

*Worldwide Satellite Magazine*

*February 2014*

# ***SatMagazine***

## **Interference**

*The IRG Continues The Attack*

## **Sailing Into Deep Space**

*JAXA / ISAS' Professor Tsuda*

## **Electric Propulsion**

*Morgan Advanced Materials' Fichou*

## **Component Shakeups**

*Author Bill Perry*

## **COTM**

*Carrick Communication's Gough*

## **InfoBeam**



Cover Image: The SMOS satellite.  
Image is courtesy of the European Space Agency.





# SatMagazine

February 2014

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Above: Artistic rendition of the SMOS satellite in orbit. Image is courtesy of the European Space Agency.





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## ESA's SMOS satellite

Why does the ESA's SMOS satellite image grace the cover of this issue of SatMagazine? After its launch and activation in November of 2009, interference with the satellite's signals became an issue—radio transmitters, TV and radar systems managed to inflict illegal interference in the "protected" L-band established by the ITU. These signals corrupted the satellite's views of 50x50km swaths of Earth, with the desired imagery required to create soil moisture and ocean salinity maps.

What occurred was that within the map structures, there were dataless (blank) patches. Data was, quite literally, drowned out by interference. ESA directly requested hot spot countries, such as the northern United States, eastern and southern Europe, China, India and some areas within MENA, to turn off their radiation sources. However, too many countries simply ignore or do not enforce frequency regulations.

The ESA and other concerned companies are working on the development of intelligent algorithms that can defeat—and, yes, even eliminate—interference. ESA's SMAP satellite launch, scheduled for October of this year, is believed to possess receivers that can defeat unwanted signals.







*The Atlas V launch of the TDRS-L satellite.  
Photo is courtesy of United Launch Alliance  
Ben Cooper.*

**A United Launch Alliance (ULA) Atlas V rocket successfully launched NASA's Tracking and Data Relay Satellite (TDRS-L) payload at 9:33 p.m. EST on January 23rd from Space Launch Complex-41.**

This was the first of 15 ULA launches scheduled for 2014 and the 78th ULA launch for ULA in just over seven years.

NASA established the TDRS project in 1973, with the first launch in 1983, to provide around-the-clock and around-the-Earth communications for the network that routes voice calls, telemetry streams and television signals from the International Space Station, as well as telemetry and science data from the Hubble Space Telescope and other orbiting spacecraft.

"ULA and our mission partners are honored to work with the outstanding NASA team and we are proud of the vitally important data relay capabilities that were safely delivered today," said Jim Spennick, ULA vice president, Atlas and Delta Programs. "With 43 successful missions spanning a decade of operational service and

launched with a one-launch-at-a-time focus on mission success, the Atlas V continues to provide reliable, cost-effective launch services for our nation's most complex and valued payloads."

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

"Atlas and TDRS have supported each other for almost 20 years, and all three of the second generation satellites, now known as TDRS 8, 9, and 10, launched on Atlas vehicles in 2000 and 2002," said Spennick. "While we were integrating those spacecraft onto Atlas in the late 1990s, we also developed a new TDRS-compatible transmitter so that Atlas could use the TDRS constellation to receive and distribute the launch vehicle telemetry relay during flight. We are now also using TDRS services for our Delta II and Delta IV programs."

ULA's next launch is the Delta IV GPS IIF-5 mission for the Air Force planned for February 20, 2014, from Space Launch Complex-37 at Cape Canaveral Air Force Station, Florida.

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

### NASA's full launch release

NASA's Tracking and Data Relay Satellite L (TDRS-L), the 12th spacecraft in the agency's TDRS Project, is safely in orbit after launching at 9:33 p.m. EST Thursday aboard a United Launch Alliance Atlas V rocket from Cape Canaveral Air Force Station in Florida.

Ground controllers report the satellite—part of a network providing high-data-rate communications to the International Space Station, Hubble Space Telescope,

launch vehicles and a host of other spacecraft—is in good health at the start of a three-month checkout by its manufacturer, Boeing Space and Intelligence Systems of El Segundo, California. NASA will conduct additional tests before putting TDRS-L into service.

"TDRS-L and the entire TDRS fleet provide a vital service to America's space program by supporting missions that range from Earth-observation to deep space discoveries," said NASA Administrator Charles Bolden. "TDRS also will support the first test of NASA's new deep space spacecraft, the Orion crew module, in September."

The mission of the TDRS Project, established in 1973, is to provide follow-on and replacement spacecraft to support NASA's space communications network. This network provides high data-rate communications. The TDRS-L spacecraft is identical to the TDRS-K spacecraft launched in 2013.



"This launch ensures continuity of services for the many missions that rely on the system every day," said Jeffrey Gramling, TDRS project manager at NASA's Goddard Space Flight Center, Greenbelt, Md.

The TDRS fleet began operating during the space shuttle era with the launch of TDRS-1 in 1983. Of the 11 TDRS spacecraft placed in service to date, eight still are operational. Four of the eight have exceeded their design life.

Boeing Space and Intelligence Systems completed the TDRS-L integration and testing at its satellite factory in El Segundo in November and launch processing began after the spacecraft arrived in Florida December 6.

TDRS-M, the next spacecraft in this series, is on track to be ready for launch in late 2015.

NASA's Space Communications and Navigation Program, part of the Human Exploration and Operations Mission Directorate (HEOMD) at the agency's Headquarters in Washington, is responsible for the space network.

The TDRS Project Office at Goddard manages the TDRS development program. Launch management of the launch service for TDRS-L is the responsibility of HEOMD's Launch Services Program based at the agency's Kennedy Space Center in Florida. United Launch Alliance provided the Atlas V rocket launch service.

