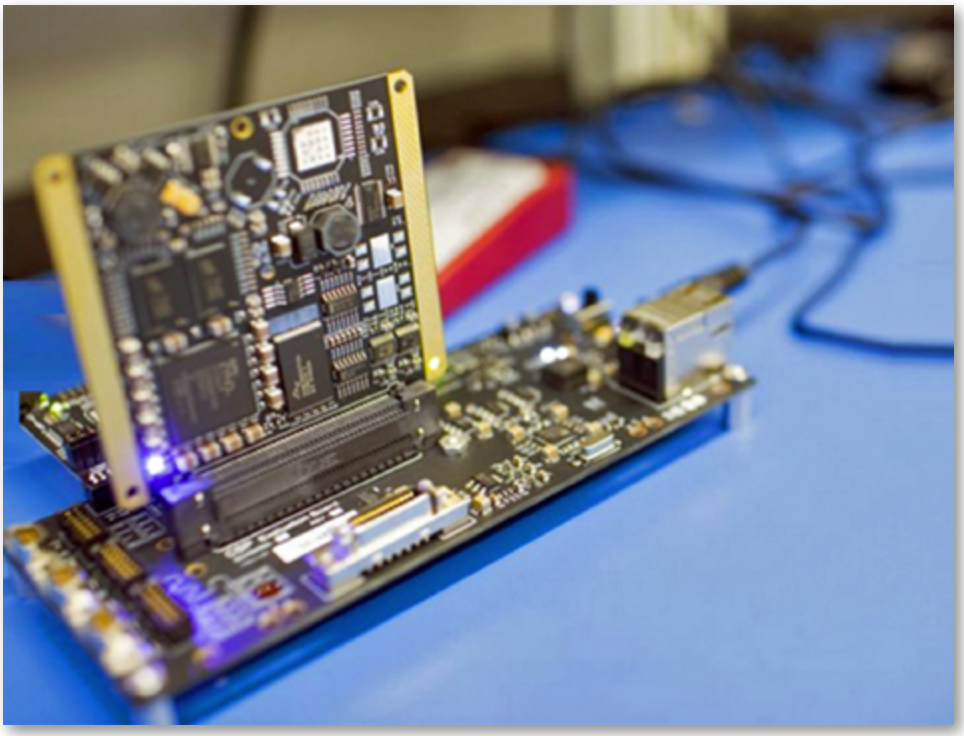
The LunaH-Map Nano Being Brought To Fruition



Arizona State University's LunaH-Map smallsat at the board level.

Elizabeth S. Eaton of the Arizona Republic's online infosite posted a feature that highlights the work being done at the University of Arizona for their LunaH-Map CubeSat.

If the size and scope of the Apollo missions are comparable to Imperial Star Destroyers, then the CubeSat being built at Arizona State University is like the probe droid that was sent to Hoth. The spacecraft are built to gather information on a more focused set of questions because their size limits what they can accomplish in space.

Craig Hardgrove is the principal investigator of the ASU-based mission which is called LunaH-Map because of the craft's goal to map the distribution of hydrogen on the moon.

A little less than a year ago, LunaH-Map was selected by NASA as one of 13 CubeSat missions to be launched in 2018.

In May, the team's lab officially opened up shop on campus. Hardgrove and his team recently began to assemble the spacecraft. They've made progress on the communication system that will eventually have to fit into the satellite, he said.

Currently, however, the wires and hardware that litter the tabletops don't seem like they could ever be condensed to fit inside such a small craft.

The radio and the "brain" of the soon-to-be CubeSat are laid out on two boards. While the pieces are being assembled, they're referred to by the more apt name—FlatSat.

A FlatSat, Hardgrove said, is like "if you took the whole box and spread it out on the table. It's not meant to simulate the mechanical function or how everything's going to fit together, but it represents how it'll talk."

Getting the two systems to communicate was a small but important achievement in the early stages of design, Hardgrove said. Getting them to fit, however, will be a whole separate odyssey.

Igor Lazbin, the chief engineer for LunaH-Map, is in charge of packaging together all the components of the CubeSat so the smallsat will make it to the moon.

The team has to work within specific weight and volume requirements—Lazbin said he's constantly in the process of selecting what and what not to put inside the satellite.

He said that they'd like to include more functionality and do more things, but are pretty heavily restricted by size and mass.

"I think NASA is hoping for these very tiny spacecraft to play a role in space exploration, even large missions in the future," Hardgrove said.

asu.edu/
http://www.azcentral.com/

Tyvak International Embarks Upon Smallsats Study

The European Space Agency (ESA) has selected Tyvak International SRL—an originator of nanosatellite technology—to demonstrate the feasibility of having nanosatellites provide autonomous inspection and support services on the International Space Station (ISS) while in orbit.

Tyvak International will serve as the prime contractor for the "Multi-Purpose CubeSat at International Space Station (ISS)" study, conducted under the ESA General Studies Program (GSP), meant to serve as a proving ground for the Agency's future space-based activities.

Tyvak International was selected for this program because of the firm's knowledge of the nanosatellite industry and prior experience working on similar demonstrations. The ESA study is expected to be complete by early fall 2016.

Nanosatellites have the capability of providing multi-purpose platforms that can be deployed, retrieved, and refurbished by astronauts or robotically in the ISS environment. As part of this contract, Tyvak Nanosatellites will:

- ***Develop a conceptual design for the ISS base platform***
- ***Identify models for the platform's launch to and deployment from the ISS***
- ***Identify logistics needed to support maintenance and refueling of small satellites from the ISS***
- ***Identify safety needs and possible constraints of having small satellite units operating autonomously in the ISS environment***
- ***Plan the optimal path forward to ensure full flight readiness in a short timeframe***

Subcontractors on this study include Politecnico di Torino University, and OHB System AG, Human Spaceflight Department.

Tyvak International CEO Dr. Marco Villa indicated that his firm hopes, one day, to serve as ESA's 'go-to' smallsat provider for inspection and proximity rendezvous missions.

tyvak.eu

Reducing Cost & Improving Performance In... Smallsat Ground Systems

By Matthew Prechtel, Business Area Director, RT Logic, a Kratos Technology + Training Solutions Company

The growth of the smallsat industry has been driven by design and manufacturing advances that have reduced satellite size, production costs and time by orders of magnitude; and by new and cutting-edge launch technologies that are driving down launch costs.

The same transformation has to occur in the ground segment. Similar to large, traditional satellites, smallsats require command and control software, data processing, networking and RF signal processing. What they don't necessarily require is the same degree of complexity and added cost of traditional ground systems designed for large satellites.

Large satellite ground systems are usually procured as a program, with requirements, design reviews and formal acceptance test programs. Smallsat ground systems, on the other hand, are procured like commercial software—smallsat operators evaluate what is available in the market, buy the product that best meets their needs, install that product, get trained, and start using it. If the newly purchased product does not accomplish everything they need, they use product Application Programming Interfaces (APIs) to add the features they want and move on.

This evolution is leading to a new and consolidated approach to smallsat C2 and RF signal processing… one that includes integrated automation of the C2 operations, day to day flight dynamics operations, real-time management of the ground equipment, and enterprise-level management of the network and computer infrastructure itself. In short, a turnkey solution that is simple to install and operate, fits tight budgets and can meet aggressive mission schedules.

This requires optimizing the capabilities for LEO satellite operations and providing powerful operational tools with significant flexibility to be tailored to customers' operations concepts. It also means designing the applications and overall system to be able to scale cost effectively and operate efficiently to support single smallsat operations up to operating satellite fleets with thousands of satellites. Finally, the product must be easy and inexpensive to deploy.

Ground System Requirements

A ground system in general can be broken into three major groups of capabilities, Command and Control (C2), Baseband, and Radio Frequency (RF), shown in *Figure 1* on the next page.

Capabilities required by a space ground system

Starting with the RF subsystem, a ground system needs an antenna and associated electronics for acquisition, tracking, and modulation/demodulation of a spacecraft's RF command, telemetry, and mission data links. The overall goal of the RF subsystem is to convert baseband bits of data into RF waveforms and vice versa.

The next subsystem in the processing chain is the baseband processing function where the bits of data from the RF subsystem (in the case of telemetry) or the bits of data from the command and control subsystem (in the case of commanding) are processed and formatted for use for either transmission by the RF system or consumption by the C2 system.

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The final subsystem moving towards the space operations center is the Command and Control (C2) subsystem. In this subsystem, the processed streams of bits have been formatted into operator understandable telemetry health and status, ready for display at an operator's console. Likewise, commands can be issued from the C2 system either automatically or via operator to manage the spacecraft while on orbit. C2 is a vital element to the architecture and deserving of a discussion of its own.

Three Keys To Reducing Cost In Smallsat Ground Systems

When considering the cost of a small satellite ground system, it's important to look past the purchase price and to also evaluate the sustainment costs of the ground system. In most cases, support is needed to fix issues with the software and hardware systems or to make modifications as the ground and spacecraft system evolves. The satellite program needs to determine if it's more cost effective to maintain engineering support staff for the ground system or to use a vendor's product maintenance and service level agreements (SLAs) to make the necessary changes.

All of these factors combine to influence the make vs. buy decision, therefore for the ground system providers to succeed; they must focus on elimination of cost in the ground architecture on all fronts. Kratos is aware of this trend and has looked into how to drive cost out of the ground system and believes that cost avoidance can be accomplished through three main tenets:

Reduced dependency on hardware based systems

The first tenet focuses on the use of less hardware based systems and more software oriented solutions for meeting ground processing needs. Traditional application of hardware based processing in the ground system typically applies to the modem and front end processing systems. For example, it's not uncommon for a narrow band, multi-mission TT&C modem to cost north of $100,000. Comparatively, software based solutions generally do not have recurring costs typical of hardware based systems, i.e., maintenance, repair, and so on and, therefore, have a lower cost of goods sold. This encourages price reduction and can help spur adoption of a particular software solution.

Today, many of the typical ground processing functions can be found in 100 percent software form. Specifically, software modems and software FEPs are common in the marketplace. However, there are limitations to these software based solutions. Software performance can be impacted in real-time operations and processing limitations are often constrained by the host platform on which the system is operating. The spacecraft program can mitigate these concerns by moving real time dependencies away from the ground system. Modern spacecraft can include features such as on-board GPS for positioning and timing. This provides a highly accurate time source and avoids the requirement that the ground radio supports ranging which often requires very tight, hardware based timing control. Likewise if the spacecraft has accurate time from GPS, the ground system can issue commands well in advance of time of execution and avoid the custom solutions required for the command release timing problem. In short, by focusing on less hardware and more software and being tolerant of the issues software can have by modifying spacecraft design, a small satellite program can reduce ground system costs through this approach.

Application Of Virtualization Technology

Virtualization is not a new technology by today's standards—it is, however, new to the ground system industry. The benefits of virtualization allow space craft programs to consolidate processing equipment into fewer, yet higher density computer platforms. Virtualization allows ground processing software to run within a minimal hardware footprint and also promotes the use of concepts like Platform As-A-Service (PAAS) offered by non-space companies such as Amazon's EC2 service or Microsoft's Azure service.

The applications must use standard libraries that work on virtual machine hosted operating systems. In addition to the reduction in physical hardware, management of the virtual environments is simplified since the ground system can be managed using a datacenter approach, common in information technology companies. By reducing the amount of physical equipment in the ground system, hardware procurement, maintenance, and refresh costs can be minimized to those ground system functions that absolutely must have supporting hardware.

Figure 2. VMs reduce hardware requirements in the ground system

Elimination Of Integration Labor

The use of software and virtualization technologies in the ground system is instrumental in reducing hardware and labor costs. Integration and test labor costs represent the largest element of cost in a ground system. This is where industry can provide costs savings by lowering upfront costs through pre-integration of COTS software components, compatibility testing with spacecraft radio providers and bus systems, and amortizing sustainment and maintenance costs over multiple users of the same suite of applications.

Furthermore, the smallsat program gains from the common experience of the vendor and their extensive experience providing similar solutions to a wide set of users. This approach ultimately reduces risk both in cost and schedule over building from scratch. A smallsat might have an in-space value of $500,000 to a couple of million dollars, versus a larger satellite which can have an in-space value of $100 to $500 million for commercial satellites, and over a $1 billion for some government satellites. How one manages a <$1M asset that can be replaced within 12 months is quite different from how one manages an asset that costs >$100M and will take two to four years to replace. The three tenets discussed here are intended to make the costs of ground systems commensurate with the value of the smallsat asset.

Mr. Prechtel has over 20 years of experience in management and engineering positions in the satellite and radar industries. At RT Logic, he manages the company's space control center product lines and their integrated small satellite ground system offerings.

Before joining RT Logic, Matt was a Project Manager at ITT Exelis Corporation leading service life extension projects for space track and missile warning phased array radar systems. Matt's education includes a BS in Electrical Engineering from the University of Pittsburgh, an MS in Electrical Engineering from Temple University and an MBA from the University of Colorado at Colorado Springs.

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Executive Spotlight: Curt Blake, President, Spaceflight Inc.

Curt Blake is the President of Spaceflight Services, and previously served as Senior Vice President and General Counsel.

Mr. Blake has led efforts to expand Spaceflight Services global network of launch service providers while building relationships with key commercial— civilian- and defense-related customers. Mr. Blake has more than 25 years of executive experience in high-growth and tech industries, with past experience including a range of senior executive and general counsel roles at Microsoft, Starwave, Corbis and Aldus.

Over the last three years, Mr. Blake oversaw Spaceflight Services first four commercial rideshare launches, on the Antares, Soyuz and Dnepr vehicles, from sales to mission management to launch. Mr. Blake is a current member of the Commercial Spaceflight Federation Board and contributor to numerous small-satellite conferences.

Mr. Blake, would you explain Spaceflight's role within the smallsat industry?

Curt Blake

Spaceflight ensures small satellites are launched and deployed so their operators can access space in a timely and cost-effective manner. We do so by acquiring capacity on launch vehicles that the primary spacecraft does not occupy and then aggregate customer spacecraft that needs to reach the same orbit as the primary spacecraft on a launch and integrate those payloads on the launch vehicle.

As a launch services provider, Spaceflight has been assisting commercial smallsats access space for several years. From your perspective, what state is the smallsat industry in today?

Curt Blake

The US is experiencing a remarkable resurgence in space—it's a most exciting time for the industry. There are companies that want to put up small satellites to image the Earth in every spectral range, to sell weather data, to mine asteroids, to conduct experiments, to go to the moon and Mars. These are goals that have traditionally been the provenance of nation states, but US. companies are deploying enormous amounts of energy, talent and capital to pursue innovative business models and ideas. The creation of entirely new markets for the data and products coming from these payloads represents a resurgence of high-paying technical and manufacturing jobs here at home as well as an increase in export opportunities.

The commercial space industry is experiencing great momentum and success. What do you see as the key challenge facing smallsat operators?

While the space industry is making impressive strides, even the very best ideas have an Achilles heel—in this case, that's launch execution and routine access. With the resurgence of the US space industry, there has not been enough US launch capacity to meet the needs of the smallsat industry. Smallsat companies represent a vital part of the new space economy and US leadership in space; some are even playing a critical role in protecting US national security interests. If these companies cannot get their payloads to the right orbit at the right time, they may go out of business before the domestic launch industry has time to catch up.

How has the lack of launch providers affected your business?

Curt Blake

Access to Low Earth Orbit for small spacecraft (those under 500 kg) is quite limited. In fact, in the past 18 months, the global launch options were so limited that we purchased an entire SpaceX Falcon 9, a vehicle with 10,000 kg of capability, to fly more than 20 small spacecraft.

However, just one commercial launch opportunity a year to the popular Sun Synch imaging orbit is not sufficient for smallsat companies that have different requirements for the success of their spacecraft. Some businesses need their spacecraft to reach a different orbit, or populate a constellation across multiple orbital planes. For some of these companies, being forced to wait an entire year to launch could put them out of business.

What do you propose to do to solve the launch issue?

Curt Blake

Ultimately, we need to provide a market that makes it easier and less costly for emerging smallsat companies to access launches. In the near term, that means allowing access to foreign launchers. Many smallsat companies are desperately trying to achieve commercial viability and this viability is directly linked to their ability to achieve access to orbit.

If the US launch industry is as underdeveloped as you suggest, are we at risk of hindering the US launch market by sending launches abroad?

Curt Blake

Ironically, forcing small satellite payloads to use US launchers exclusively in the near-term may actually have the unintended consequence of wiping out some of those smallsat companies. If that were to happen, that would eliminate the potential future payloads that domestic launchers would need to sustain their businesses. Granting companies access to the global launch market will generate a catalyst to ensure future US launch companies have the demand necessary to grow the US launch sector.

Does Spaceflight currently assist US operators to launch with foreign providers?

Curt Blake

We seek US launch opportunities for our clients in every case. To date, Spaceflight has launched more than 80 small satellites for commercial companies and government agencies and has another 150 scheduled to deploy in the next few years.

To meet the needs of these smallsat companies, Spaceflight has scheduled, or will schedule, payloads on just about every existing launch vehicle including, SpaceX Falcon 9, Orbital ATK Antares, Soyuz, Dnepr and PSLV. We are currently engaged with all of the emerging smallsat launch service providers to procure launch services and very sincerely want them all to be successful.

Which foreign launch providers are popular with small satellite operators and why?

Curt Blake

Historically, Russian launch vehicles have had the lowest price point in the market. If you were to look at the launch manifest for the Dnepr, Soyuz, Rokot and Zenit launch vehicles, you would find a long list of foreign emerging economies obtaining access to space through Russia.

However, following the Russian invasion of Crimea, the US Department of State slowed the processing of export licensing for US commercial payloads attempting to launch using Russian vehicles such as Soyuz and Dnepr. Due to the shortage of launch capacity available to US "secondary" customers, we began seeking waivers to the Department of State's restrictions on using the Indian PSLV launch vehicle.