The Tracking and Data Relay Satellite System (TDRSS) is a space-based communication system used to provide tracking, telemetry, command, and high-bandwidth data return services. The TDRSS, also referred to as the NASA Space Network, consists of satellites in geosynchronous stationary orbits and the associated TDRS ground stations located at White Sands, New Mexico and Guam. Aboard each satellite are multiple antennae that send and receive signals to and from the ground to multiple satellites simultaneously.



*Artistic rendition of the TDRS-L satellite. Image courtesy of NASA.*

As a result, the TDRSS provides a wide variety of services to meet customers' needs and demands.

Microwave communications equipment and gimbaled antennae are the primary payload of each TDRS. The TDRSS is capable of providing near continuous high bandwidth (S-, Ku-, and Ka-band) telecommunications services for Low Earth Orbiting spacecraft and expendable launch vehicles, including the Hubble Space Telescope and the International Space Station. The TDRS System is a basic agency capability and a critical national resource.

The Atlas V 401 consists of a single Atlas V booster stage, the Centaur upper stage, and a 4m diameter payload fairing (PLF).

The TDRS-L mission is flown on an easterly trajectory from Space Launch Complex 41 at Cape Canaveral Air Force Station (CCAFS), Florida. The TDRS-L satellite will be released into a highly elliptical geosynchronous transfer orbit (GTO).

The mission begins with ignition of the RD-180 engine approximately 2.7 seconds prior to liftoff. Liftoff occurs at T+1.1 seconds. Shortly after the vehicle clears the pad, it performs its pitch/yaw/roll maneuvers.

Following maximum dynamic pressure, the RD-180 is throttled down to 95 percent. Guidance steering is enabled approximately 120 seconds into flight. At 212 seconds, the vehicle throttles up to a constant 5.0 G-level.

Here's what took place after the launch: Approximately 10 seconds prior to booster engine cutoff (BECO), the Atlas V throttles down to a constant 4.6 G's. BECO occurs 242 seconds into flight followed by Centaur separation approximately 6 seconds later.

Approximately 4 minutes into flight, the Centaur stage ignited its main engine (MES-1) which began a 14-minute burn to place the vehicle into a parking orbit.

Eight seconds into the first Centaur burn, the payload fairing jettisoned. Following an 82-minute coast, the Centaur main engine ignited for a second burn (MES-2), nearly 60 seconds in length. Two seconds after main engine cutoff (MECO-2), the Centaur began a spacecraft separation attitude alignment and spins up to 5 RPM. TDRS-L was released approximately 106 minutes after liftoff.

## Thales Alenia Space, Gazprom+ International Launch Services—Yamal-601's Benefactors



**Thales Alenia Space has signed a contract with Russian operator Gazprom Space Systems (GSS) to build the Yamal-601 telecommunications satellite, which will provide fixed communications, broadcast and Internet access services.**

Thales Alenia Space won the contract from Gazprom in competitive international bidding.

As program prime contractor, Thales Alenia Space is in charge of the design, production, testing and turnkey delivery of the satellite and its associated ground segment.

The satellite will be launched by International Launch Services (ILS) on a Proton rocket.

The Proton vehicle is built by Khrunichev State Research and Production Space Center (Khrunichev), the majority owner of ILS, and a pillar of the Russian space industry. Proton has an extensive heritage with 393 launches since 1965.

ILS has the exclusive rights to market the Proton vehicle commercially and has launched 84 missions over its 20 year history.

The satellite is based on Thales Alenia Space' Spacebus 4000C4 platform and will carry 18 C-band transponders, 19 Ku-band transponders and 26 Ka-band transponders focusing on Russia.

It will weigh more than five metric tons at launch, with 11 kW of payload power and a design life exceeding 15 years.

Yamal-601 will replace the Yamal-202 satellite, offering extended coverage of Europe, the Middle East, North Africa, south and southeast Asia, from its orbital position at 49 degrees East.

Along with the construction of the Yamal-601 satellite, which should take about 26 months, the Gazprom contract included a skills transfer plan, providing for training of GSS staff by Thales Alenia Space engineers, to enhance their expertise in different space industry disciplines.

Thales Alenia Space' infosite is available at <https://www.thalesgroup.com/en/homepage/worldwide/space>

## USAF + SMC—Adding More To GPS IIR-M



**Since October 2012, U.S. Air Force Space Command's Space and Missile Systems Center (SMC) has been analyzing, characterizing, testing and implementing modified battery charge control rates across the GPS IIR/IIR-M fleet.**

This fleet of 19 satellites comprises more than half of the Global Positioning System (GPS) constellation.

As of November 15, 2013, the USAF's 2nd Space Operations Squadron (2SOPS) completed the modification, which will extend the life of these satellites' operational capability.

Batteries are projected to be the primary life-limiting component when GPS IIR/IIR-M vehicles are past their design life.

Analysis by SMC, The Aerospace Corporation and Lockheed Martin indicated that reducing the charge rates during solstice season would add an average of one to two years of life per space vehicle.

SMC GPS directorate and 2SOPS will closely monitor the real-world results of this project to ensure they are in line with the expected gains. In total, it is anticipated that the modification will add more than 27 years of cumulative life across the GPS IIR/IIR-M fleet.

The Air Force Space Command's Space and Missile Systems Center, located at Los Angeles Air Force Base, Calif., is the U.S. Air Force's center of acquisition excellence for acquiring and developing military space systems.

## IRG + RFI-EUI—Joining Interference Forces

The merger sees IRG creating an umbrella over RFI-EUI, forming two advisory committees/working groups. The first will be the EUI, covering training, best practices and documentation. The second will deal with Carrier ID and will merge the two existing Carrier ID working groups of IRG and RFI-EUI.

The joined working groups will be chaired by Roger Franklin, CEO, Crystal Solutions and George Melton, Director of Engineering - Teleport, Turner Broadcasting Systems, Inc.

The newly formed EUI advisory committee will keep its remit of addressing the concerns and interests of the end user community, helping bolster their interests within IRG, as well as continuing to work closely with the Global VSAT Forum (GVF) and ITU. EUI will also bring a stronger emphasis on the end users to the newly formed Carrier ID group, especially towards the support, adoption and institution of Carrier ID activation over the next few years for all video transmissions.

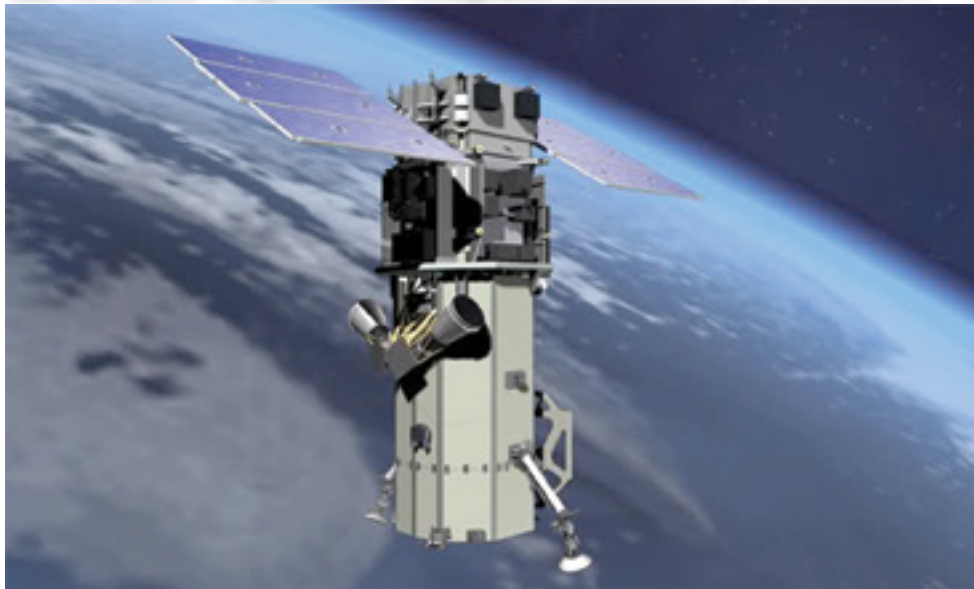
Rich Wolf, Co-chair, RFI-EUI, said, "This merger will give us much needed access to IRG's resources and enable us to better represent the needs and responsibilities of the user community within the group"

"Satellite interference continues to be an issue for the entire industry," said Dick Tauber, Co-chair, RFI-EUI. "We have been working closely with other groups, such as IRG, for over a decade and this merger makes our shared co-operation official, helping us conduct a more focused, spearheaded and definitely a more coordinated approach to mitigating satellite interference."

"RFI-EUI has an extremely important role to play in mitigating satellite interference, with its unique position of representing in particular the media end users," said Martin Coleman, Executive Director, IRG, "Having worked with them for many years, making our relationship official in this way was a natural step for us, and will ensure both groups have full visibility of our joint initiatives."

For additional information, please visit: <http://www.suirg.org/>





**Ball Aerospace & Technologies Corp. has completed integration of WorldView-3, the next generation commercial remote-sensing satellite being built for DigitalGlobe, a leading global provider of high-resolution Earth imagery solutions.**

WorldView-3, the fourth remote-sensing satellite built for DigitalGlobe by Ball, is scheduled to launch from California's Vandenberg Air Force Base in Summer 2014.

With the imagery sensor and associated electronics now integrated, the completed satellite bus is ready for system-level performance testing, followed by thermal vacuum and environmental testing.

"Ball's third commercial platform in the WorldView series will equip DigitalGlobe with advanced technologies to enhance its high-resolution imagery constellation," said Cary Ludtke, vice president and general manager for Ball's Operational Space business unit. "Ball and DigitalGlobe have proven to be a strong team for providing government and commercial customers with some of the highest quality and resolution satellite imagery available."

WorldView-3 is the first multi-payload, super-spectral, high-resolution commercial satellite for Earth observations and advanced geospatial solutions.

Operating at an expected altitude of 617m, WorldView-3 collects 31cm panchromatic resolution, 1.24m multispectral resolution, 3.7m short-wave infrared (SWIR) resolution, and 30m CAVIS resolution.

In addition to the satellite bus, Ball Aerospace is providing the atmospheric instrument called CAVIS, which stands for Cloud, Aerosol, Water Vapor, Ice, Snow. CAVIS will monitor the atmosphere and provide correction data to improve WorldView-3's imagery when it images earth objects through haze, soot, dust or other obscuring factors. CAVIS has also been integrated with the spacecraft.

"With each successive payload developed in partnership with Ball, DigitalGlobe has expanded the range of questions about the surface of the Earth that can be answered with high-resolution satellite imaging," said Dr. Walter Scott, executive vice president, chief technical officer and founder of DigitalGlobe.

"DigitalGlobe prides itself on owning and operating one of the most agile and sophisticated constellations of high-resolution commercial Earth imaging satellites in the world, currently capable of collecting over 1

billion km<sup>2</sup> of the highest quality imagery per year.

"WorldView-3 follows in this pioneering tradition with innovations like CAVIS that continue to enable DigitalGlobe to lead the industry and help our customers see things never before possible."

WorldView-3 builds upon WorldView-2 and WorldView-1 technology by carrying forward the satellites' advanced Control Moment Gyroscopes (CMGs). The CMGs reorient a satellite over a desired collection area in 4-5 seconds, compared to 30-45 seconds needed for traditional reaction wheels.

WorldView-3 employs the Ball Configurable Platform BCP 5000 spacecraft, designed to handle the next-generation optical and synthetic aperture radar remote sensing payloads and is currently meeting or exceeding all performance specifications on the WorldView-2 satellite.