Are PSLVs typically more cost effective than other launch providers?

Curt Blake

No, not at all—that's actually a common misconception. The truth is, we find the reality to be quite the opposite. PSLV pricing is above worldwide "secondary" payload pricing. It is above pricing available from SpaceX, the Dnepr and the Soyuz. As Indian launches are subject to ITAR regulations, this can result in additional "monitoring" fees ranging from $150,000 to $300,000 per payload.

There are also other costs associated with shipping, travel and customs. It is much easier and cheaper for Spaceflight and its "secondary" payload customers to use US launch vehicles, if and when they are available.

If the process to launch on PSLV is so difficult and costly, why pursue it?

Curt Blake

PSLV has allowed Spaceflight, our clients and several other US companies, to orbit their business-critical "secondary" payloads that would otherwise still be sitting on the ground. Despite the added cost and difficulty, access to a foreign launch has been critical to our customers' businesses and will continue to be critical to maintaining a vibrant smallsat industry.

When do you envision the US launch industry will be able to meet the demand of the US smallsat industry?

Curt Blake

We are noting an increase in US "small launch vehicles." In fact, there are three small launch vehicles in various stages of test, ranging from mere months to several years away from beginning launch tests. Realistically, we do not expect non-test commercial operation of these vehicles until 2019 or 2020 at the earliest.

As anyone familiar with the launch industry will tell you, launch vehicles do not succeed on their first launch, or often even on their tenth launch. Many more launch vehicle companies fail than succeed. However, as I've said earlier, the US is experiencing a resurgence in space and we remain hopeful launch is simply a few steps behind.

If increased availability of US launches is at least five years away, what activity do you propose in the meantime to maintain a healthy, competitive smallsat market?

Curt Blake

Currently, US launch options are the most cost effective and efficient option for companies like Spaceflight and our customers. We are very much looking forward to the day when the smallsat market demands can be met with US launch capability. However, the required US launch capacity simply doesn't exist today to meet the needs of the smallsat market.

We strongly believe that the US government should allow US payloads to seek appropriate Indian launch opportunities if domestic alternatives are not available. We would like to see the current restrictions on international launches reduced, serving only to mitigate the present shortage in US launcher capacity.

We would like to suggest that the government allow US payloads to continue to launch on PSLV until there are at least two proven US smallsat launch vehicle alternatives with two successful flights each; only having one viable US launcher would potentially subject the industry to monopoly pricing. Small satellites are driving the new space revolution, creating new advances in technology and jobs in manufacturing and engineering. Limiting the launches available to these operators has the potential to severely hinder and slow the growth or this burgeoning industry.

spaceflight.com/

A NorthTelecom Perspective: Mind Your Supply Chain

By Mahdi Mehrabi, Chief Technology Officer and Managing Director, Asia, NorthTelecom

Satellite industry structure and trends, opportunities and the threats of new technologies were discussed by Mahdi Mehrabi during a panel discussion at the recent APSAT 2016 event.

The satellite industry, as an integral member of the space economy, has experienced some significant shifts and structure changes over the past two decades. Since the industry's inception in 1957, the main driver and dominant purveyor of services has been by none-commercial companies, mainly servicing government and institutional customers as well as the militaries, with the attendant regulation upon regulation barring many from entry into this growth segment.

Early in the 1990s, the space industry shifted away from a highly centralized market focus to one that was far more decentralized—the market witnessed an evolution by major organizations into the commercial use of space and the a modification of space regulation alterations. This eased the barriers for entry into the market; however, the dynamic and structure remained one that was managed by a few major players as an oligopoly.

Moving forward, the past ten years has experienced another major shift in the space segment and has witnessed the arrival of numerous new entrants into the assembly of satellite companies. With evolving social media and a plethora of apps, many Over-The-Top (OTT) broadcast and streaming firms started to increase their market shares by penetrating areas of new business.

As they moved forward into consumer-oriented SATCOM segments, these companies had to confront a big dilemma—more than 50 percent of the world population remained underserved and had little to no communications connectivity whatsoever— to the tune of somewhere more than three billion people across the globe.

This obstacle was one of the main motivations for companies engaged in these areas to engage in a growing interest of satellite technology. No other technology could offer a feasible and fast solution to reach the underserved in the short to midterm timeframe.

Companies such as Google and Facebook are planning to orbit hundreds of smallsats to provide Internet connectivity to those in emerging countries. Concepts, such as High Throughput Satellite (HTS), replaced the older satellite technologies as the earlier craft reached end of their life.

HTS pumps huge capacity—resulting in over supply and these technologies then started to be considered a disruptive technology and somehow a threat. Consider—the expansion of capacity was an element all had been dreaming of occurring several years ago, and now such is a threat and disruptive?

The first and foremost element for success in any new technology is the ecosystem and ensuring there is a proper and matured supply chain to deliver the service/product from top to bottom, as well as sending all relevant feedback from the bottom back up to the top. These elements seem to be a "big miss" for today's industry.

The initial industry oligopoly who dominated market share in the early years actually did not have care about the supply chain, due to the breadth of their services. And incumbent players have been destroyed and undermined due to their fragile supply chains—and that is where we seem to be today. Without supply chain management, there can be little success.

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Small Ideas Can Result In Big Successes

One of the fastest growing market sectors within the satellite industry is... smallsats.

The smallsat environment is rich with business potential, both for companies that have already committed their resources to work in this market segment as well as for firms considering their entry into these exciting territories.

To assist companies and individuals with acquiring smallsat knowledge, Satnews Publishers is delighted to announce the ***SmallSat Symposium—Silicon Valley 201***7, with smallsat workshops to be held on *February 6, 2017*, and the smallsat conference to run from *February 7 to February 8, 2017*. The **Computer History Museum**, located at 1401 North Shoreline Boulevard in Mountain View, California, is the venue for the symposium.

Subject matter expertise from leading actors already involved in the development, manufacture, launch and command and control of smallsats will be resident at the symposium to offer attendees their insights into this growing… and challenging… market.

Those participating in the SmallSat Symposium will have the opportunity to network with the most prominent smallsat professionals from around the globe. Sessions will be conducted by the executives and leaders who are changing the face of the SATCOM industry… *small ideas can result in big successes.*

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Attendees will acquire knowledge that will help them to understand what is required to secure smallsat market share and learn how to develop the core and advanced competencies for the next stages of smallsat involvement. From business aspects to technologies, the financial and legal channels, those present will gain the upper hand in achieving the knowledge necessary for success.

A broad range of thought-provoking panels with their expert moderators and speakers will present visionary as well as concrete ideas, all of which have been culminated through years of business experience. These professionals are being brought together to offer thought provoking presentations that will result in a thorough exposure of their smallsat expertise that will surround attendees with that all important element… knowledge.

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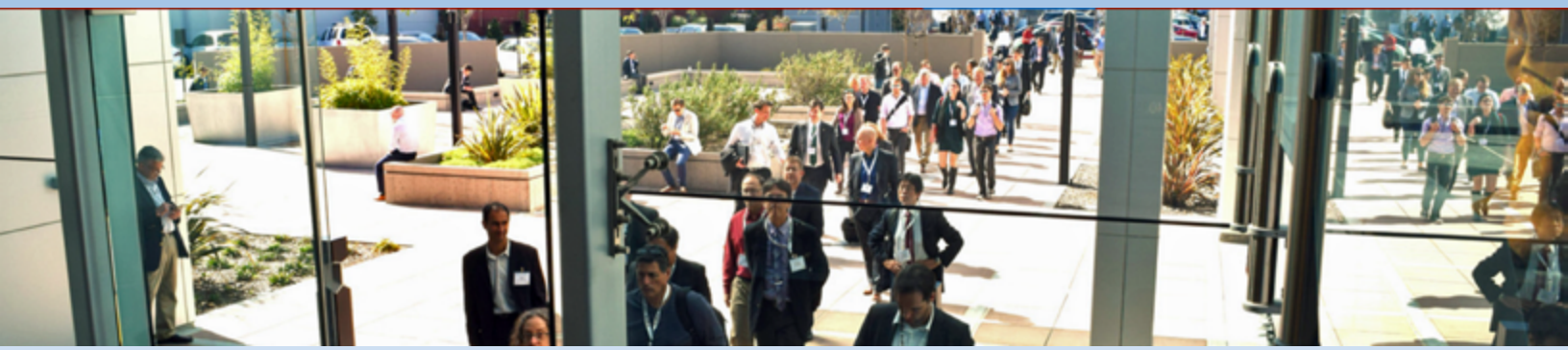

Why Attend?

Exhibitions, trade shows, symposiums, seminars and the like are filling business calendars around the world. There is so much knowledge to acquire, so many networking opportunities to take advantage of, so many product showcases and demos to experience, that time committed to external activities does become a crucial concern. Is attendance at this particular event going to be interesting and could such result in a profitable outcome?

Resource commitments, such as your participation at an industry event, depends upon a positive Return On Investment—these are the crux of business successes and can help you determine whether to engage in a project, or not.

However, there is also another investment that should be considered when determining whether to participate in an event that goes beyond the financial ones—that is the investment in the people who work at the company—Return On Personnel (ROP). With acquired knowledge they can enable a company to reach greater heights.

When considering attendance at an event, the wise manager will look at those who will be offering their expertise to the attendees. For ***SmallSat Symposium—2017***, a listing of the veritable "Who's Who" subject-matter experts who have already committed to presentations during this impact-filled symposium is in order… the accepted speakers, as of this writing, in alphabetical order, include...

- Chad Anderson, Managing Director, Space Angels Network
- Jason Andrews, CEO Spaceflight Industries
- David A. Anhalt, Vice President and General Manager, Iridium PRIME
- Chris Baugh, President NSR—Northern Sky Research
- Peter Beck, CEO & CTO Rocket Lab
- Dr. Sami BenAmor, Director of Marketing, Thales Alenia Space
- John Booher, Partner, Hogan Lovells
- Dr. Sean Casey, Managing Director, Silicon Valley Space Center
- Carissa Christensen, Managing Partner, The Tauri Group
- Craig Clark, Founder, Clyde Space Ltd.
- Mike Collett, Founder and Managing Partner, Promus Ventures
- James Crawford, Founder and CEO, Orbital Insight
- Randy Culver, CEO AMERGINT Technologies
- Stuart Daughtridge, Senior VP, Advanced Technology, Kratos
- Dr. Lars Dyrud, CEO, OmniEarth
- Dr. Shahin Farshchi, Partner, Lux Capital
- Dr. Jenny Gautier, Director of Commercial Programs, The Aerospace Corporation
- Dr. Steve Goldberg, CEO & Co-Founder, Venrock
- David Hartshorn, Secretary General GVF—Global VSAT Forum
- Susan J. Irwin, President, Irwin Communications, Inc.
- John P. Janka, Partner, Latham & Watkins LLP
- Adam Keith, Managing Director, Euroconsult Canada
- Debra Facktor Lepore, VP and GM of Strategic Operations, Ball Aerospace & Technologies Corp
- Tony Lin, Counsel, Washington, DC, Hogan Lovells
- Dr. Clare Martin, Vice President of Programs, Surrey Satellite Technology US
- Clayton Mowry, President, Arianespace
- Carlos Niederstrasser, Business Development & Special Initiatives, Orbital ATK
- Sunil Nagaraj, Vice President of Marketing and Communications, Bessemer Venture Partners
- Dara A. Panahy, Partner, Milbank, Tweed, Hadley & McCloy
- Will Pomerantz, Vice President for Special Projects, Virgin Galactic
- Dr. Alex Saltman, Senior Vice President, GeoOptics Inc.
- Randy S. Segal, Partner, Co-Lead, Satellite Practice, Hogan Lovells
- David Strobel, CEO and Program Manager (PM), Space Micro
- Chris Stott, Chairman & CEO (PM), ManSat
- Tom Stroup, President SIA—Satellite Industry Association
- Professor Sir Martin Sweeting, Founder and Executive Chairman, Surrey Satellite Technology Ltd.
- Stig-Are Thrana, U.S. Sales Director and Head of Kongsberg, Silicon Valley Office, Kongsberg Satellite Services
- Dr. Joe Thurgood, Vice President Corporate Development and Marketing, Hera Systems
- Dr. Marco Villa, President & COO, Tyvak Nano-Satellite Systems

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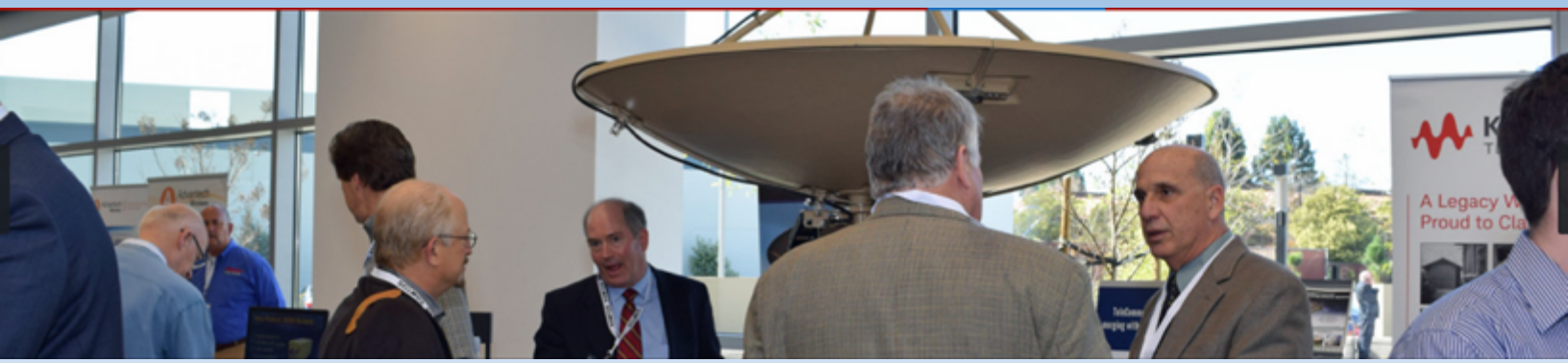

- Tony Wilkey, Senior Vice President, AvL Technologies
- Bruce Yost, Project Manager, NASA Ames Research Center
- Louis Zacharilla, Director of Development, Society of Satellite Professionals International (SSPI)

There can be little doubt that the subject matter experts who will be presenting at the ***SmallSat Symposium—Silicon Valley 2017*** are of the highest caliber... they will blend their expertise with the unparalleled networking opportunities attendees will experience with the smallsat industry's peers.

Some of the many reviews of the SmallSat Symposium 2016...

"I frankly believe that your event was the finest interchange of ideas among the new wave of space entrepreneurs that I have ever attended… it was certainly the most raucous and passionate and honest discussion of what has been called New Space or Space 2.0.1. I very much look forward to the next event."

"…It was a great event and very useful for me. I am glad to have come and to have spoken."

"It was an excellent conference and I thoroughly enjoyed my couple of days with you, the speakers and the delegates. I was really pleased to be involved… Congratulations, and I look forward to joining you again next year."

" I thought it was very successful and productive. Congrats!"

"Thanks and congrats on a hugely successful event. I heard only positive comments from attendees during and after the event, so you really have a solid foundation for next year. Please do keep me in the loop as your plans for next year progress."

"Many thanks for setting up a wonderful conference. Lots of great panels, and many excellent networking opportunities."

"We found the conference a great success, and with some very interesting personalities and talks. I believe you know that we are very interested in continuing to participate in future symposia."

"You did a stellar job putting the event together. I gleaned much value from it in terms of insight and networking, and would gladly be involved next year."

"It was a great conference and I was really happy to be able to speak and also hear all of the other sessions. Thank you for organizing!"

"Thank you for the opportunity to participate and congratulations on a great event. I look forward to joining you again next year!"

"Thank you for having me. It was loads of fun and an excellent show."

"Awesome! I'd love to participate again."

"That really was a nice event. Happy to hear your plans for next year… it was a lot of fun, definitely worth the trip over."

Satisfy Your SmallSat Appetites—The Sessions...

Day 1 — Tuesday February 7th, 2017

The State of the Small Satellite Industry

Today's small satellite industry demands sound business and financial practices. How do we best cultivate dependable practices? Panelists explore the various types of small satellites (Nano, Pico, Cube, Etc.), their leading applications, as well as trending uses in each subset. How do we define the small satellite marketplace and what is its size? How much new growth can come from small satellites and which segments and markets represent the greatest opportunities? What "traditional" types of capacity and services are changed by the growth in small satellites? Importantly, how do small satellites affect the satellite market as a whole?

Financing Small Satellite Operations

Investment in small satellite ventures originates from a variety of avenues including angel investors, venture funds, private equity firms, corporations, commercial banks and public markets. How do the varying demands of each of these financiers affect small satellite operations and planning? What are their expected returns and financing terms? What are the most important criteria investors look for in choosing ventures to fund? How much of a role does private equity activity and debt financing play in funding SmallSat operations and what effect does this have on management behavior? Panelists will discuss how different types of investors perceive the small satellite industry.

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Launch Provider Roundtable — Efficiency, Risk & Trends

Launching any satellite is inherently a risky and expensive business. Multiple new launch options are being created that offer opportunity to minimize risk and reduce costs. Executives from commercial launch service providers will share their views on current market trends and on their strategies to deliver the most adapted solutions for the launch of small satellites. How will new innovations, launch availability, changes in satellite designs and durability in small satellite design alter the future of the launch sector? What is the impact of re-usable engines on future launch costs? Which propellants, engines, components and new technologies are the launch sector investing in? What are the game changers? Panelists will discuss strategies for funding launch operations and the time it takes to book a flight.