The high-performance BCP 5000 has a design life of more than seven years, and provides a platform with increased power, resolution, agility, target selection, flexibility, transmission capability and data storage. Ball provided the BCP 5000 under a fixed-price contract.

For more information regarding Ball Aerospace' configurable platforms, access this downloadable PDF infodoc link: [http://www.ballaerospace.com/file/media/D1920\\_BCP%20SC\\_01\\_14\\_2.pdf](http://www.ballaerospace.com/file/media/D1920_BCP%20SC_01_14_2.pdf)

For additional details regarding DigitalGlobe, access: <http://www.digitalglobe.com/>







## ViewSat—A View From The Top... Broadcasting In Different Regions



**Following initial success in North America after launching on the Galaxy 19 satellite in November of 2013, ViewSat shares its perspective on the broadcasting landscape within the region and its growing FTA (free to air) audience.**

With approximately 86 percent of the North American population using payTV services, ViewSat offers a cost-effective alternative to the growing numbers unable to accommodate the rising subscription fees of many payTV providers.

As households are required to purchase an FTA receiver, a one-off cost to access hundreds of channels, an increasing number of consumers favor this solution to meet their viewing requirements.

This change has bought North America more in line with ViewSat's established regions of Sub-Saharan Africa and the MENA (Middle-East, North African) region where the payTV penetration is significantly lower. The MENA region is dominated by FTA services, while Sub-Saharan Africa audiences are concentrated around FTA, with elements of payTV, as well.

ViewSat is currently broadcasting a number of channels from Sub-Saharan Africa and the MENA region into North America via Galaxy 19.

The company has understood its clients' specific requirements and has intelligently chosen to broadcast via Galaxy 19 platform, which enjoys excellent penetration to ethnic audiences across the continent.

Awaes Jaswal, CEO of ViewSat, said, "Galaxy 19 is the right premium satellite for us as it reaches the most relevant communities throughout North America and a reputation for quality broadcasting of which ViewSat is keen to enhance."

While ViewSat is primarily a FTA broadcast service provider, the company will look to supplement its existing streaming solutions with greater OTT capacity in 2014.

Awaes continued, "While FTA remains our core and a fast growing part of our business, we are also looking to develop our OTT capacity. It is clear to us the importance of audiences accessing content on the go and the importance of clients linking their online presence with programming."

ViewSat's infosite:  
<http://www.viewsat.eu/>

## SPACEBEL + Vietnam—PROBA Project



*Artistic rendition of a PROBA satellite.  
Image courtesy of ESA.*

**SPACEBEL has signed the contract for the supply to Vietnam of an Earth observation system that is "Made in Belgium"—the satellite is to be named VNREDSat-1b (Vietnam Natural Resources, Environment & Disaster Monitoring satellite) and will be launched in 2017.**

A photo of the contract signing event for SPACEBEL and Vietnam is displayed in the next column.

The industrial consortium under the leadership of SPACEBEL is comprised of several Belgian space companies: AMOS, QinetiQ Space, Deltatec, the Space Centre of Liege, and



VITO, all gathering their skills to develop and validate the flight segment as well as the ground segment.

The project also includes a training program, in partnership with the University of Liège, which is intended for the training of a number of Vietnamese engineers who will be in charge of the satellite data reception and analysis.

Based on ESA's PROBA satellite platform, VNREDSat-1b will be placed in a Sun-synchronous orbit for a five year observation mission.

The satellite will allow Vietnam to strengthen its autonomy in the monitoring of phenomena such as deforestation, river and maritime pollution, flooding, agricultural and fishery activities, the effects of climate change, etc. With this information, the Vietnamese authorities will be able to better adapt their environmental management policy to the specific needs of the country. The contract amounts to more than 60 million euros.

SPACEBEL's infosite:  
<http://www.spacebel.be>

## Russia—3.3 Billion Rubles Committed To A DARPA-Like Agency

**Russia's rival of the US military research agency, DARPA, will receive 3.3 billion rubles (\$100 million) of state funding this year, its spokesman has said.**

However, this year's budget for Russia's Advanced Research

Foundation was actually decreased 12.5 percent year-on-year, the spokesman said. The US Defense Advanced Research Projects Agency (DARPA), founded in 1958, has an estimated annual budget of \$2.8 billion. The Russian agency

needed more money in 2013 as it was only setting up its operations, the spokesman said. "The funds are quite enough," he said.

The Advanced Research Foundation, established in fall

2012, is the brainchild of Deputy Prime Minister Dmitry Rogozin. The foundation has a staff of 30 and is currently supporting 12 projects, selecting them from 1,100 proposals.

## InfoBeam

NewSat Limited—For Careers, The Sky's The Limit



NewSat's Chief Technologist, David Ball, with recipients.



Implementation engineer Mark Wallace leading a tour.

**NewSat Limited is proudly supporting the future space workforce in Australia by sponsoring the Southern Hemisphere Summer Space Program (SHSSP).**

Held annually, the SHSSP is run by the University of South Australia in partnership with the International Space University (ISU).

Australia's only space program of its kind, SHSSP is a unique, five week live-in experience which focuses on a variety of space topics including policy and regulatory issues, systems engineering and technology, as well as space business and management.

Adelia and Eren, along with the other participants, have been attending lectures and workshops and visiting local sites of interest in Adelaide.

On Monday, January 20th, the lectures featured satellite communications and Earth stations followed by a commercial satellites workshop, involving NewSat Chief Technology Officer, David Ball.

Students and program coordinators also attended a tour of NewSat's Adelaide teleport, hosted by VP Engineering and Operations, Len McGoldrick, Spacecraft Systems Engineer, Mark Ramsey, SA Operations Manager, Bruce Mayberry and Implementation Engineer, Mark Wallace.