Ground Systems Economics Architecture

As hundreds of new small satellites are launched ground systems must keep pace to track and communicate with them. What will be the increasing demands for these systems, as well as new autonomous onboard TT&C developments mean for the ground system market? What are the most important criteria in selecting ground system architectures for small satellites? What current and recent trends might change market dynamics in the future?

Pricing and Marketing SmallSat Services

Disruptive innovations create new markets. Business development executives will present their views on market opportunities and where to sell the multitude of products that have resulted from the SmallSat revolution? The collision of finance and technology has produced both turbulent markets and spectacular innovations. Who has bought, who will buy, and what will they pay? More importantly, how should products be priced to maximize revenue?

Cost Savings in Small Satellite Alternatives

How do small satellite alternatives compare to older technologies? Panelists will discuss foremost applications where cost savings are changing paradigms. The focus will be on different development models, prototypes and early operations including the overall positioning, level of vertical integration and cooperation with other industry stakeholders. Also under discussion will be budgetary considerations unique to the small satellite platform.

Day 2—Wednesday, February 28, 2017

Keynote Speaker

Professor Sir Martin Sweeting, Founder and Executive Chairman, Surrey Satellite Technology Ltd. Sir Martin has a BSc in electronics and PhD in radio engineering from the University of Surrey (UK) and is the founder and Executive Chairman of Surrey Satellite Technology Ltd. (SSTL). Following two experimental 'microsatellites' built by his research team at the University of Surrey and launched in 1981 and 1984, he pioneered rapid-response, low-cost and highly-capable small satellites using modern consumer electronics to 'change the economics of space' and has established the UK at the forefront of this new field.

Sir Martin also chairs the Surrey Space Centre comprising around 100 researchers investigating advanced small satellite concepts and techniques and which acts as the research laboratory for SSTL – an exemplar of real academic-commercial synergy. The SSC collaborated with SSTL on the world's first 'smartphone' nanosatellite, STRaND-1, launched in February 2013 and launched a research nano-satellite for orbital debris mitigation in 2015. Full Bio

Small Satellite Constellation Dynamics

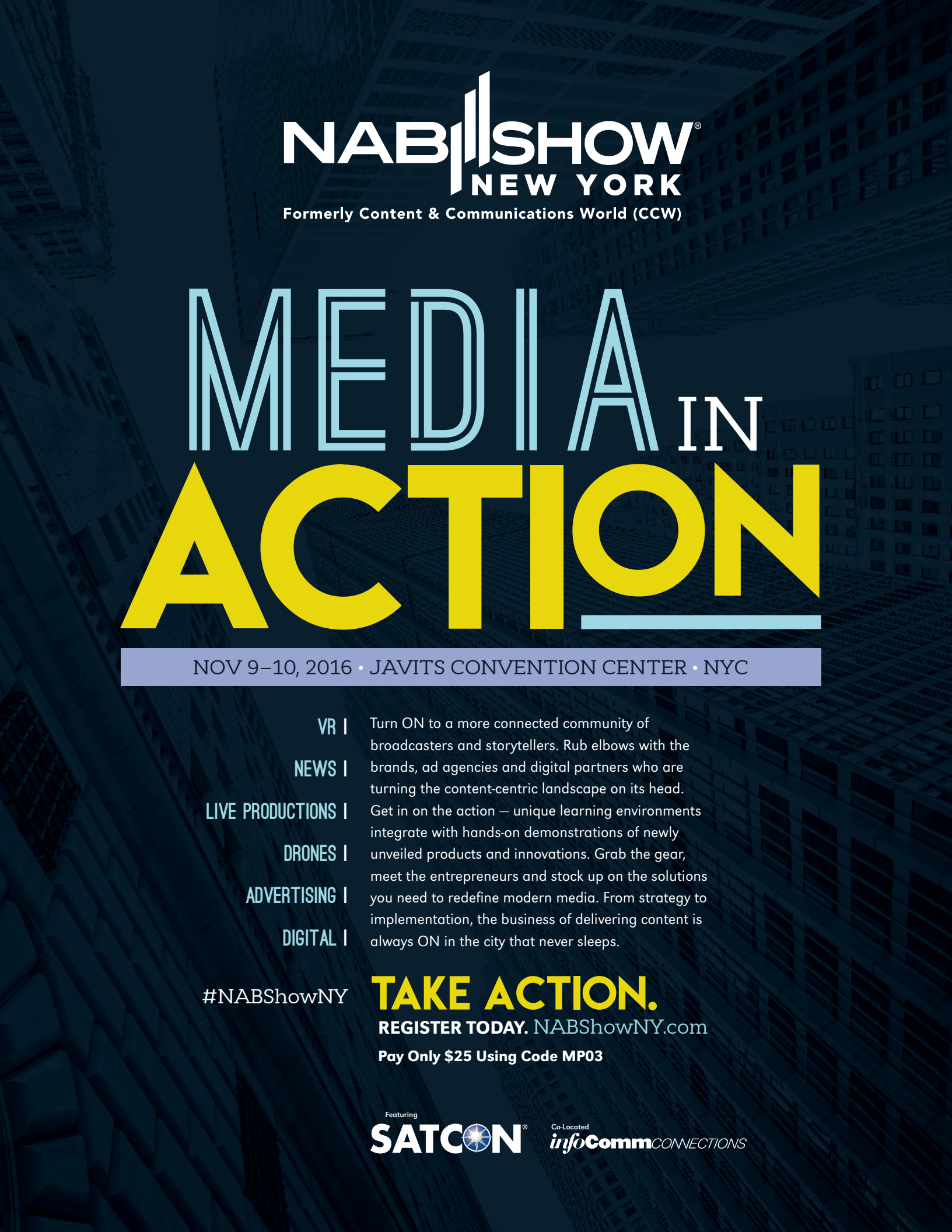
As small satellites spread across the skies, questions about constellation management arise. What is involved in designing, implementing and maintaining multiple satellites in a small satellite constellation? How does operating a small satellite constellation differ for a more traditional satellite system? What are the most important applications flying in constellations today and what might they be tomorrow?

Earth Observation

With more than 400 Earth observation satellites (50 kg+) planned for launch by 2025, and an additional 1000 satellites below 50k flying in constellations, the coming decade of growth in observation satellites is enormous. From agriculture and mining to traffic observation, mapping and weather, small satellites provide an opportunity to observe our planet in considerable detail. High resolution, accurate data provides a range of solutions to meet the immediate needs of emergency responders, defense users and location-based services. In how many ways can Geospatial Data be presented and be useful? Who are the important customers and what are their primary concerns and requirements?

Securing Capital In New Small Satellite Ventures

What is the optimal way to secure capital for the startup phase of a SmallSat venture? What are the different dynamics of getting funding for a startup SmallSat operator vs a startup manufacturer/launch service provider or data processing company? Explored in this panel are the various ways capital suppliers view revolutionary ideas. Has the complexity of the financial market led to roadblocks for SmallSat operators and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manufacturers? How do operators avoid financial pitfalls (funding gaps, etc.)? Beyond the first funding round, how will investors approach adding capital to a maturing venture? What is the past and present performance of the sector and what are the current and expected trends for industry consolidation and M&A transactions?

Traditional Large Integrators—
What is their Role in the SmallSat Industry?

Threat or opportunity? What are the majors doing independently or with their affiliates to capitalize on the SmallSat market? Airbus, Boeing, General Dynamics, Hughes, Lockheed Martin, Northrop Grumman, Raytheon, SSL and Thales Alenia are known for the scale of the systems they implement. How does each approach the small satellite market, and how does the scale of their organizations affect that approach?

Next Generation Technology

What new technologies will fly in the next generation of small satellites? What terrestrial equipment will be necessary to support these innovations? Speakers will discuss potential new applications, private sector technologies, space tech incubators, notable advances in design and implementation, advanced materials, 3D printing and robotics. What will be the role of NASA, NOAA, and Research Universities? What new business models and applications might be enabled by the birth of new technologies?

Defense and Government Applications

Defense, Government and NGO sectors require both remote sensing intelligence to detect and classify objects and also connectivity for secure, mission-critical communications. With advancements in small satellite technology, what kinds of improvements could SmallSat bring to existing solutions? What kinds of innovative new solutions might materialize? How do SmallSat operators work with government partners?

Concluding Remarks

By the way, **the first 100 registrations qualify for a $200 discount** on the standard event admission—take advantage of this saving and register today at: ***http://www.cvent.com/d/0fqt81/4W***

Additional event details are available at ***smallsatshow.com/***.

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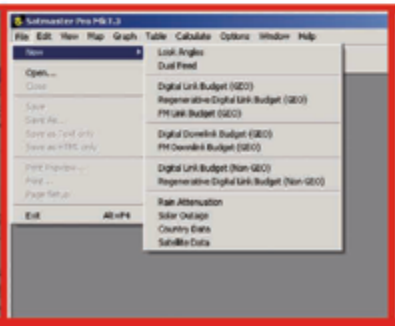
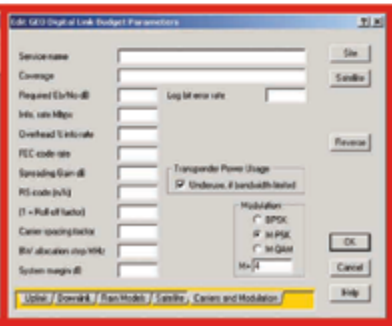




http://www.satnews.com/satfinder

Further Evolution In Satellite Technology

By Darren Ludington, Senior Director of Sales, iDirect, + Alvaro Sanchez, Sales & Marketing Director, Integrasys

Rural areas across the globe are lacking connectivity, especially in Latin America, Asia and Africa.

Now, worldwide governments and commercial entities are trying to connect the unconnected. For example, Silicon Valley players are focusing their efforts to provide affordable Internet to the most remote areas of the world at a lower price point and doing their best to bridge the digital divide.

Thanks to the advances in satellite technology in the space and ground segments, VSAT technology has been extremely well positioned for connecting the unconnected in a reliable, fast and secure way.

High Throughput Satellites (HTS) allow end users to experience greater bandwidth capacity at a lower cost. Among HTS advances are the frequency reuse through multiple spot beams architecture—by minimizing the footprint, the bandwidth is increased and the price drops by reusing the same spectrum multiple times within the same spacecraft.

Space technology innovation has pushed ground technology to quickly adapt to this new way of thinking; therefore, equipment manufacturers, such as iDirect, are innovating to lower the cost of network deployment and to also support massive network expansion.

Integrasys has developed the cutting edge technology on self-installation antennas and commissioning of the remotes. Together, iDirect and Integrasys bring forward an unprecedented combination for simplicity, service availability and performance in approaching the solutions for the digital divide.

Today, VSAT is the preferred solution for many service providers as this technology is much easier to deploy (previously a main concern), is more cost-effective and provides a greater service.

Recently, VT iDirect was awarded by Entel Chile for the provisioning of a Universal Satellite Hub and several Evolution® remotes for the rural VSAT market, specifically for 2G, 3G and 4G backhaul deployments. This will allow Entel Chile to deploy their networks with the latest iDirect technology.

iDirect leverages Satmotion Pocket from Integrasys as the iDirect remote commissioning solution for intelligent and quick deployment of VSATs. Satmotion Pocket is used by Entel Chile for auto-commissioning their VSATs without contacting the NOC—that adds the important value of having the maximum quality of the service and, at the same time, being able to complete deployments in as short a time frame as possible.

Satmotion Pocket enables the installer to perform the commissioning process by using the intuitive iOS or an Android App. This brings extreme efficiency to those service providers who aim to benefit their customers of the most innovative technology.

While the collaboration between these two technology providers has been successful, customers are demanding even more and asking: Why not use Satmotion Pocket from the hub to virtually monitor the site?

Typically, site monitoring requires sending an installer to the site, which can take a few days. Today, Integrasys has introduced Alusat, the evolution of Satmotion Pocket. Alusat allows users to check the RF health of the overall network at the hub without the need of the tedious processes necessary to coordinate all actions with satellite operators or the local support at the site.

Service providers can ensure Quality of Service (QoS) and Service Level Agreements (SLAs) compliance automatically using an intuitive tool for remote maintenance. This is a huge step forward in the ground technology innovation that is being driven by HTS.

This new remote maintenance technology aims to further simplify the VSAT solution by providing greater value to service providers looking to save operational expenses without compromising service availability and network performance.

www.idirect.net/
www.integrasys-space.com

Darren Ludington is the iDirect Senior Director of Sales for the Latin America region where he currently manages the commercial activities for Mexico, Central and South America. Since joining iDirect in 2004, Ludington has held various technical and customer-facing roles and was responsible for assisting customers across the globe with product selection, designing satellite networks and infrastructure, and delivering technical training.

He has worked in the engineering and satellite communications industries for over 15 years, spanning a wide range of technologies. Ludington is also fluent in English and Spanish, written and spoken.

Alvaro Sanchez is Sales & Marketing Director at Integrasys. Alvaro is responsible for Satellite Carrier Monitoring at Integrasys and providing the most innovative solutions for satellite operators and service providers.

Currently Alvaro is the head of the USA office in DC area. Prior to Alvaro joining Integrasys, he was a signal analysis expert at CERN European Organization for Nuclear Research.

Finding The Value In The Data Driven World

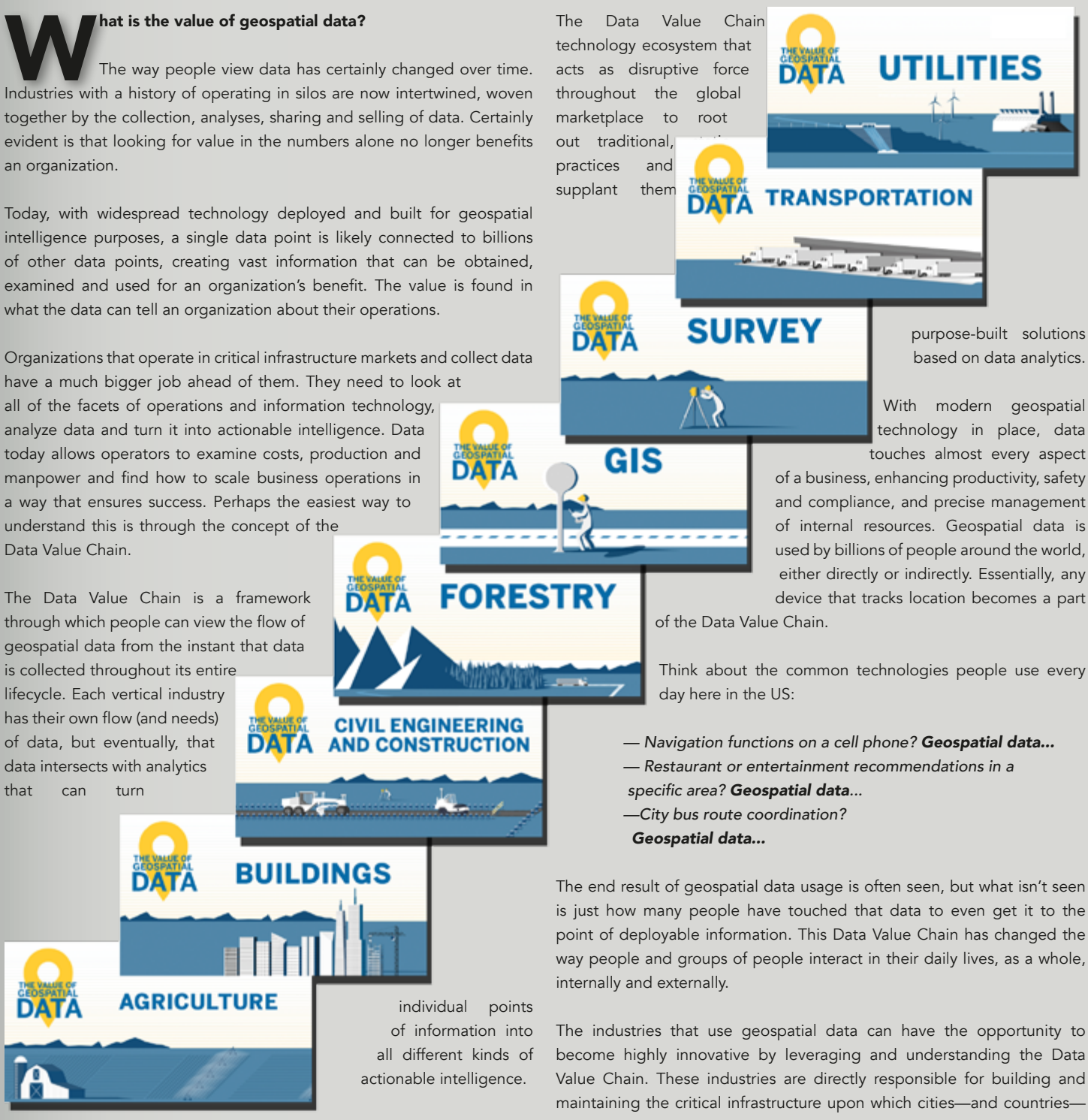
What is the value of geospatial data?

The way people view data has certainly changed over time. Industries with a history of operating in silos are now intertwined, woven together by the collection, analyses, sharing and selling of data. Certainly evident is that looking for value in the numbers alone no longer benefits an organization.

Today, with widespread technology deployed and built for geospatial intelligence purposes, a single data point is likely connected to billions of other data points, creating vast information that can be obtained, examined and used for an organization's benefit. The value is found in what the data can tell an organization about their operations.

Organizations that operate in critical infrastructure markets and collect data have a much bigger job ahead of them. They need to look at all of the facets of operations and information technology, analyze data and turn it into actionable intelligence. Data today allows operators to examine costs, production and manpower and find how to scale business operations in a way that ensures success. Perhaps the easiest way to understand this is through the concept of the Data Value Chain.

The Data Value Chain is a framework through which people can view the flow of geospatial data from the instant that data is collected throughout its entire lifecycle. Each vertical industry has their own flow (and needs) of data, but eventually, that data intersects with analytics that can turn individual points of information into all different kinds of actionable intelligence.



The Data Value Chain technology ecosystem that acts as disruptive force throughout the global marketplace to root out traditional, practices and supplant them purpose-built solutions based on data analytics.

With modern geospatial technology in place, data touches almost every aspect of a business, enhancing productivity, safety and compliance, and precise management of internal resources. Geospatial data is used by billions of people around the world, either directly or indirectly. Essentially, any device that tracks location becomes a part of the Data Value Chain.

Think about the common technologies people use every day here in the US:

— Navigation functions on a cell phone? ***Geospatial data...***
— Restaurant or entertainment recommendations in a specific area? ***Geospatial data****...*
—City bus route coordination?
Geospatial data...

The end result of geospatial data usage is often seen, but what isn't seen is just how many people have touched that data to even get it to the point of deployable information. This Data Value Chain has changed the way people and groups of people interact in their daily lives, as a whole, internally and externally.

The industries that use geospatial data can have the opportunity to become highly innovative by leveraging and understanding the Data Value Chain. These industries are directly responsible for building and maintaining the critical infrastructure upon which cities—and countries—are built and maintained.

For example, did you know an innovative geospatial cleanup app was used for sprucing up San Jose, California, during the 50th anniversary of the Super Bowl? The City of San Jose wanted to present the best face possible to visitors and devised a cleanup campaign to ensure a positive impression for more than a million people where they viewed a clean, safe city in action. Following this major event, this initiative would become part of the city's improved processes.

The above example is just one of many to demonstrate the value in the Data Value Chain—this extends from the boots on the ground mapping geographic terrain and gathering data in urban and rural settings—to the engineers and project managers transforming the data into actionable use and developing creative solutions for difficult infrastructural dilemmas. Even the back-office decision makers tasked with solving the problems of today can keep an eye on the obstacles of tomorrow. When the Data Value Chain is recognized and used, work can get done faster.

The Data Value Chain is the summation of many individual companies and applications and is ubiquitous to anything that touches an industry or company in today's global marketplace. The Data Value Chain shapes the way humans interact with the world around them at a micro and macro level.

The Data Value Chain has the power to disrupt industries with new ways of thinking and doing as well as the ability to unify disparate business practices by transforming data into intelligence and placing that information into the hands of decision makers across each workgroup or department. The data informs them about daily workflows, from simple deployment of resources, to the strategic placement of those resources and ultimately the value those resources provide in return.

By embracing and cultivating a Data Value Chain, industries across all verticals will reap the benefits. The Data Value Chain provides a conceptual framework that ignites a greater capacity to disseminate valued information across an organization (vertically and horizontally) and helps industries derive actionable intelligence from all points of operation. When this is accomplished, organizations see scheduling and manpower improvements, increased regulatory compliance, overall cost reduction, efficiencies in the use of heavy machinery and much more. As data points continue to expand and grow, so does the importance of understanding the role of the Data Value Chain in the ecosystem of the global marketplace.

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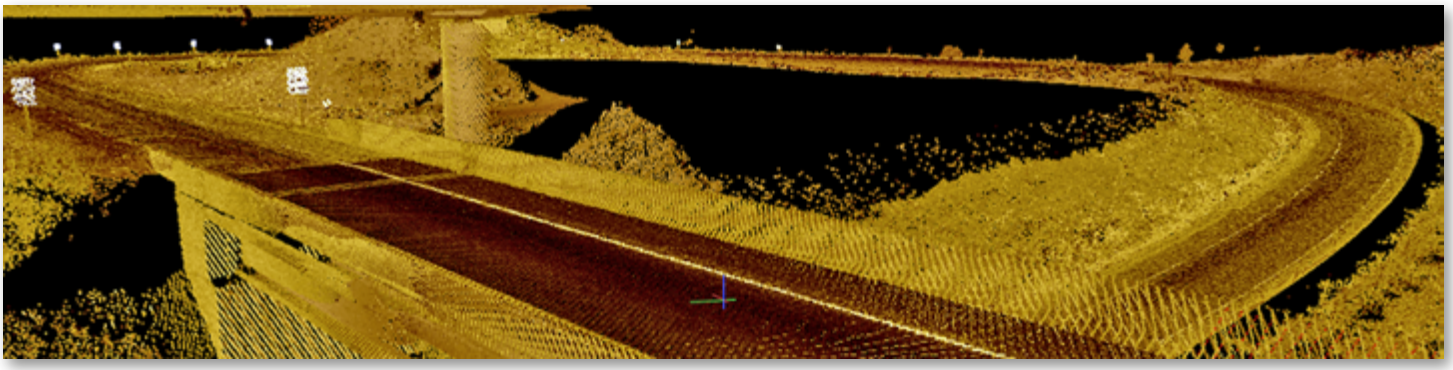

Mobile Satellite Services In LATAM... The Opportunities + The Challenges

By J. Alberto Palacios, Chief Executive Officer, Globalsat Group

The decrease in growth and even contraction in activities related to oil & gas as well as mining are often referred to as the cause of negative effects on satellite services in Latin America (LATAM).

These activities, which traditionally operate in remote areas where terrestrial communications infrastructure is scarce or nonexistent, represent a significant demand for mobile satellite services (MSS) and fixed services (FSS). This lack of a communications structure has the potential to create new opportunities. While the day-to-day operations may be diminished and, therefore, human activity and need for higher bandwidth FSS may decrease, companies will not just abandon their infrastructure.

According to the *CESLA*, although contraction of GDP was negative in three countries of the region in 2016, such will be negative in only one country—Venezuela—in 2017. The IMF states that their own projection of negative growth (-0.5 percent) hides that most countries in the region continue to experience growth. The OECD also predicts 2017 will be good for several countries in Latin America. Consequently, much of the infrastructure can stay in "pause." This creates opportunities through demand for satellite surveillance, telemetry and remote command, allowing their owners to maintain control over the infrastructure and even operate some of that infrastructure without human interaction in the field.

The road to satellite controlled automation is facilitated by a growing supply and a maturity of solutions that are tailored to IoT / M2M through existing services, such as Inmarsat's IDP and BGAN M2M, Iridium SBD and Globalstar Simplex, in addition to the usual VSAT-based solutions. The modern enterprise is mobile, and must be mobile even in the most remote and hostile environments:

The real-time connectivity to mobile resources provided by these platforms opens the door to a true revolution in process optimization, updating complete production structures to up-to-the-minute demand rather than month by month optimization. Permanent connectivity can, therefore, allow efficiency to increase almost up to the theoretical limit. To make this possible in practice, customers need a true service partner they can trust, not just a hardware provider. This requires a company with the experience to add value, customize and integrate technology.

Additionally, customers require prompt and highly granular access to their services. Globalsat Group provides tools for self-management, through which customers can see their resources in real time and even turn terminals off remotely, at will, to control costs through specialized tools such as AirtimeSAT. This kind of service control is especially appealing in these times of increased corporate risk in the LATAM region.

Connectivity Can Provide Value + Savings

Permanent connectivity even in areas where terrestrial network coverage is available can be a challenge in Latin America. The rapid growth of mobile Internet users pushes the limits of mass use infrastructure. In example, there is a case in Brazil where Globalsat Group operates more than 500 mobile satellite broadband terminals for a company linked to the energy sector. That company does not want to rely solely on the quality of service and coverage of cellular companies—their business in these critical times is 24x7 mission critical.

Permanent and redundant connectivity allows that firm to monitor and communicate with their entire fleet, optimizing routes on the fly as conditions change across their infrastructure. This capability provides significant savings to their operations and increased service continuity for their customers and the country. Addressing such projects where a turnkey solution comprised of multiple terminals must be developed and operated reliably, all based on specific customer needs. To simply be a provider of satellite airtime is no longer enough for business success.

An agile and cohesive team connected to the operational and regulatory situation in each country can make the difference between growing steadily in an increasingly demanding market or maintaining a status quo that will reduce competitiveness and cause market loss.

A Flexible Organizational Structure To Adapt To Difficult Times

To increase efficiency and user satisfaction across a diverse market, the Globalsat Group affiliates operate as parts of a mesh network: customers in each country are directly served by a local team, and within each team there are experts in specific solutions.

When expertise that is available in another team is required, there is direct contact from team to team without going through the central organization. This allows for streamlined management and also gives all clients access to all experts in all areas of the operation, such as standard voice and data, IoT / M2M, software development and hardware, aviation and maritime satellite technology, streaming / media and even land mobile radio.

Frost & Sullivan, which recently granted the company the *2016 Latin America Satellite Company of the Year Award*, has estimated that for success in Latin America, there are several key points: fulfilling unmet needs, anticipating scenarios, commercial best practices, financial performance, product price/performance, customer purchase experience and brand value are some of the areas where a satellite services company must maintain excellence in order to survive.

According to Euroconsult, the future of the MSS industry will depend on how quickly suppliers are able to adapt to new market conditions. Globalsat Group believes those of us who are able to anticipate these conditions have the winning hand. This is an experience that the company wishes to share—because if other market players do well, a positive spiral will be generated for the entire satellite industry.

globalsatgroup.com

J. Alberto Palacios is the Chief Executive Officer of Globalsat Group, the first pan-American group to provide Mobile Satellite Services (MSS). Mr. Palacios is well known for his extensive experience in the industry with particular focus on emerging countries. Under his vision, the group he founded in 1999 has become the leading multinational MSS organization to serve the Latin American market, with an accelerated growth over the past years, offices in eight countries and distributors throughout the region. He is currently based in the Palm Beach area in Florida, where the group headquarters is located.

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A Look At A Distruptor: Clyde Space

Clyde Space is a trusted innovator and supplier of smallsat solutions and has forged a highly regarded reputation over 10 years of fostering the smallsat market and building an extensive mission heritage.

The company has an extensive heritage, offers cutting-edge products and a robust management approach within smallsat market. Significant success has been achieved through the supply of off-the-shelf 'CubeSat' class nanosats.

Throughout the firm's history, innovation was key, all the while ensuring that there was no compromise in quality. Pioneering new technology for an evolving space industry, Clyde Space has disrupted the utility value of nanosatellites; enabling, for example, ever higher power applications by bringing low cost, high efficiency and reliable electronics to market.

Customers worldwide have included; the Massachusetts Institute of Technology, the US Army, US Navy, LuxSpace, NASA and JAXA. Clyde Space has supplied more than 1,800 subsystems for small spacecraft that have ranged from 1 to 250 kg in size and have also contributed to the success of the most challenging CubeSat missions around the world.

In recent years, the smallsat market has grown exponentially and the company has grown into several, new, geographical markets. Recently announced was the firm's international expansion plans—the first North American subsidiary company, Clyde Space Inc., will come online in the not-too-distant future.

Clyde Space supports space missions at all levels, from conceptual design, development, integration, testing, through to launch and on orbit operations. There are actually two halves to the offerings: off-the-shelf products that consist of subsystems and full platforms, available for purchase at the click of button online; and bespoke solutions, which are designed specifically to meet customers' requirements, which range from tailor-made subsystems to full mission design, integration and test.

The off-the-shelf products encompass a variety of products, from batteries, electronic power systems, solar panels, onboard computers, communications equipment, attitude and orbital control systems, to software and spatial platforms.

As a result of previous mission experience developing bespoke satellite platforms, such as Outernet and UKube-1, Clyde Space can offer standard platform designs for 1U and 3U spacecraft. These affordable, flight-proven spacecraft consist of off-the-shelf platform solutions that culminate in shorter development times and reduced costs.

The modular design of the subsystems ensure the ability to deliver platforms ranging from 1U to 27U which combine space-qualified, off-the-shelf subsystems and bespoke products to deliver end-to-end, mission-ready platforms.

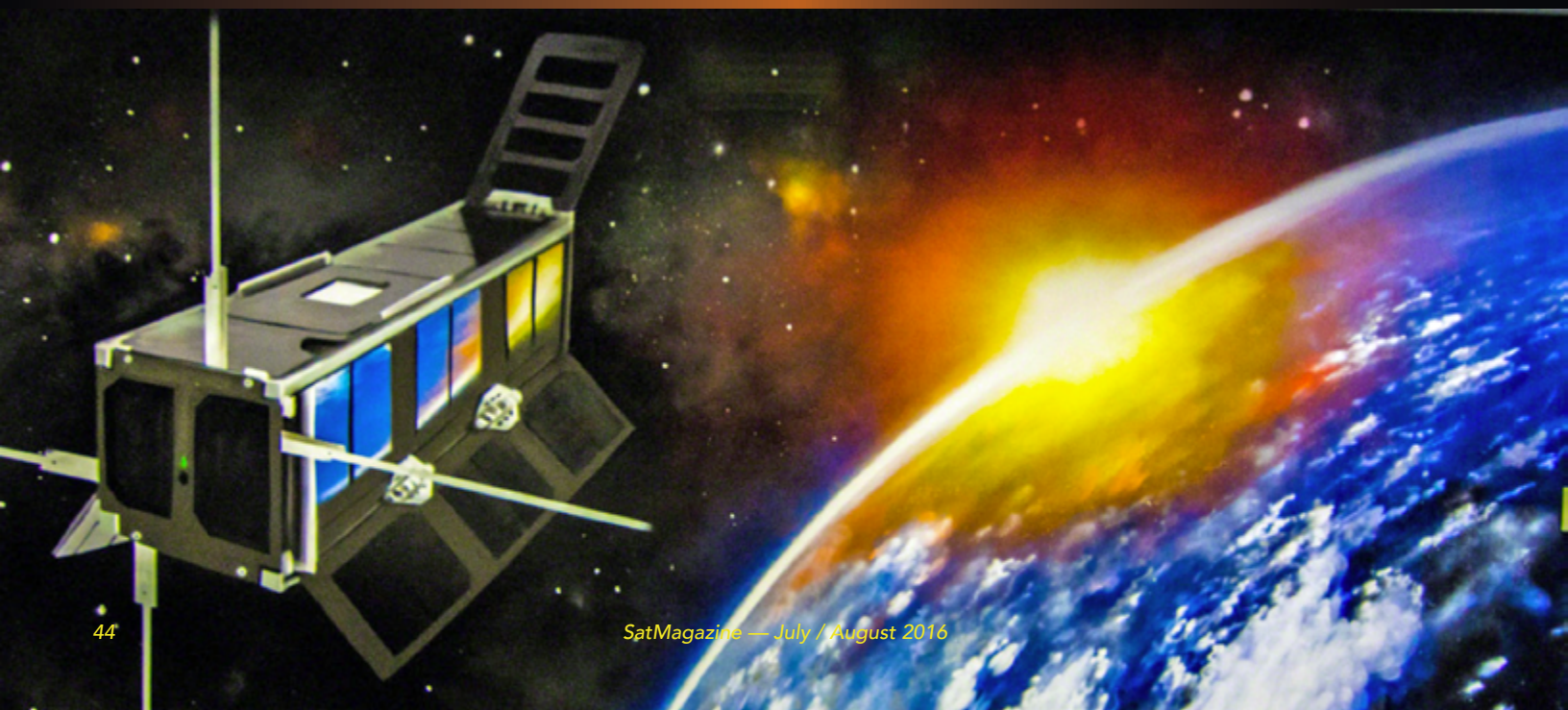
Clyde Space is named after the River Clyde, the main river running through Glasgow, Scotland, which once built 25 percent of all of the world's ships. The company is aiming for this to be true for the spaceships of the future and, currently, 40 percent of all CubeSat missions are supported in one form or another by the company.

Clyde designed and manufactured Scotland's first satellite, UKube-1, which was launched in July 2014 and was commissioned by the UK Space Agency—the smallsat mission was completed at the beginning of 2016.

Clyde Space Growth + Innovation

Innovation is at the company's forefront and business is based on innovative solutions for the smallsat industry. Market needs are anticipated and new technologies and applications are constantly being pioneered.

Solutions remain at the forefront of all technological advancements through the development of comprehensive roadmaps. Several subsystems are now in the their third generation and are considered some of the best



CubeSat products available on the market today. Inspiration for product development stems from addressing customers' needs of our customers.

Through promotion of the downstream application possibilities that can be achieved through high performance platforms, the firm assists customers with the realization that smallsats offer potent solutions.

Clyde Space was the prime contractor for the UK Space Agency's UKube-1 pilot program, which has been one of the most exciting company projects to date. This is one of the most advanced nano-satellites ever manufactured and is also the first satellite to be designed and built in Scotland, a fact of pride for Clyde Space. The success of the UKube-1 moved the firm from a subsystem to a system contractor and highlighted the skills and capabilities at Clyde Space in priming a full spacecraft mission.

Standardization and a high degree of professionalism has been introduced to the development of complete smallsat solutions. Building on the experience gained working as the prime contractors on the UKube-1 mission, through development of nexgen, advanced platforms, such as the upcoming ESA PICASSO mission and the UK Space Agency's recently announced In-Orbit Demonstration mission, the latter is intended to provide a platform for up and coming UK based payload developers.

In response to an ever increasing demand from 'big business,' Clyde Space has developed a range of CubeSats specifically designed for deployment as a constellation to provide global coverage at a fraction of the development time and cost normally associated with traditional satellite solutions. Examples include the Outernet and SeaHawk missions that will provide free Internet access to isolated locations and capture images of sea color to aid in oceanographic analysis, respectively.

Clyde Space has a proven track record of developing high quality flight hardware that meet challenging delivery deadlines at a market-disruptive price-point, adding real and immediate value to customers' mission developments. Recently introduced is high value bundle pricing to entice those seeking quality and cost savings. This has been introduced within the Power Bundle family product pricing and will be additionally rolled out in 2016 for other bundles.