Scholarship winners Adelia and Eren were grateful for the support from NewSat and have been finding the course beneficial to their career goals.

Fascinated by all aspects of space, 26 year-old Adelia said "the best part of the experience has been bringing together different disciplines, and seeing how they are integrated to create a space mission."

Eren, 22, said "programs like SHSSP are important for Australia, as they put the country on the map in the world of space and provides a place for students to network and develop new skills."

This is the fourth time this international space education program has been held in Adelaide.

Proudly supporting the future space workforce, Adrian Ballintine, NewSat Founder and CEO said, "We are excited to support the SHSSP program again in 2014. This is a fantastic platform for young professionals to launch their space careers, applying their knowledge in a practical sense and a great opportunity to share what NewSat is doing in the industry, particularly featuring our world-renowned Adelaide teleport facility. We are proud to support Adelia and Eren, and look forward to watching them progress in the space industry."

For more information, please visit <http://www.newsat.com>



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## InfoBeam

### MEASAT + Telered—Philippine Persuasion

**MEASAT Satellite Systems Sdn. Bhd. ("MEASAT") and Telered Technologies & Services Corp. ("Telered") have an agreement for capacity on the MEASAT-3a satellite.**

Under the terms of the agreement, Telered will use

for the distribution of the Viva TV and Pinoy Box Office (PBO) channels across the Philippines.

The agreement also contains an option for additional capacity to support Telered's planned future expansion of video distribution services in the Philippines market.

"Telered is excited to embark upon the next stage of its growth plans," said Redentor Laset, President, Telered. "With this capacity, we will be able to serve local and regional programmers for their local distribution requirements."

"Our decision to

enter into partnership with MEASAT was also on account of their ability to provide a flexible working approach customized to our requirements," he added.

"MEASAT is pleased to support Telered's plans to provide new distribution channels and playout services to the Philippines market," said Raj Malik, Senior Vice President – Sales & Marketing, MEASAT. "We look forward to continue supporting Telered's expansion plans to carry exciting new content to audiences across the Philippines."

The Telered infosite is located at: <http://www.telered.com.ph/>

For additional information regarding MEASAT, access: <http://www.measat.com/>

### Ericsson + Dialog Axiata—M2M Mechanics



In addition to supplying the Device Connection Platform, Ericsson has been recruited for consulting and systems integration to accelerate Dialog's M2M go-to-market plans, according to the vendor's release.

Jeremy Huxtable, head of Dialog's enterprise division, said, "M2M allows for simplified and improved processes, and this brings us a step forward in capitalizing on existing assets to drive market leadership of M2M in Sri Lanka."

For more information on this Ericsson offering:

<http://www.ericsson.com/ourportfolio/products/device-connection-platform>

**Sri Lanka's largest mobile operator by subscribers Dialog Axiata has selected Sweden's Ericsson for the provision of its Device Connection Platform to develop existing machine-to-machine (M2M) products and services aimed at enterprise customers in diverse sectors such as utilities, finance, telematics and transport.**

Ericsson's M2M platform enables enterprise users to monitor devices, access information, and integrate devices into existing systems, while the solution promises Dialog new opportunities to increase revenue while cutting both operational costs and time-to-market.

### Euroconsult—India, In-Depth



**The newly released report, "India Satcom Markets 2014", India's satellite communication sector has experienced significant growth over the past five years driven by explosive demand from DTH payTV platforms and growing telecommunication needs in the country.**

The SATCOM value chain is strongly influenced by the Indian Space and Research Organization

(ISRO) that is present all along the SATCOM value chain including for satellite manufacturing, launch, satellite operations, regulations and partially for services. On the manufacturing level, roughly half of the country's satellite manufacturing sector spending is currently dedicated to developing communications satellites.

"While ISRO dominates the satcom manufacturing landscape, outsourcing to foreign and

national companies will continue to provide growth opportunities for a number of players with hundreds of millions of dollars to be outsourced from 2013-2021," said Deepu Krishnan, Senior Consultant at Euroconsult.

Satellite capacity demand from DTH broadcasting grew at a CAGR of over 7 percent from 2008-2013, now representing 32 percent of the country's total commercial satellite capacity usage. TV distribution services to cable operators and VSAT enterprise networks have equally seen growing demand in recent years, leading to an increasing number of players now operating in the country's teleport and VSAT service market.

In particular the cellular backhaul market has begun to see strong take-up in India with the arrival of HTS systems such as IpStar, but also government backed networks connecting schools, remote villages, etc., are currently growing with increasing capacity needs. Alongside satellite services, the annual satellite ground equipment market has also seen growth, generating \$40 million in equipment revenue in 2012, dominated by international ground terminal manufacturers.

While domestic operator ISRO/Antrix enjoys significant regulatory advantages in the market, only a proportion of the commercial demand for satellite capacity is being met by domestic capacity today, with the majority being provided by foreign satellite operators. Regulatory barriers and capacity supply constraints still challenge market growth.

In total, demand for regular C- and Ku-band capacity is expected to grow at 6 percent p.a. between 2013 and 2023 in addition to new demand for SATCOM services using HTS systems that should see strong take up towards the end of the decade.

Additional report information: <http://www.euroconsult-ec.com/research-reports/satcom-reports/india-satcom-markets-2014-39-54.html>

**With many new HTS systems launching within the next 12 – 24 months, it is easy for classical FSS C-band capacity to get lost in the mix.**

Yet, as NSR projects in its Maritime Satellite Markets report, FSS C-band is not going anywhere—adding another 55 TPEs of capacity over the next 10 years.

Maritime service providers continue to expand their FSS C-band capacity, as more end-users continue to increase their bandwidth demands. Even KVH recently announced a doubling of the capacity for two of the three global C-band beams of its mini-VSAT Broadband network.