Clyde Space is the only dedicated CubeSat vendor to have an ISO9001:2008 accredited Quality Management System and has no known on orbit subsystem failures.

A large number of projects are currently in the development queue; with the growth of the space industry in general, and the smallsat market in particular, Clyde Space has been able to secure an increasing number of contracts. In response to this increase in demand, Clyde Space has grown production capacity to ensure that the capability to deliver on these projects is not compromised.

Various initiatives have been implemented to drive Clyde Space and the firm's customers forward, including the introduction of automated test setups, pick-and-place manufacturing for standard products, expansion of on-site testing capabilities and, of course, a significant recruitment drive. Clyde Space plans to continue this growth for the foreseeable future. Over the past 12 months, Clyde Space has shipped more than 1,000 units to customers across the globe—this represents a 100 percent increase in manufacturing throughput when compared to the previous year.

Perhaps more importantly, the "On-Time Delivery" quotient has remained constant throughout, demonstrating that even the larger number of projects have not had any detrimental impact on the company's ability to deliver projects to schedule. Growth strategy has been heavily influenced by the need to set up shop internationally in order to access strategic markets where nationalism is essential in order to win contracts. Clyde Space aims to establish trading offices in certain key markets across the globe to unlock these sectors of the market.

Clyde Space both supplies to, and nurtures this new space market, and the market's success is such that even organizations that include NASA and ESA, and large aerospace Primes such as Airbus and OHB, are taking an interest and looking to Clyde Space as a valuable partner.

2015 has been Clyde Space's most successful year to date—2016 will be even better. With an expanding consumer base and the resulting orders, such has propelled the company further into a strong, market leading position.

The growth in the smallsat sector witnessed the company attaining record revenues in the 2015 to 2016 financial year. Recognizing the continued growth of the market, and capitalizing on a market-leading position to drive growth—and, indeed, to maintain that very position— Clyde Space has invested heavily in capability development over the past year, and continues to do so, recruiting heavily and expanding its facilities. For example, currently in the process of development is a ground station that will support the growing fleet of Clyde-built spacecraft. This facility is expected to come online this year and will initially feature VHF, UHF, and S-band communications capabilities.

With the space market showing sustained growth at almost 10 percent over the past few years, and the company's specific smallsats market segment revealing growth at close to 40 percent per year, market conditions are extremely favorable.

With a record number of deals and orders won for projects such as a £1 million deal to build three CubeSats for American global broadcast company Outernet Inc., Clyde Space has illustrated that in a market dominated with a few giant international players, smaller organizations can still enter this competitive landscape and receive a highly lucrative proportion of the market share, while providing customers with high-end solutions.

clyde.space

A Dynamic Opportunity For Teleports... IoT

By Robert Bell and Randall Barney, World Teleport Association

The Internet of Things, also known as Machine-to-Machine (M2M), is hardly a new market for the satellite industry.

M2M has been around for years in the form of SCADA or Supervisory Control and Data Acquisition, an industrial control system for remote monitoring and control that dates back to the age of the mini-computer. The M2M protocol is designed to be quite compact and data rates are low which have long made this technology cost-effective over satellite.

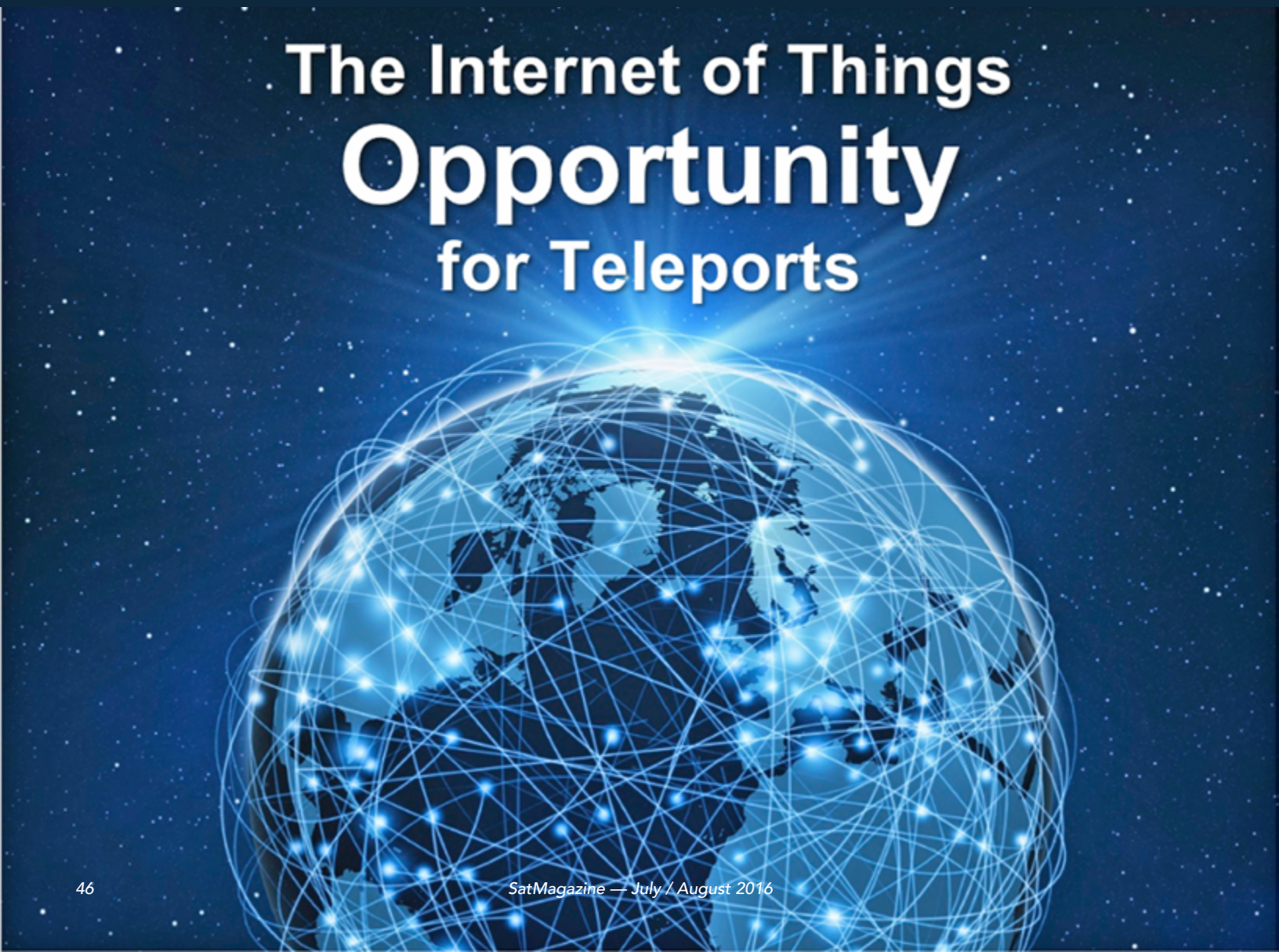
Where IoT differs is in volume. A typical SCADA system might involve a few hundred sensors across a pipeline network. Today's IoT systems are scaled for thousands of endpoints, and are designed for flexibility in terms of bandwidth. For example, an IoT system may transmit low-resolution video but automatically switch to high-resolution video on a single camera when triggered by a motion sensor.

Growth in IoT is projected to be astronomical: anything from 25 billion to 70 billion connected devices by 2020, depending on which survey you read, far exceeding the number of broadband connections between human beings.

The vast majority of these devices will connect over terrestrial networks, but a meaningful percentage will do it over satellite. The research firm NSR estimates a global market of 5.3 million units by 2024, which will bring in revenues of US$2.3bn for the satellite industry.

The oil and gas business has always been a major market segment for SCADA, so there should be no surprise that this is one of the first industrial segments to adopt IoT via satellite. Despite the current slump in oil prices, interest from this sector remains strong, according to our respondents.

Companies are looking for the increased efficiencies, reduced costs and the improved safety that can be derived from strategically located sensors. Other IoT growth sectors for the satellite industry include utilities, maritime, aeronautical, mining and land transportation: essentially anything that is beyond the reach of good terrestrial coverage.



This points toward markets in the developing world, but operators also have networks in the rural regions of the developed world, from environmental monitoring to digital signage at bus stops indicating when the next bus will arrive.

A totally new market that may emerge is updating the software systems on modern cars. This is an application that is ideally suited to the broadcast capability of satellites. It does however depend on the commercial production of flat panel antennas.

The Internet of Things Ecosystem

The full ecosystem is a complex network of sensors or actuators, communication carriers, applications, analytics, security, data storage and systems integrators. No teleport operator, satellite operator or technology provider has the capability to deliver all of this.

Some operators are better placed than others, by virtue of natural affiliations (ownership or a common parent company) with telcos and other companies operating in IoT. For those teleport and satellite operators without a telco parent, there is great variation in the approach being taken to finding and aligning with other players in the value chain.

Nearly half of respondents saw the need for alliances and partnerships, and focus proactively on creating them. The more aggressive operators are actively seeking out new projects and then taking the lead in assembling terrestrial carriers, mobile technology firms and systems integrators to pursue the business.

Clearly, the best course for teleport and satellite operators is to try talking to everyone: the systems integrators and terrestrial carriers they already do business with as well as new connections with mobile and wireless technology companies that manufacture devices and integrate them into IoT solutions.

High Throughout Satellites

High Throughput Satellites (HTS) push more bits through the transponders, and this is driving the cost of bandwidth down by a factor of ten in some cases. IoT applications are generally low-bandwidth, however, so it is not obvious that lower bandwidth cost would be a major attraction.

As the number of sensors grows, demand for bandwidth and the associated costs will also grow. Not only is the number of sensors increasing, so are the bandwidth demands per sensor.

Some applications are expected to transmit more frequently than in the past and some will use higher data rates—for example, to switch on a surveillance camera automatically when a motion detector is activated. Add all this together and suddenly the cost of bandwidth begins to matter.

Cheaper HTS bandwidth is already starting to open up new markets, according to some respondents, particularly in maritime where L-band has dominated for so long. Gathering data from an entire fleet of ships and combining it with meteorological forecasts, for example, make it possible to optimize shipping routes, saving fuel and time.

High Throughput Satellites are designed to deal with a high number of remote terminals, something that is ideal for IoT systems. The focused power of HTS spot beams make possible smaller antennas and lower-power terminals, which reduce terminal costs. Though IOT applications do not really need high throughput, the lower capital costs of terminals will tend to make HTS dominate over time.

Satellite-based IoT is a work in progress. Revenue from IoT applications, if it is measurable at all, makes up only a small proportion of revenue for most of the respondents we interviewed. One tech executive noted that *"Cisco has a patent on a sensor that can be sprayed into fields to monitor moisture, sunlight and other factors. That's the kind of application that would be ideal for satellite."*

Another technologist attributed the increase in applications to the increase in bandwidth: *"Data analytics, machine learning—they will just become a standard part of the business, an expected capability. This will open up new opportunities for us all."*

For the details regarding this information report, please visit:
worldteleport.site-ym.com/store/ViewProduct.aspx?id=6593820

A Frontrunner For Smallsat Services: SSC

By Guillermo Bosch, Senior Vice President, Sales + Marketing, Swedish Space Corporation (SSC)

Space is in the midst of its own renaissance—this is seen with the number of launches managed by great companies such as SpaceX and Blue Origin all paving the way forward with emerging capabilities.

These companies are also redefining industry standards in respect to affordable access to space. Also breaking new ground, although not as widely known, is Swedish Space Corporation's (SSC) innovative, flexible, and affordable capabilities that transcend the space value chain; namely, space propulsion, space launch, and ground network services. SSC has been inspired by the exciting changes in the global space market and the company remains at the forefront by continuously developing new capabilities in close coordination with its customers.

Access to Space—Unique Esrange

Cost efficient and flexible access to space has long been a core competence of SSC. SSC's Esrange Space Center, located above the polar circle, has been and remains a leading space facility in Europe since the early seventies.

Esrange Space Center is currently going through a modernization effort that will add new capabilities and strengthen its position as a leading Center of Excellence for rocket and balloon launch services and satellite communications. In light of the increasing demand for dedicated launches of small satellites into carefully designed orbits, SSC has initiated "SmallSat Express". This is a service that is intended to launch satellites weighing 1 to 150 kg.

SSC's goal is to perform the first satellite launch from Esrange before 2021. "SmallSat Express" will bring spacecraft to a standardized orbit that is suitable for most small satellites; a sun-synchronous "dawn to dusk" orbit at 500 km altitude. The intention is to make Esrange a "green" launch site, replacing hydrazine with green propulsion systems. With this small satellite launching capability, Esrange can provide a unique set of capabilities, complimentary to one another and covering a large sphere of the space service segment.

Satellite Management Services—SSC Infinity

Ground Segment Development

Twenty-five years ago, a new satellite ground network services industry was born. Several organizations, with the first being USN, based in the US, launched operations to build a global ground infrastructure based on large and complex ground stations placed in strategic locations around the world and connected to a common control center by wideband terrestrial fiber circuits.

The primary target for this new industry, however, was not the commercial space market. The impetus for the business model arose from executives at the National Aeronautics and Space Administration (NASA), who decided that the agency needed to reduce costs of space operations by outsourcing a part of their near-Earth tracking capability to the commercial sector in order to reduce operational costs.

NASA became the initial primary market and the new NASA Small Explorer series of missions (SMEX), among others, willingly adopted the concept, which then became an integral part of the nominal operational system. Simultaneously, in Europe, SSC found similar interest from the European Space Agency (ESA) and the space agencies and space boards operated by individual European and Asian countries. In 1999, a strategic alliance was formed between USN and SSC and that relationship grew stronger until SSC eventually acquired and integrated USN in 2009.

The tremendous growth in the smallsat industry, pushed forward by new commercial actors who possessed great entrepreneurial spirits, are driving space technology advances that deliver space-based capabilities for a fraction of the previous costs. This has also resulted in new demands for ground network capabilities. In this context, SSC has recently introduced an enhanced service called ´SSC Infinity´ that is based on the company's worldwide network of ground stations, complemented by an increased number of locations for access between satellites and ground systems.

SSC's Maxus 6 launch from Esrange Center. MAXUS is a joint venture between SSC and Astrium, Germany that provides up to 14 minutes of microgravity. The program started 1991.

SSC's Infinity Antenna at Esrange.

SSC Infinity is specifically designed for the support of the emerging smallsat industry. To act in this new segment, cost and reliability are crucial. By standardizing configurations and setups, SSC can offer affordable reliable solutions that expand the services of SSC's global ground station network by including smaller, yet extremely capable antennas, optimized for flexible self-service access to communications with constellations of small satellites in Low Earth Orbits (LEO)

Space Propulsion

Through its ECAPS subsidiary, SSC has invested more than 10 years in space propulsion R&D, including successful on orbit demonstrations. The result is SSC's High Performance Green Propulsion technology (HPGP) that has proven to provide improved performance, enhanced volumetric efficiency, reduction of propellant handling hazards and safer launch operations compared to hydrazine. ECAPS are now in serial production of one Newton system modules for Google-owned Terra Bella, with the first launches scheduled for 2016. Furthermore, SSC's development of Micro Electro Mechanical Systems (MEMS) technology, through its NanoSpace subsidiary, is at the core of SSC's space propulsion products. MEMS technologies reduce weight and volume and provide precise control abilities, benefits that are revolutionizing the space industry, especially the smallsat and cubesat communities.

The ECAPS Thruster.

The future of small satellites is truly exciting. SSC is proud to be at the forefront, meeting the new requirements by a unique suite of services and products that impact several aspects of the value chain—all with one ultimate focus: Help Earth make the best possible use of space.

sscspace.com/

Mr. Guillermo Bosch has almost 30 years of experience in the space and satellite telecommunication business holding important positions in many international Companies. Mr. Bosch joined SSC (Swedish Space Corporation) in September 2015 as SVP Sales and Marketing. In his capacity, Mr. Bosch is currently responsible for leading and coordinating global sales and marketing initiatives across all SSC divisions and to explore and drive opportunities to broaden the Company's existing Customer base. Mr. Bosch is particularly focused in developing new markets and introducing new business concepts in SSC.

Prior to SSC, for three years Mr. Bosch was with Signalhorn Trusted Networks based in Germany, a leading satellite telecommunications services provider with the role of Vice President of Enterprise sales; 10 years with ViaSat, Inc. of Carlsbad, California, as Sales and Marketing Director for Europe; 10 years with Hughes Network Systems of Germantown, Maryland, in various roles in technical marketing and sales, with specific focus in the introduction of advanced satellite-based telecommunication services in EMEA; and four years with Cap Gemini as a Systems Engineer.

Mr. Bosch holds a Master degree in Electrical Engineering from the University of Rome at ´La Sapienza, speaks fluent English, Spanish, Italian and French, and has published extensively with Artech House, Horizon Publishers, Intex, Gruppo Editoriale Jackson, IDG and IIR. He is a Senior Member of the IEEE, and is an invited Lecturer on Satellite Telecommunications at the University of Rome at La Sapienza and Tor Vergata.

The Bebop 2 "Leisure Drone" + Additive Manufacturing

By Matteo Levoni Bemposti, Engineer, Head of Reverse Engineering, CRP Technology

Parrot's Bebop 2 is a prime example of how professional 3D printing and Windform materials helped in the construction of this first "leisure drone."

The body of this drone was built using Selective Laser Sintering techniques in combination with innovative Windform GT Additive Manufacturing material, which combined excellent aesthetic results with excellent resistance to impact and temperature changes. Reinforced composite materials for use by auto racing teams have taken the technology of 3D Printing to new heights, now producing parts for the entertainment industry and for consumers. This article describes the construction of the first leisure drone, Bebop 2, using these manufacturing techniques.

A Lightweight + Compact Drone.

With impressive stability and maneuverability—even in extreme conditions—Bebop 2 offers easy-to-use craft piloting with little learning required of the user (pilot). Data collected by the Bebop 2's seven sensors is analyzed and processed quickly, thanks to the impressive calculation capability of the craft's onboard computer.

A specifically designed, front facing camera is integrated into the BeBop2. A pilot can digitally alter the angle of the camera by 180 degrees simply by sliding a finger across the screen of the piloting device. Digitally stabilized on three axis, thanks to powerful algorithms, images are bright, perfectly stable and without distortion, regardless of the drone's movements.

Parrot developed the final Bebop 2 version with the help of Windform GT material. The first Bebop 2 structure was built on injected parts that were constructed with polyamide-based, glass reinforced composite material. Parrot then moved to Selective Laser Sintering (SLS) technology in collaboration with CRP Technology. This move was made to optimize structure performance that did not require a long lead time and to also avoid high cost injection tooling. Also acquired was the ability to accelerate unit iteration generation, improve manufacturing time and to facilitate series production.

The Bebop 2 parts in Windform GT are the main structure (central body) and all single arms. The body is robust and flexible and the arms are reinforced. Parrot carried out an original development approach that was based on experimental analysis and FE modeling, both aimed at improving the quality of captured video during flight (which is usually altered by drone vibration) through drone design optimization. The unit's structure was also implemented through smart design to reduce overall weight.

Parrot established that the natural frequencies of the parts made with Windform GT were quite similar to those parts that had been obtained through injection molding techniques that had been applied to glass fiber reinforced polyamide. Parrot was also able to evaluate the toughness of the product structure with the new manufacturing process, for, as a consumer drone, there was a tendency by beginner pilots to lose altitude and improperly land the Bebop 2—as falls from height do take their toll. Windform GT technology proved to be the only material for 3D Printing that was able to overcome the fall tests that were carried out by Parrot's technicians.

Bebop 2 structure detail.

Other advantages obtained with Additive Manufacturing and Windform GT material included the ability to run small production batches to provide functional products to the team (i.e., quite helpful when developing other product functionalities, such as flying performance).

CRP Technology provided fast response time for new requirements, good cooperation with engineers and CAD designers, and provided the best output quality through the use of their unique proprietary process. All resulted in a fast model iterative process, the best ratio between structural strength and weight, acceptable and consistent end-results, as well as an opportunity to combine functionality from a single and unique part for multiple uses.

For additional information, please access:
http://www.crptechnology.com/2535-parrot-uas-bebop2-windform-gt-additive-manufacturing.html

Matthew Levoni , who specializes in Additive Manufacturing and Windform Materials, is the Head of the Reverse Engineering Department at CRP Technology in Modena. He attends international conferences as speaker on the use of the Additive Manufacturing in different fields, such as aerospace, motorsports, aviation, the automotive and maritime industries and UAVs . In his career Matteo Levoni has designed engines for a major automotive manufacturer.

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ALLWORLD EXHIBITIONS

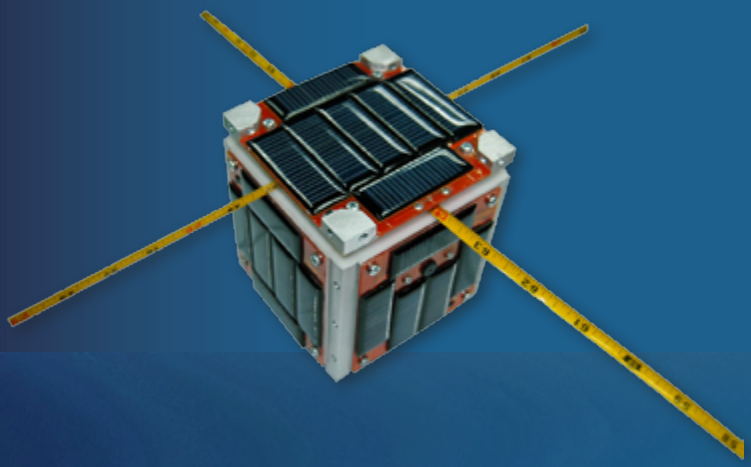
Interconnections: Smallsat Signal Integrity

By Derek Hunt, Omnetics Connectors Corporation

On any given day, approximately 2,300 man-made satellites are orbiting the Earth's surface.

These satellites are responsible for relaying analog and digital signals that carry a plethora of voice, video and data-streaming to and from various locations across the globe. Each second, these satellites directly impact everyday luxuries that most enjoy, such as cellphones and email to mission critical scientific and military communications.

Space is one of the harshest and most severe environments imaginable; however, just getting there is half the problem.



During the launch phase, each individual component, whether on the aircraft or the physical payload, is subjected to an intense array of shock and vibrational elements that can damage the electronics, including the interconnect system.

This means that designers must find manufacturers who are capable of designing and manufacturing these components to meet these stringent requirements regarding shock, vibration and extreme temperature cycles and to exceed them during the launch and deployment.

Once on orbit, these satellites range in size from microsatellites that weigh less than 1 kg to larger satellites that weigh more than 6,500 kg and, although the gap in size difference is quite large, many design characteristics relating to the components in use are also quite similar.

Going Smaller

If the space industry has taught anything, it is that whenever something has been proven to be viable on a larger payload, there's an immediate interest in reducing that particular element in size without affecting the overall capabilities and/or purpose; however, affordability has always been a limiting factor.

As time goes by, organizations have specifically focused on CubeSat designs and the affordability gap is slowly, but surely, being bridged. These smallsats are generally designed for space research in a form factor that is composed of multiples of 10×10×11.35 cm cubic units… hence, their name.

On average, CubeSats (***pictured to the right***) have a mass of no more than 1.33 kilograms per unit and often tend to incorporate small,

Commercial-Off-The-Shelf (COTS) components for their electronics—this includes the standard Micro-D and Nano-D subminiature connectors. The size and weight of all of the components employed within a payload is a crucial consideration.

Previously, satellite templates allowed designers to design in comfort connectors such as D-Subminiature connectors and 38999's; however, as satellite technology continues to expand, larger connector options, such as D-sub connectors, are no longer a viable option.

Manufacturers such as Omnetics Connector Corporation of Minneapolis, Minnesota, have taken this interconnect challenge to the next step.

"*It's truly ingenuity at its best*," said Derek Hunt, a field application engineer with the company. "*We took an existing concept and simply made it better for the user without jeopardizing the performance or overall rugged nature of such a product, oh yeah…. did I mention we ditched the jackscrews without affecting the reliability?*"

The connector being referred to is Omnetics Latching Micro-D. (Pictured to the right). This new interconnect option offers designers a significant weight savings from previous D-Subminiature footprints.

At only 1.27 mm (0.050-inches) contact spacing, these connectors are half the size of D-subminiature connectors and are an ideal solution for designers who are faced with SwaP (Size, Weight and Power) specifics. Omnetics Micro-D's, in particular, have saved designers on average of $10 per gram on Low Earth Orbit (LEO) Satellite applications and as much as $20 per gram on a Geostationary Orbit (GEO) satellites.

This is a cost savings of as much as $30,000 per satellite. Additionally, not to be forgotten, companies such as Omnetics also offer a Space Grade Nano-D Sub-miniature solution at .64 mm (.025-inches).

Space Grade Connectors

Space grade connectors come in a variety of sizes, shapes and complexities and are a mission critical electronics. All of Omnetics connectors encompass a unique flex-pin, gold-plated contact, which is polarized and shrouded by a low, outgassing insulator material.

The pin-to-socket strength makes these connectors capable of more than 2,000 mating cycles. Omnetics components meet the quality standards as mandated by: ESA (European Space Agency), ISRO (Indian Space Research Organization), JAXA (Japan Aerospace Exploration Agency) and NASA (National Aeronautics and Space Administration).

These Space-grade offerings are readily available in a number of tail terminations and pin counts. Pre-wired connectors are available with 80 micro inches of silver-plated PTFE insulated wire options—board-mount options include surface-mount and through-hole variations.

If designers are looking to move away from pre-wired assemblies by way of a flex circuit, flex tails are also available for optimal placement. Shell finishes include nickel-plated aluminum, stainless steel and titanium. Miniature cable to board interconnect systems can be designed concurrently using interactive Solid Models online with the small sat design team.

Satellite applications frequently require cable to connector shielding for EMI and potentially Cyber Security controlled lines. Omnetics shielded backshells and electrically shielded and grounded protection systems add to the long term performance of the system.

Smallsat interconnect cabling must often be wound through tightly selected routes within some of the smallest spaces imaginable. Omnetics interconnects can include highly flexible cable designs with specialty insulation that save space and meet current and voltage levels above the space and vacuum deratings expected by the design team.

Interconnect systems also include full cable assemblies consisting of mixed signal wiring that is controlled within the cable and has isolated wiring sections for zero crosstalk and inductive coupling. A number of Omnetics Micro and Nano-miniature connector wiring systems are currently available that offer the combination of high speed digital data and power. Wire hook-up protocol formats for the signal speed integrity are also available, as are special test modeling.

Dating back to the Hubble Telescope, the Omnetics design team has been working daily with space agencies, contractors and commercial space agencies to create the next "big thing" as such relates to mission critical solutions for manned and unmanned deep space explorations. Omnetics Connector Corporation offers designers the high-performance solutions necessary for space applications, with an emphasis on low outgassing materials, wide temperature ranges, smaller size and lighter weight which yield longer flight times.

Omnetics space grade interconnect solutions bring to users the reassurance of NASA's mission critical screening per EEE-INST-002, with an underlying emphasis on overall quality and reliability for their COTS's offerings and custom designed solutions.

omnetics.com/

"NewSpace" To Ground... Kongsberg's Key Solutions

By Stig-Are-Thrana, US Sales Director, Kongsberg

KSAT adapted ideas and solutions early on to form the KSAT lite network by understanding the mindset of the company's NewSpace customers.

The LEO market segment has talked about smallsat's for decades; however, this time, there was a difference that KSAT noted… that analysis resulted in the firm dedicating R&D resources to become a preferred ground station provider for the NewSpace industry, an industry that embraces new methods of approaching space and are highly motivated by competition.

While others talked, KSAT deployed ground stations and created a platform that was ready to use. The company continued hands-on learning with their clients to understand their needs, from both a technical and business perspective. The company created viable technical solutions at affordable price points and developed new business models, all leading to KSAT becoming a leading NewSpace ground station provider.

In a little more than a decade KSAT has taken the position as a world leading ground station provider for the LEO satellite market. KSAT is currently operates 20 ground station sites around the globe and runs apertures on all of the world's continents.

KSAT owns and operates uniquely positioned ground stations that span from 78 degrees north in Svalbard to 72 degrees south in Antarctica. Between five different sites in the Arctic and the one in Antarctica, KSAT has 14 additional sites located in the mid-latitude regions.

Access To Satellite Anywhere + At Anytime

The KSAT goal is to provide their customers with access to satellites from anywhere, anytime. The company has a clearly defined philosophy to provide to customers a global network that offers a one-stop-shop, rather than a station-per-station service approach. This allows KSAT ground network customers to make use of the entire global and operational network, a service that enables satellite owners to focus on their core business, which is to deliver crucial data and information services to end customers.

Unlike other companies, KSAT already has an operational network with more than 15 dedicated NewSpace assets in place. The network, KSATlite, has been designed and implemented in just under three years and is already providing services to several of the rapidly growing smallsat constellations, and more are underway. All assets in the KSAT network are KSAT lite capable and are deliver KSATlite support from the global networks.

Ground Systems Leader

How has KSAT reached this position as the world`s largest NewSpace ground segment provider? Customer centric business models and attractive prices, that's how. The firm determined that the best way to conquer market share is to focus directly on the customer and to understand their needs. By providing better solutions and better prices that have been adapted to the new needs of the NewSpace companies, KSAT firmly believes that the best marketing program is via satisfied customers.

Technology and service flexibility is another key factor that drives success. KSAT operated ground stations since 1969 and, therefore, has a strong core of expertise in the field. KSAT explains that optimizing solutions for constellation support was crucial to meet the industry's new mind-set. Customer input and adapting to the NewSpace way of thinking was a key accomplishment.

KSAT also understood that challenging the engineering group to take ownership and to design the system from a commercial NewSpace approach was important. The challenge was in trying to standardize the technology while at the same time allowing for a high degree of flexibility A plug-and-play and one-size-fits-most approach was developed—thanks to customer feedback and significant growth, KSAT has hit the target and offers a solid platform for clients, while ensuring all solutions work on the continuously moving target that continues to move this industry forward.

Ka-band in Svalbard—Less Rain, More Gain

Pole-to-pole Ka-band support from Svalbard and Antarctica is already offered by the firm and Ka-band capabilities are being incorporated into the KSAT lite network. The first Ka-band support will be ready by the fall of 2016 from Svalbard. This will be a leap forward for the smallsat community. Svalbard is by far the best location for Ka-band support, as atmospheric loss is quite low. For the client, less rain means more gain.

Fully integrated solutions are offered, including baseband units that support a variety of the most used modulation types and protocols. Users are also able to "bring their own devices" to connect into the KSAT network. This allows customers to select what makes the most sense based on their mission needs and technical designs.

By using the KSAT integrated baseband units, customers can connect to a truly global KSAT lite network, and any needed satellite access time from this global network can be provided to customers in merely a matter of days.

Bringing Home The Data

KSAT can deliver data according to customer preferences over the Internet to cloud servicing companies such as Amazon, Google or Microsoft, or access to an onsite processing and storage can be provided. Flexibility is the aim; KSAT can enable the entire value chain for the customer, who can accesses the entire network through a centralized network operations center (NOC) located in Tromsø—TNOC, 24/7.

The power of TNOC unleashed the ability to purchase satellite contacts "by the drink,"through bulk passes or with global support for constellations. All this is available through a single interface and machine-to-machine (M2M) or human-to-machine(H2M) interface via a web browser. KSAT has taken measures to ensure satellite owners can access their satellite(s) anywhere, and at anytime.

ksat.no

Bio: Stig-Are Thrana is US Sales Director and Head of Kongsberg Silicon Valley Office. He holds a Bachelor degree in Entrepreneurship and Innovation and has been working with professional radio and satellite communications for more than 10 years. Stig has been one of the entrepreneurs and pioneers of the KSAT lite network, the world largest NewSpace network.

Kongsberg Satellite Services—KSAT is a world-leading provider of ground station services from their uniquely positioned global ground network for Low Earth Orbit (LEO) satellites.

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ESA's Fly Your Satellite! Mission

For three student teams, the dream of building and working on a real space mission is coming true—at 01:50 CEST (23:50 GMT) on April 26th, a trio of student-built CubeSats were released into space as part of European Space Agency's (ESA) Education Office '*Fly Your Satellite!*' program.

Transmissions from the Fregat upper stage revealed that the door on the CubeSat deployer opened normally, around 2 hours and 48 minutes after launch, and the CubeSats traveled to their final orbits, and then the university teams waited for them to establish contact.

During the first hour of flight, the CubeSats worked autonomously to stabilize their motion, perform internal health checks and deployed their antennae to establish communication with Earth.

For the teams who programmed the satellites to accomplish these tasks, this was the most difficult time. There is nothing the team can do except trust their satellites, similar to the feeling parents have waiting at the gate to see how their children managed on their first day of school.

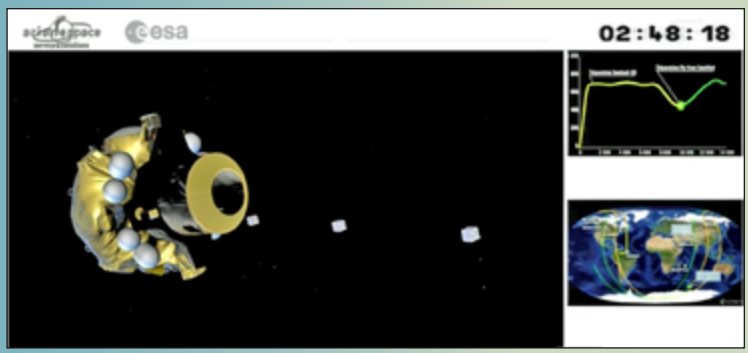
"*During testing, if something went wrong we could fix it. Now, like in all space missions, we have to count on the work done so far on the ground*," said Piero Galeone, Head of Tertiary Education at ESA and *Fly Your Satellite!* program manager.

According to Galeone, the painstaking preparations to make sure that something doesn't go wrong has been a key lesson for the students. During the test phase, they were taught not to hurry.

Fit checks for the CubeSats' P-POD on ASAP-S.

The CubeSats, which each measure 10x10x11 cm, hitched a ride on Soyuz flight VS14, piggybacking on the launch of the rocket's other passengers: Europe's Sentinel-1B, the primary payload, and CNES's Microscope satellite.

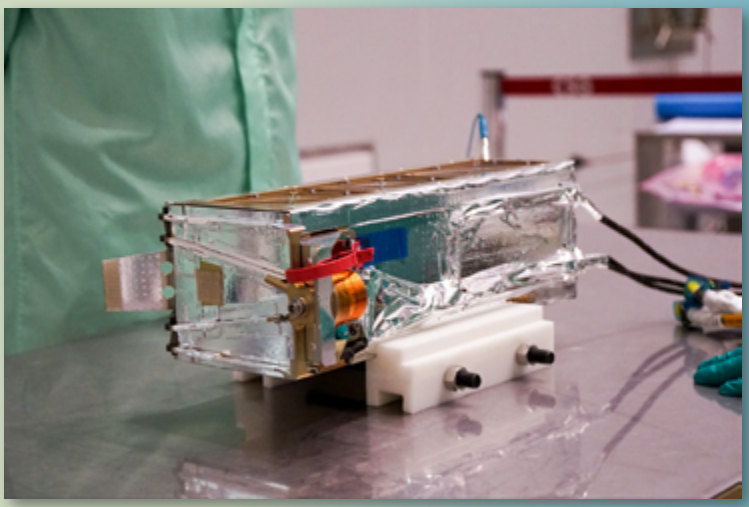
The launch itself occurred on April 25th at 23:02:13 CEST (21:02:13 GMT). Everything went according to plan, and Sentinel-1B was placed into orbit 23 minutes and 35 seconds after launch. Microscope was released later at 03:02 CEST (01:02 GMT)].