Given C-band's near ubiquitous coverage for maritime markets (minus the polar regions), high tolerance for rain-fade, and almost 8,000 In-service units by 2022, FSS C-band still has a lot of momentum within the marketplace. However, the real question remains: could there be an end in sight for FSS C-band for maritime markets?

In short, it is unlikely within even the next 15 years. Even as GEO-HTS C-band based systems come online, their limited coverage outside of major areas of maritime concentration (such as Atlantic shipping routes or centers of Oil & Gas concentration) continues to bolster support for the traditional FSS C-band networks.

Although merchant maritime traffic will follow highly predictable routes between the major land-masses, other maritime markets continue to roam the oceans—from cruise

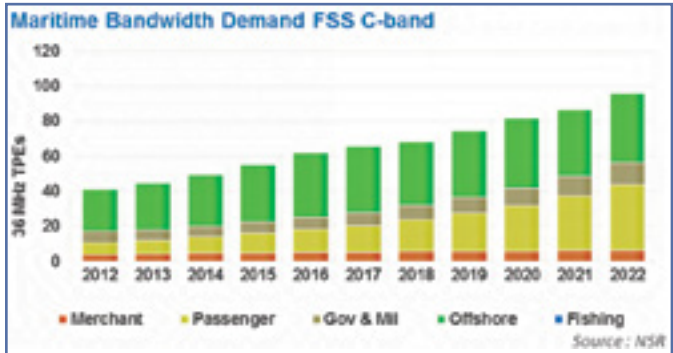
ship routes opening up within the Pacific, new areas of O&G activity, to ongoing military activities throughout the high seas. These are all heavy users of FSS C-band capacity and even with the introduction of GEO-HTS and MEO-HTS, they will continue to rely on FSS C-band.

Even merchant shipping—the largest market for maritime satellite-based connectivity—will continue to lean on FSS C-band capacity to enable highly robust network availability at higher throughputs and better price-points than MSS-based offerings can strictly provide.

Additionally, robust network design continues to be the significant factor in FSS C-band's appeal. However, some steady migration of FSS C-band from primary to co-primary or secondary roles will impact the per-unit revenue growth prospects for service providers going forward.

As more traffic shifts towards FSS Ku-band, GEO-HTS or MEO-HTS solutions, ARPU will likewise decline. Instead, revenues will be driven by new vessels coming online with hybrid systems installed where FSS C-band will remain a critical component for service providers to enable high network availability regardless of vessel location.

Taking the lead, offshore maritime markets and passenger vessels will be the largest consumers of FSS C-band capacity due in part for their need for high availability (both in frequency and in coverage), and larger bandwidth demands compared to other maritime markets such as fishing or merchant shipping.



With frequent travels outside of major maritime shipping routes, including trans-oceanic transit of vessels between regional hot-spots, FSS C-band will remain a critical component of their connectivity solutions. In short, hybrid solutions with a combination of FSS C-band and GEO-HTS will be a leading network design going forward within the offshore and passenger vessel market.

Not to be forgotten, FSS Ku-band will remain a critical piece of the connectivity puzzle for maritime end-users, with demand spread almost equally across the maritime market. But, for the higher-end verticals, and higher-end maritime customers, FSS C-band prospects still remain strong.

With many other satellite markets shifting away from FSS C-band, the maritime market remains a strong market with ongoing bandwidth growth prospects.

Driven by the higher-end segments of the market—larger passenger vessels, offshore end-users—FSS C-band will remain a key ingredient for maritime service providers looking to capture high-end customers...

alongside investments into GEO-HTS architectures.

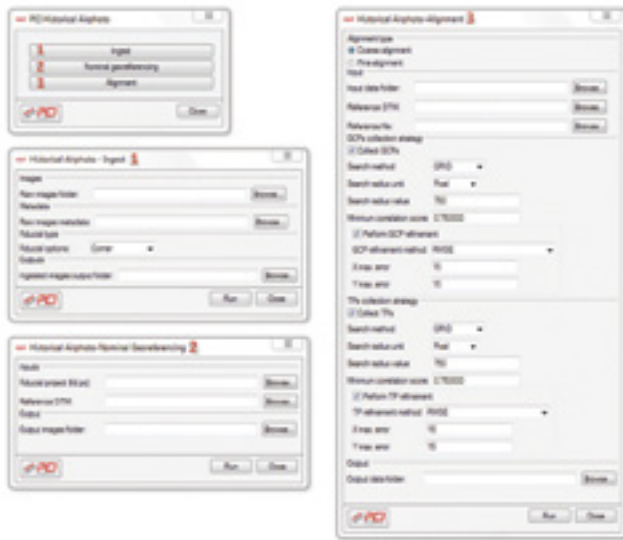
### About the author

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Maritime Satellite Markets info:

<http://www.nsr.com/research-reports/satellite-communications/maritime-satcom-markets/>

### PCI Geomatics Updates Historical Airphoto Processing Workflow



#### PCI Geomatics has updated its Historical Airphoto Processing (HAP) workflow.

The HAP workflow, released to the public in March of 2013, provides a semi-automated means to align, orthorectify, and mosaic digitally scanned airphotos.

The system can greatly reduce manual labor, increase throughput, and achieve high accuracy.

This update adds a functional and intuitive Graphical User Interface (GUI) to the workflow.

"The strong demand for historical airphoto processing drove the decision to add a user-friendly interface to the HAP system," said David Piekny, Product Marketing Manager at PCI Geomatics. "The GUI further simplifies the process, allowing more users to take advantage of this technology and unlock their historical archives."

The HAP workflow uses multi-pass processing and automated ground control and tie point collection.

This produces an accurate math model that can be used to generate individual orthos or seamless ortho-mosaics from hundreds or thousands of airphotos without camera calibration files.