The CubeSat separation. Image is courtesy of Arianespace + ESA.

From the moment the CubeSats began transmitting, they were visible to radio amateurs from all over the world.

The CubeSats are positioned in an elliptical Low Earth Orbit (LEO), swinging from about 665 km to 453 km and back again. The final orbital parameters were confirmed over the next few hours.



Their orbit is very inclined over the Equator, taking them over the poles of the planet. This orbit placed them, periodically, in good view of the ground stations. From this orbit, they will re-enter Earth's atmosphere in approximately eight years—they will not become space junk once their missions are over.

The radio signal from AAUSAT4 was received by multiple ground stations— including ESA's ESTEC site in the Netherlands—and established bidirectional communications with its own ground station. Oufti-1 was also received by multiple ground stations, including ESTEC. e-st@r sent a first weak radio signal, which was received by at least one radio amateur in Germany.

The student teams responsible for these missions then started checking out their spacecraft and prepared to conduct the designated missions. The e-st@r team first worked on consolidating a radio communication link with their satellite.

ESA's Education Office challenged the amateur radio community to listen for the tiny satellites. All three *Fly Your Satellite!* CubeSat teams watched closely to receive the first signal acquisitions from their smallsats. Many did not sleep at all that night. Once the signals are acquired, the smallsat missions can begin.

OUFTI-1, University of Liege, Belgium, is testing a new communications subsystem; e-st@r-II, Polytechnic of Turin, Italy, demonstrated an attitude determination system that uses measurements of the Earth's magnetic field; and AAUSAT4, University of Aalborg, Denmark, operated an Automated Identification System (AIS) receiver to identify and track the position of ships transiting away from coastal areas.

In addition to these valuable contributions, the students who participated in the *Fly Your Satellite!* program now have the real world experience of working on a space mission. Having started to operate their mission in orbit, the students have entered the final phase of an exciting educational journey that started more than three years ago.

This is one of the key objectives of ESA's Education Office: to equip the next generation of scientists and engineers with the skills required to keep Europe at the forefront of space exploration, utilisation, and research.

For the students taking part in the ESA Education Office's *Fly Your Satellite!* program, the launch of their CubeSats marked the beginning of their missions. Now that the miniature satellites are in orbit, the teams are learning what it really means to '*Fly Your Satellite!*'.

"*Having your own project launched into space is so exciting! We have been working in the lab for a long time waiting for this moment. When we were notified that the first signal was received, I realized a dream was coming true!*" said a student from the e-st@r-II team.

AAUSAT4 is designed to test the Automatic Identification System (AIS) for tracking ships on navigation routes, mainly around Denmark and Greenland. The team has already downloaded a lot of AIS data and is in the process of fine tuning the system.

The received data shows that the CubeSat is in the best of health, all subsystems are working correctly and the conditions on the spacecraft are within the expected range. No anomalies have occurred and the on-board computer has functioned continuously without the need for any re-boots.

"*We are now getting down to the real work and learning what running a space mission is all about. It's a great feeling!*," said a student from AAUSAT4.

e-st@r-II is designed to demonstrate an attitude control system that uses measurements of the Earth's magnetic field. However, this smallsat is proving to be a little shy. Although a signal was picked up on the correct frequency at the correct time soon after launch, that signal was too weak to be decoded.

A concerted effort by radio amateurs around the world yielded a decoded signal on May 2nd; however, it is now clear that the CubeSat is not transmitting as strongly as it should—the student team found that their *Fly Your Satellite!* experience took a different turn.

Instead of operating their mission, they have now been given a masterclass in how engineers diagnose problems on spacecraft. This is a painstaking, step-wise process that cannot be hurried and involves excluding as many possible causes for the problem as possible to be able to focus on the root cause of the weak signal. To listen even harder to the spacecraft, the team also received help from the 25 meter radio telescope in Dwingeloo, The Netherlands.

"*The days after orbit injection have been crazy!*" said a student working on the mission, "*We had a team meeting with Professor Corpino who told us: 'Ok guys, e-st@r-II needs your help. This is a challenge that you cannot skip!' We started then to work hard on two fronts: receiving and decoding telemetry data, and running a fault tree analysis to understand what was going wrong. I have been personally involved in the development of software to decode the telemetry packets despite the very weak transmission signal, and the nice thing is that it works!*"

Work continues but one element is certain: e-st@r-II cannot be in better hands. Even if the communications cannot be brought up to projected strength, the team is obtaining important information regarding the issue, and that will serve as invaluable lessons learned for the students to apply to their future projects.

Sentinel-1B lifted off on a Soyuz rocket, flight VS14, from Europe's Spaceport in French Guiana on April 25th. With the Sentinel-1 mission designed as a two-satellite constellation, Sentinel-1B will join its identical twin, Sentinel-1A, which was launched two years ago from Kourou. Three CubeSats piggybacked a ride on Soyuz. These small satellites, each measuring just 10×10×11 cm, have been developed by university student teams through ESA's ***Fly Your Satellite!*** *effort. The other passenger is the Microscope satellite from France's CNES space agency.*

The launch photo is courtesy of ESA–Manuel Pedoussaut, 2016.

The third CubeSat, OUFTI-1, is designed to test a new radio amateur transmission protocol—the first signal was picked up soon after the smallsat was deployed from the launch rocket. During the first 12 days in orbit, OUFTI-1 was heard by radio amateurs all over the world and they forwarded more than 500 reports to the OUFTI-1 mission team, including recordings of the satellite's transmissions and decoded telemetry data.

However, on May 7th, OUFTI-1 fell silent. Investigations are on-going to determine the root cause of this failure with the hope of then recovering the mission.

Similar to their e-st@r-II colleagues, the OUFTI-1 team are also learning how to investigate the anomalous behaviour of their satellite. Starting on May 10th, they began uploading commands to the spacecraft with the aim of triggering a reset or a reaction—OUFTI-1 continues to remain silent.

The *Fly Your Satellite!* program is just one endeavour from ESA's Education Office that is designed to help train the next generation of European space professionals.

"*Having the Cubesat launched into orbit has been emotional. Seeing the happy faces of my students in that moment has been the most valuable reward for me. I followed their work in the past months and I know how much effort, time, and energy they put into it. Apart from the technical success of the mission, from my point of view the most important result of the project is that all the students had a fantastic learning experience which will be part of their professional background forever*," said the e-st@r-II academic advisor.

esa.int/Education/

Editor's note: This article is courtesy of the European Space Agency's ***Space For Educators*** *infosite.*

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AIS: Saving Lives, Improving Maritime Safety

By Andrew Loretta, Director, Maritime Business Development, ORBCOMM

Automatic Identification System (AIS) is a technology that has been adopted by vessels for collision avoidance.

Broadcasted AIS messages are captured by other vessels, satellites or terrestrial-based radios and the location and course information can be mapped and used to provide situational awareness for any vessels in motion in the immediate area.

Image is courtesy of McMurdo.

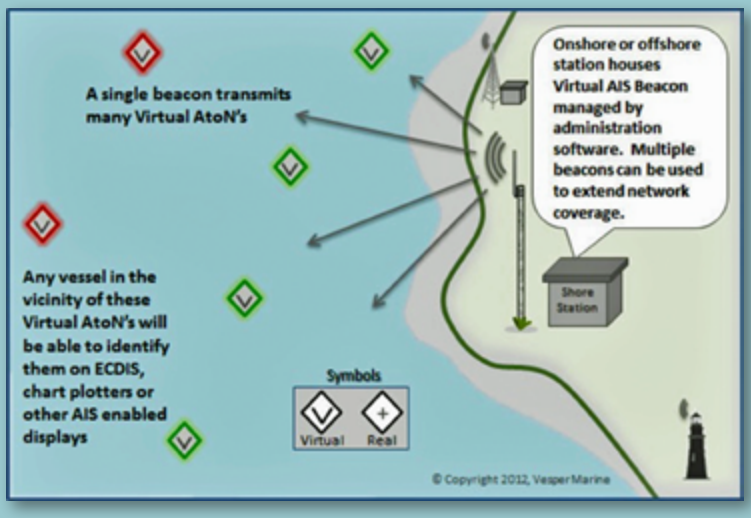
An AIS Man Overboard (MOB) device is designed to be carried by individual crew members and used in the event of a Man Overboard situation or other personal emergency.

However, AIS is not reserved exclusively for ships. Some companies, such as McMurdo (***mcmurdomarine.com/***), have produced man-overboard devices that attach to crew members and transmit emergency location beaconing signals if someone falls into the water.

Another company, Vesper Marine (***www.vespermarine.com/)***, is using AIS with their virtual beaconing system where, instead of being located on a ship, this virtual beacon is connected to a terrestrial based radio and transmits AIS messages describing the locations of stationary objects.

This allows identification of any stationary hazards close to a port, thereby enabling AIS-data equipped ships to plot and avoid dangerously shallow and rocky areas or underwater cabling.

The Vesper Marine product can also be used for demarcating dynamically changing environmentally sensitive boundaries or other keep out areas—a most interesting proposition for the effective and safe management of ports and their environments.



Infographic is courtesy of Vesper Marine.

Vesper Marine's Virtual AIS Beacon can be used to mark a shipping channel.

AIS as a location awareness technology is becoming more and more powerful, with many additional uses evolving from its original design intent of ship avoidance, especially now that the available data is no longer restricted to terrestrial/port based data.

Since the initial introduction in 2008, satellite AIS has become a permanent fixture for most organizations involved in search and rescue, fleet management, maritime surveillance, commodity monitoring, and more.

AIS has proven to be a useful tool for the location of vessels, the monitoring of traffic corridors and assisting in those examining illegal activities among others.

Augmenting satellite AIS data with other services, such as Radar Sat, Optical Satellite Services, Infrared Satellite Services, LRIT, VTS, Aircraft Surveillance and Coastal Radar has shown that with such a combination, global maritime authorities can gather a better picture of maritime awareness around the world.

Andrew Loretta is Director, Maritime Business Development for ORBCOMM. ORBCOMM operates the largest space-based AIS network, with 18 total AIS-enabled satellites, including 11 new OG2 satellites launched in December 2015. Combined with its existing network of 16 ground Earth stations around the world, average AIS data latency as short as one minute can be achieved, which enables near real-time monitoring of vessels and increased analytics capabilities.

*For more information on the ORBCOMM Satellite AIS system, please contact 1-703-433-6525; **satelliteais@orbcomm.com** or visit **www.satelliteais.com**.*

An IRG Workshop @ Telenor Satellite

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

In early May, IRG headed to Norway for a workshop that was hosted by Telenor with a drinks reception courtesy of VeriSat and an evening dinner provided by Kratos.

For many, this was a first visit to Norway—unfortunately, those of us coming from the UK managed to bring the rain with us, as well! However, the inclement weather didn't prevent thorough discussions regarding satellite interference and associated topics.

The workshop started with a decision that the organization will be returning to a single main conference, or workshop, a year for members and other interested parties. IRG attendance at shows and conferences will certainly continue. This will be an annual in mid October; however, the location will change to ensure a continued, global perspective.

The host of the event, Telenor Satellite, offered their presentation. Part of the larger Telenor Group, this satellite arm represents just one percent of the group's overall business, in spite of being a major player.

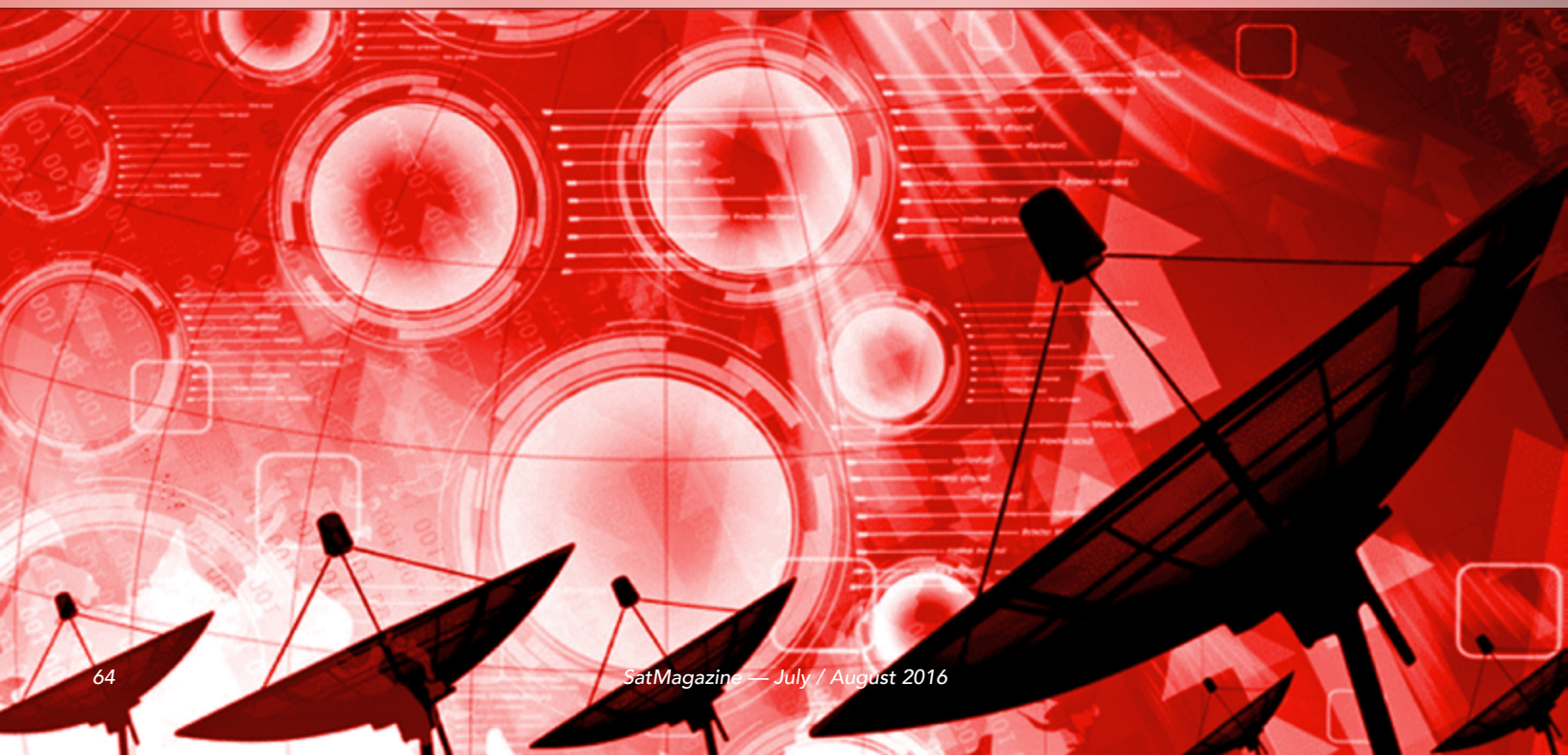
Peter Olsen, who heads up the space system, discussed how the changing face of the industry is having an impact upon customer needs. The hype around disruptive technologies means that customers require more bandwidth at a lower cost to handle that data. This means, quite simply, that those satellite operators who can offer the lowest cost per sellable Mbps will prevail.

Customers are also becoming frequency band agnostic, with satellite operators able to use the band that is the best fit for their clients, rather than being driven by a demand for a specific band. This, coupled with the need for more bandwidth, will lead to a big move towards Ka- and Ku-band. Customers are more and more seeking simplicity and they, for the most part, want to be able to just plug and play. Managed services are becoming more in demand and many satellite operators are shifting their priorities to satisfy this need. Peter Olsen also highlighted the increased threat of interference and stressed the importance of frequency coordination and the implementation of best practices.

Carrier ID (CID) again took center stage and the military also was featured in the discussions. There remains a certain amount of apprehension around CID for the military, with many government and military entities not too keen to get on board with CID unless there can be a way to ensure the technology doesn't easily lead back to them.

That said, at the same time there is interest from certain players who do appreciate that CID can make a huge difference in resolving global interference disruptions. This is not about tactical operations, but rather commercial operations, and the details of who that ID information belongs to will only be displayed to that customer's satellite operator. The flip side of the coin is that once widespread implementation is completed, the military will suddenly stand out by default as the only user not displaying CID.

One of the biggest barriers to entry for CID in the military and commercial space remains the costs involved. There were a number of discussions about how such can be resolved to make CID affordable. In many cases, users already have CID. Most DVB-S2X equipment and nexgen modems ship with CID switched off as the default—users simply don't realize that is the case and never enable CID.



Ground view of Telenor Satellite's Nittedal Teleport 45.

The workshop then moved into the world of Adjacent Satellite Interference (ASI) on mobile VSATs. Eutelsat's Andreas Voigt and SES' Russ Hogan teamed up to present how these companies work together when interference becomes an issue. With VSAT systems responsible for a large proportion of all interference, VeriSat's SatGuard and SatScan can really make a difference, as these run in the background and can alert the operator to issues before an interference impact occurs.

This is also true of other monitoring tools in additional environments, as well. The more monitoring that occurs, the more a defensive posture can take place prior to the impact.

Andreas and Russ continued with a case study where a high amount of ASI was being experienced, making the determination as to whose customer was causing the interference difficult to identify. SES and Eutelsat teamed up and, using the aforementioned tool from VeriSat, were able to quickly identify the cause of the interference and halted the problem. The solution simply could not have been resolved as quickly as it was without teamwork and the correct tool for the job.

Coordination finds groups such as IRG and the Space Data Association (SDA) playing a crucial role. One of the biggest challenges is actually getting the operators to request help. That question was raised, as well as why operators are not fully using IRG and the SDA. What was obvious from the discussion was that the answer is somewhat more complicated and steeped in sensitivities.

Those who coordinate well together have good personal relationships and have built trust on that level. IRG has a critical role to play here, joining the operations teams in the same room and building those important relationships.

One potential challenge is that eventually those people with good personal relationships may retire or move onto a new position, leaving a gap in that relationship. Ensuring the correct operations staff are at the IRG workshops, for example, can help ensure those relationships don't become lost.

When management reassurance is required, the SDA provides the vital legal framework for operators to share data, knowing that their information is legally protected. Despite these being in place, many operators are still reticent to fully make use of the groups, and this may be due to operators not fully understanding the benefits of membership in such organizations.

With all of the discussions regarding expertise, one question that repeatedly came up is how to ensure a viable intake of new talent into the industry. This is an important concern for the industry and not only to ensure a consistent approach to interference mitigation.

Many of the operators have training programs in place and IRG has already built links with some universities, something that needs to be repeated across the globe. Relationships could also be initiated to build enthusiasm by children for the satellite industry.

satirg.org/

A Millennium Space Systems Focus: Advancing The Smallsat Cause

By Jason Kim, Director of Strategic Planning, Millennium Space Systems

Millennium Space Systems is a vertically integrated provider of affordable, small to medium sized, advanced spacecraft and constellations to support LEO, MEO, GEO, and deep space missions.

The company was founded in 2001 to provide credible, low-cost alternatives for National Security Space, NASA, civil and commercial customers and is a privately owned company founded and led by Mr. Stan Dubyn, the Chairman and Chief Executive Officer. Mr. Dubyn possesses a wealth of satellite business experience and he co-founded other notable companies, one of those being Spectrum Astro.

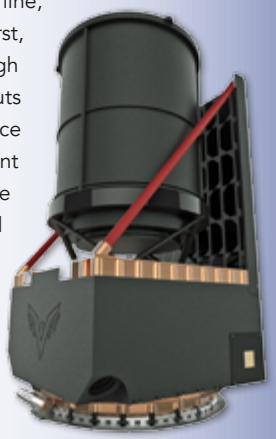
Millennium Space Systems is flexible as well as collaborative and delivers on all of their commitments with an "it must work" attitude. As one of a handful of satellite companies who have designed, manufactured, launched and operated satellites for the Intelligence Community, a majority of Millennium Space System's business is for National Security Space to include NRO, SMC, DARPA, and AFRL.

The remaining portion of Millennium Space System's business is comprised of NASA and Commercial contracts. The company has a flat organization that is aligned to provide unprecedented operational efficiency and technology refresh to reduce time and cost to market of advanced systems. The firm has a powerful mix of young and industry seasoned workforce personnel who have a wealth of experience on multiple flight programs with various Aerospace companies.

Millennium Space Systems' flight heritage spacecraft is the AQUILA™-M1 LEO spacecraft, which is a 203 kg, 3-axis stabilized, small spacecraft that hosts three advanced mission payloads. This spacecraft was launched on a dedicated Minotaur-I on February 6, 2011, from Vandenberg Air Force Base in California and has operated flawlessly for more than five years and with 99 percent availability.

AQUILA™-M1 set a new price point and responsive schedule for the space industry at less than $20 million and launch-ready in less than 24 months. Since then, Millennium Space Systems has been awarded over six flight programs to deliver more than 30 spacecraft for diverse customers and missions that include the AQUILA™-M8 GEO spacecraft, which is a 1,000 kg, 3-axis stabilized, medium spacecraft able to host over 400 kg payloads and is planned scheduled for a 2018 launch.

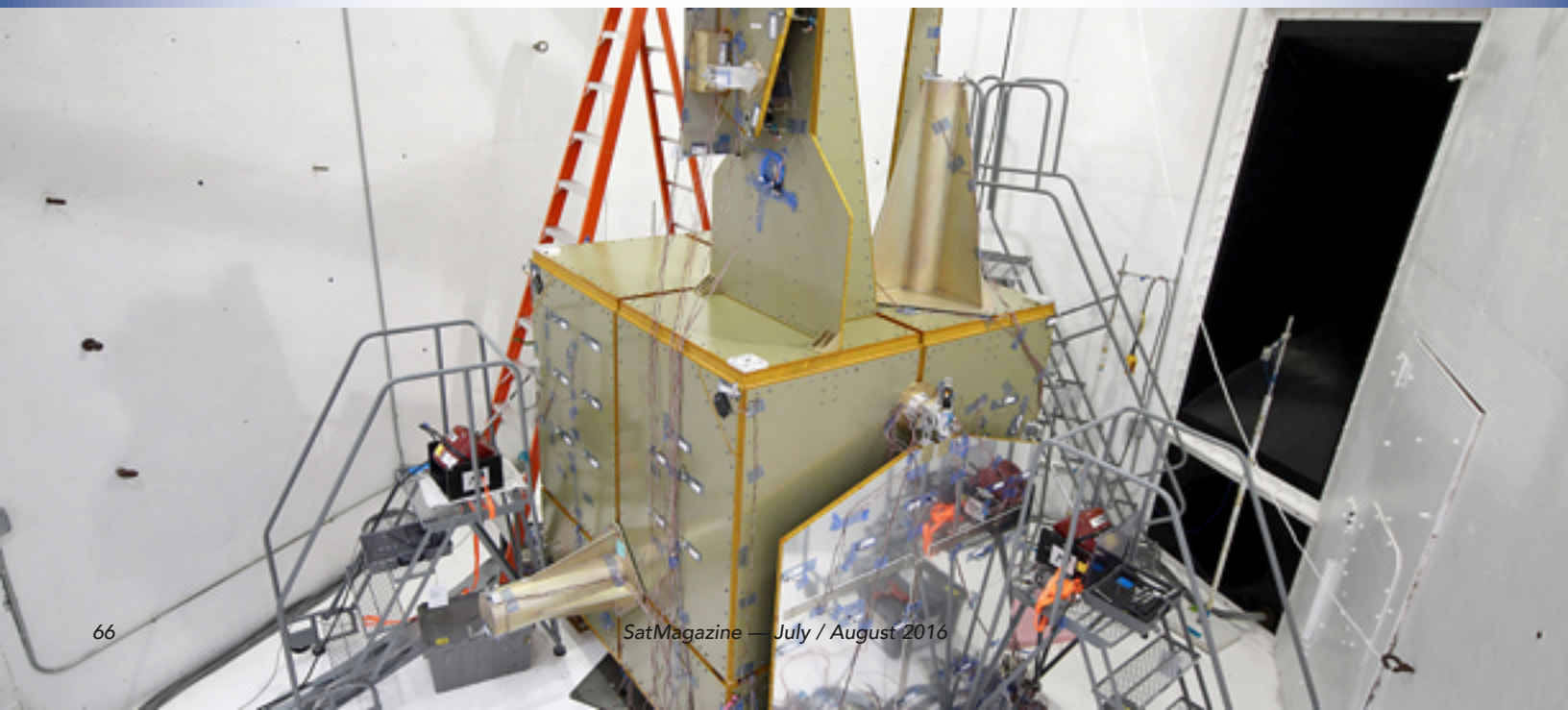
Introducing a new spacecraft product line, the company has just launched their first, software-defined, 3D-printed, ALTAIR™ high performance small spacecraft. ALTAIR™ cuts Millennium Space Systems' previous price record and schedule by more than 75 percent to offer more affordable, high performance constellations, offering unparalleled persistence on responsive timelines.

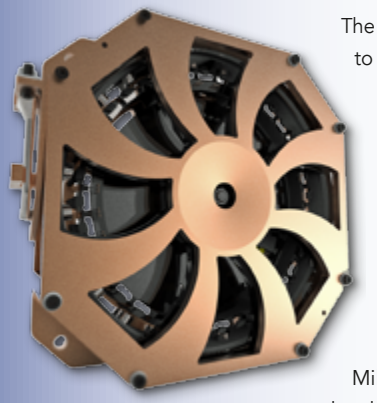


Pictured to the right: Millennium Space Systems ALTAIR™ smallsat platform.

The company was an early pioneer of the propulsive ESPA spacecraft with their Orbital Maneuvering System (OMS), capable of high ΔV missions and hosting multiple deployed and non-deployed secondary payloads in mission-unique orbits.

Millennium Space Systems takes bleeding-edge Silicon Valley technology, infusing it into space systems to provide revolutionary capabilities.





The company has an exclusive license to develop and deliver the Sinclair Interplanetary 1Nm-sec RWA-1000 reaction wheels at a $60,000 firm fixed price, as evidenced by their recent contract order for 75 reaction wheels.

Pictured to the left: Millennium Space Systems RWA1000—Small Reaction Wheel

Millennium Space Systems also develops other vital spacecraft components, such as high throughput, low-latency, low-SWaP avionics, miniature high precision star trackers, multi-mission radios for TT&C and Mission Data Links and crosslinks, all of which will have flight heritage in 2016. Light-weight, reliable mechanisms and actuators for deployables are also offered by the company.

As an end-to-end mission service provider that includes program management, systems engineering integration and testing, design and analysis, modeling and simulation, cost estimation, prototype risk reduction, spacecraft manufacturing, assembly integration and testing, payload integration, hardware-in-the-loop and software-in-the-loop testbeds, launch integration, launch support, ground development, and mission operations services, Millennium Space Systems is also able to provide commercial launch vehicle procurement and launch brokering services, if so desired by customers.

The firm operates a 70,000 sq. ft. satellite manufacturing facility in El Segundo, California, conveniently located next to Los Angeles International Airport. This facility includes a high volume production line with the capacity to deliver as many as 10 ALTAIR™ spacecraft per month, 1 AQUILA™ spacecraft per month and 100 reaction wheels per month.

This manufacturing hub also includes mission operations, secure facilities, cleanrooms and laboratories. There is also has a 5,000 sq. ft. engineering office in Chantilly, Virginia, that is resident next to Washington Dulles International Airport.

The future of space finds that, every three to five years, technologies are refreshed with a 2x increase in performance for the same SWaP and cost—this leads to a new paradigm as to how space architectures are imagined.

Millennium Space Systems foresees more disaggregated constellations of diverse mission payloads hosted on small spacecraft that are interconnected with fault-tolerant networks, providing near real-time decision quality information.

The firm sees multiple smallsat launch services to provide access to space at affordable price points and with a higher frequency of payload launches. There's also a trend of providing persistent, global, big data to analytics houses to provide activity based information.

Platforms will have open architectures and flexible interfaces to accommodate third party application software, a multitude of payloads and subsystems as well as a variety of launch and ground segments. Systems will have higher levels of autonomy and on-board processing to decrease costly ground footprints.

Customers will take advantage of alternative business models to include commercial data purchases. Millennium Space Systems envisions resilient systems that can operate through evolving threats. Their people, platforms and products, services, and facilities are positioned to make the smallsat future a reality.

www.millennium-space.com

CASBAA Satellite Industry Forum 2016: Post-Show Report

The emergence of new technologies in the satellite industry, including the arrival of HTS GSO and NGSO systems, is prompting the industry to embrace a substantial shift, from offering one-size-fits-all capacity to creating value propositions better tailored to customers' fast-growing, diverse demand and the price pressures in dynamic economic circumstances.

This was a key focus at ***CASBAA Satellite Industry Forum 2016***, attended by close to 200 industry leaders at Pan Pacific Singapore. Nine high-level panels discussed a wide range of topics, from the latest strategies in the challenging market landscape, the rise in NGSO systems, to developments in the launch market and perspectives on airline communications, broadband and enterprise solutions.

Demand For Superior Value Proposition

In the *Asia Pacific Satellite Leadership Roundtable*, key industry leaders agreed that despite cyclical downturns in industries such as oil and gas, there is still immense market potential in Asia. "*These are cyclical forces that don't fundamentally lead to long-term decline in demand,*" said Mr. Jean-François Fenech, CEO of Eutelsat Asia. "*Usage in data is continuing to pick up.*"

Panelists highlighted long-term fundamentals for sustained growth in video and broadband data connectivity, which lead to continued investments in growth across the region. These are manifested in initiatives to enhance satellite efficiency and launch new ones to expand capacity.

Amidst intense competition in the industry, the second panel—"***Is the NGSO Revolution Coming?***"—discussed the arrival of the NGSO systems as a new alternative for delivering the optimal experience in the most cost-effective manner. Mr. Mark Rigolle, CEO of LeoSat Enterprises, said, "*Satellites are now better than terrestrial solutions. Our focus is to be the fastest, most secure network, do it better than fiber and do it better than what satellites have so far been able to do.*"

However, beyond debates on seemingly competing technologies—between NGSO and GSO, Ku- and Ka- bands, terrestrial and satellite—the discussion called for the industry to take a more customer-focused approach. "*You want to offer end-to-end services; you don't want to merely sell bandwidth and MHz. Ultimately, what your customers care about are the end benefits,*" said Mr. Stéphane Chenard, Senior Associate Consultant, Euroconsult.

Featuring updates from leaders in the launch market, the third panel underlined the need to focus on the economic calculus of satellite launches and not just the technology. Mr. Jacques Breton, Senior Vice President, Sales & Business Development, Arianespace, said half of the company's backlog comprises NGSO, but also added: "*We are agnostic on any orbit; for us, it's about providing the appropriate vehicles and solutions at the appropriate cost.*"

The discussion on cost is especially pertinent with the advent of new innovations that claim to offer greater efficiency and lower costs, unlocking industry-disrupting possibilities that make space more accessible.

"*We have been successful in changing the cost paradigm,*" said Mr. Jonathan Hofeller, Vice President of Commercial Sales, SpaceX. "*We will continue to see smaller satellites and newer constellations come online that couldn't afford to previously. For small satellites, we have tapped on third party ride-share missions.*"

In addition, the panel cited reusability and automation as measures that are being adopted for enhancing efficiency.

Aeronautical Applications In An Ongoing Evolution

The fourth panel featured an exciting discussion on whether satellite applications in aeronautics and in-flight connectivity are merely a flash in the pan, especially given the challenges in monetizing this service proposition. Panelists agreed that there is no single model, as airlines integrate connectivity in different ways, from 'freemium' offerings to pay-as-you-go among low-cost carriers.

The panel also highlighted the fact that in addition to passenger and consumer connectivity, the aeronautics sector generates demand for satellite applications in aircraft operations. Even as antenna and satellite technology evolves, airlines are demanding options that are readily available to support their capabilities.

Towards World Radiocommunication Conference (WRC) '19

In a rallying call, Mr. Gonzalo de Dios, Associate General Counsel, Intelsat, emphasized that in the aftermath of WRC '15, the industry needs to advocate for a vision of the critical role that satellite will play in an ever-connected world through close coordination between service providers, end users, and customers at domestic and regional levels. "*This is about connectivity on a global level and the imperative to serve underrepresented areas.*"

Continued Optimism Amidst Price Pressures

While demand for satellite capacity is rapidly increasing, pricing remains low. Panelists in the "*The Customer is Always Right—Sometimes*" discussion tackled growing customer expectations by advocating for more aggressive business models to attract and retain customers. They also identified video as an emerging opportunity for huge growth potential.

Mr. Vaibhav Magow, Regional Director, Asia-Pacific, Hughes Network Systems, LLC, said, "*The industry is opening up many market segments that were not available to us in the past. With new technological developments, we are now starting to gain back a space in the traditional telecommunications world and fight back through innovation. That's a really strong reason to be optimistic.*"

Meanwhile, panelists on the "*CEO Panel — The Sharp End*" responded to falling transponder prices by stressing the need for businesses to increase flexibility and quality of their services to remain competitive in the market. Mr. Steve Collar, CEO of O3b Networks, said falling prices offer opportunities for the industry to innovate and deliver solutions that are more relevant to customers, and urged the satellite business to transform from a scarce, niche industry into a more accessible one.

Indonesia As A Growth Market

At the session "*Focus on Indonesia,*" panelists said weak economic fundamentals and the gap between rising operational costs and consumers ability to pay are key challenges for the satellite industry in Indonesia. Nevertheless, the fragmented archipelago heavily relies on satellite services, and demand for bandwidth in Indonesia has quadrupled in the last five years, said Mr. Henry Mulya, Sales Director, Asia Pacific, SES.

The Way Forward For The Satellite Industry

In closing, CEOs of leading satellite businesses discussed the way forward for the satellite industry and the challenges to be faced. Acknowledging the harsh stock market perceptions of the industry, the key business leaders emphasized that the business realities point towards long-term growth that can be accomplished through continuous innovation.

Summing up the day's discussions, Mr. Paul Brown-Kenyon, Chairman, CASBAA Satellite Industry Committee and CEO of MEASAT, said, "*We are at an important transformational place, and the world is changing dramatically. The amount of money we pay for data today is the same as five years ago, but the data we consume is 10 times more. I think our business would change, and the role we play in the communications sector would change.*"

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CASBAA is the Asia Pacific region's largest non-profit media association, serving the multi-channel audio-visual content creation and distribution industry. Established in 1991, CASBAA has grown with the industry to include digital multichannel television, content, platforms, advertising, and video delivery.

Encompassing some 500 million connections within a footprint across the region, CASBAA works to be the authoritative voice for multichannel TV; promoting even-handed and market-friendly regulation, IP protection and revenue growth for subscription and advertising, while promoting global best practices.