The system is built with PCI's proven Geomatica technology and can be scaled to meet all requirements for historical airphoto correction.

The HAP workflow corrects imagery to make it usable in GIS and image processing software environments so users can benefit from multi-year image analysis, tracking changes that have occurred across the landscape.

"For decades, access to historical imagery was typically restricted to archives and difficult to access – requiring onsite consultations that consume valuable time and resources," explained Piekny. "Even in cases where the photos were scanned and cataloged digitally, use in GIS applications was severely limited due to misalignment and scale. HAP changes that, and the update makes it even easier to modernize a complete collection."

PCI Geomatics is a developer of software and systems for remote sensing, imagery processing, and photogrammetry. With more than 30 years of experience in the geospatial industry, PCI is recognized for accurately and rapidly processing both satellite and aerial imagery.

PCI has installed more than 30 thousand licenses, in more than 150 countries worldwide.

More info at:  
<http://www.pcigeomatics.com/pressnews/photos/PCI-HAP-GUI.jpg>

### SNC + NASA: Facility Prep For Launch



Space Launch Complex 41 at Cape Canaveral Air Force Station.

In the latest example of NASA Kennedy Space Center's transformation into a multi-user spaceport, Sierra Nevada Corporation (SNC) of Louisville, Colorado, has announced the steps it will take to prepare for a November 2016 orbital flight of its Dream Chaser spacecraft from Florida's Space Coast.

The announcement included the purchase of an Atlas V rocket from United Launch Alliance (ULA) for the launch, sharing the Operations and Checkout (O&C) development and testing facility with Lockheed Martin Space Systems, establishing an operation center at Kennedy Space Center and using the former Shuttle Landing Facility (SLF) runway at Kennedy.



The steps are considered substantial for SNC and important to plans by NASA and Space Florida for Kennedy's new availability to both commercial and government customers.

SNC said it plans to work with ULA to launch the company's winged Dream Chaser spacecraft into orbit from Space Launch Complex 41 at Cape Canaveral Air Force Station.

The Dream Chaser spacecraft is designed to carry crew and critical cargo to destinations, as well as perform servicing and science in low-Earth orbit. SNC said they intend to complete Dream Chaser missions with a landing on the 3.5-mile runway at the SLF. Space Florida, which will operate the SLF in the future, will negotiate the terms and

conditions for the runway's use with SNC.

The company said it plans to prepare the Dream Chaser spacecraft in the high bay of the O&C building at Kennedy, with Lockheed Martin performing the work.

The facility also is used for the development, assembly and testing of NASA's deep space Orion spacecraft. Dream Chaser testing will take place without disrupting Orion, NASA's flagship human exploration vehicle. SNC also plans to lease office space at Exploration Park, located just outside Kennedy's gates.

The Dream Chaser spacecraft is deep into development of flight hardware and specific plans ranging from ground support equipment to what to include in a mission operations center.

For more information about Sierra Nevada Corporation's Dream Chaser, visit:  
<http://www.sncspace.com/ss-space-exploration.php>

For more information about NASA's Kennedy Space Center, visit: <http://www.nasa.gov/kennedy>



## InfoBeam

### Virgin Galactic—You're Fired, And For Good Reason



**Virgin Galactic has announced the company has reached a significant milestone in the testing of a new family of liquid rocket engines for LauncherOne, the company's small satellite launch vehicle.**

As part of a rapid development program, Virgin Galactic has now hot-fired both a 3,500 lbf thrust rocket engine and a 47,500 lbf thrust rocket engine, called the "NewtonOne" and "NewtonTwo" respectively.

Further, the NewtonOne engine has successfully completed a full-mission duty cycle on the test stand, firing for the five-minute duration expected of the upper stage engine on a typical flight to orbit.

These tests are being conducted on two new state-of-the-art test stands that the team designed, assembled and installed internally.

The new rocket engines were designed and assembled in-house by Virgin Galactic engineers and technicians, and mark the first firings of engines designed and built by the privately-funded company, owned by Sir Richard Branson's Virgin Group and Abu Dhabi's aabar Investments PJS.

As part of the ongoing test program, the NewtonOne engine has now been fired dozens of times, achieving the target thrust during a full-duration test.

The test team has successfully completed as many as six distinct test firings in a single day, as a demonstration of the rapid test-retest capability critical to the liquid engine program.

The larger NewtonTwo engine has also been fired multiple times at short duration, with longer duration firings scheduled to occur in the coming months.

Additionally, Virgin Galactic engineers and technicians successfully completed a quick turnaround test in which engines were swapped out and fired within 12 hours, an important early demonstration of LauncherOne's responsive, quick call-up capability and of the versatility of both the engines and the test stand.

Both engines were custom-designed by Virgin Galactic to serve as the propulsion system for the LauncherOne satellite launch vehicle, which uses a single NewtonOne on the upper stage and a single NewtonTwo on the main stage.

Both engines are simple, pressure-fed LOX/RP-1 systems built with a low part-count design. The NewtonTwo engine is a scaled-up version of the NewtonOne, sized to serve as the first stage engine for LauncherOne, with a nozzle optimized for air-launched performance.

Powered by those two engines, LauncherOne will carry small satellites to low-Earth orbit affordably and responsively, enabling a new generation of private and government missions.

Further info:  
<http://www.virgingalactic.com/>

## InfoBeam

### Signalhorn + Digitaria—On-Board Presence



**Digitaria International has selected Signalhorn to provide satellite communications services to passengers and crew aboard a fleet of 12 luxury vessels operated by a leading provider of shipboard travel in the Americas, Mediterranean and South African markets.**

Signalhorn will provide passengers and crew with on-board Internet access and voice-over-Internet (VoIP) phone service with connectivity through its teleport in Leuk, Switzerland.

This connectivity will also allow shipboard crews to use positioning applications for offshore safety.

Digitaria International, based in Luxembourg, delivers network services to its customer's fleet, following the seasonal location of each of the dozen ships.

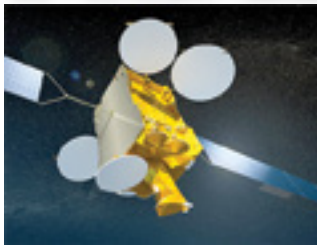
The firm provides continuous service with roaming capabilities independent of each ship's physical location in the Caribbean, Mediterranean and Southern Africa.

Additional routes are planned for the near future. Under the contract, Signalhorn will provide the service through four different satellites for a term of three years, with options for extension.

More information regarding Signalhorn is available at: <http://www.signalhorn.com/>

Digitaria's infosite is located at: <http://www.digitaria-international.com/>

### ILS + EUTELSAT—Slotting Soon



**International Launch Services (ILS) and Eutelsat Communications have announced that the EUTELSAT 9B satellite will be launched in 2015 by an ILS Proton launch vehicle.**

The EUTELSAT 9B satellite is a high-capacity Ku-band spacecraft that is being built by Space Systems (formerly Astrium) of Airbus Defence and Space. Based on a Eurostar E3000 platform, its 66 transponders will deliver to Eutelsat fresh resources and enhanced performance for broadcasting at the established 9 degrees East location via multiple service areas over Europe.

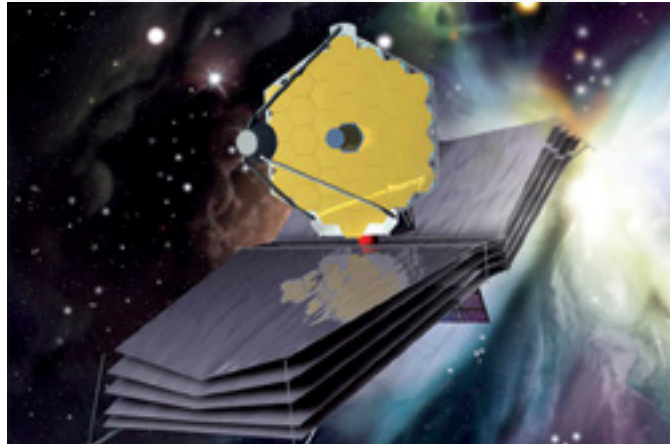
EUTELSAT 9B will also host the first data relay payload for the European Data Relay Satellite System (EDRS) being implemented through a Public-Private Partnership (PPP) between Space Systems and ESA.

The EDRS system of telecommunication satellites in geostationary orbit will enable very high data rate, bi-directional data relay communications between Low Earth Orbit Earth observation satellites and an associated ground segment.

The Proton launch vehicle is Russia's heritage heavy-lift vehicle, built by Khrunichev Research and Production Space Center, the majority owner of ILS and one of the mainstays of the global space industry.

The ILS infosite is located at: <http://www.ilslaunch.com/>

### Northrop Grumman + NASA—Milestone Marvel



**Northrop Grumman Corp. (NGC) has passed a Critical Design Review (CDR) for the James Webb Space Telescope way ahead of schedule.**

The CDR ensures that the construction of this space will support the powerful telescope and science instruments that will deliver astonishing views of the universe.

NGC passed the CDR five months ahead of schedule. The spacecraft provides the power and communications for the entire observatory and is responsible for pointing the telescope and image stabilization.

Northrop Grumman is under contract to NASA's Goddard Space Flight Center in Greenbelt, Maryland, for the design and development of the Webb Telescope's optics, sunshield and spacecraft.

An independent panel of experts conducted a rigorous, week long review of the detailed design, construction and testing plans, and flight software for the Webb Telescope's spacecraft.

The CDR included extensive discussions on all aspects of the spacecraft to ensure construction of a vehicle that will enable the powerful telescope and science

instruments to deliver astonishing views of the universe.

The team successfully completed more than 76 preceding reviews on the spacecraft subsystems to prepare for this CDR.

"Our Northrop Grumman team did an incredibly thorough job preparing for this design-review and demonstrated impressive knowledge of Webb's subsystems," said Andy Cohen, Webb spacecraft manager, Northrop Grumman Aerospace Systems. "I am exceptionally proud of how hard this team worked to meet this important mission milestone on an accelerated schedule."

NASA's James Webb Space Telescope is comprised of three major components; the telescope, the tennis-court sized sunshield, and the spacecraft. The sunshield separates the observatory into a warm sun-facing side and a cold anti-sun side to protect the telescope optics, or mirrors, from the sun and Earth's heat. The warm side below the sunshield is the spacecraft side. The spacecraft provides power, pointing capability and fuel for station keeping.

The completed mirrors arrived at NASA's Goddard Space Flight Center in December 2013, and production of the final flight sunshield layers is currently underway. The spacecraft CDR

was the last major design to complete, marking significant progress toward completion of the Webb Telescope.

Following this successful review, manufacturing of the various parts that make up the spacecraft such as the fuel tanks, gyroscopes and solar panels will continue.

The James Webb Space Telescope is the world's next-generation space observatory and successor to the Hubble Space Telescope. The most powerful space telescope ever built, the Webb Telescope will observe the most distant objects in the universe, provide images of the first galaxies formed and see unexplored planets around distant stars.

The Webb Telescope is a joint project of NASA, the European Space Agency and the Canadian Space Agency.

To follow the JWST's progress, access: <http://jwst.nasa.gov/>

### Spaceflight + NanoRacks—The Cubes Have Arrived



**Whether you are a well-funded start up, a university, or kick starter campaign, access to space for nanosats is steadily improving with each launch and deployment.**

Spaceflight and NanoRacks had multiple CubeSats sent to the International Space Station on the Orbital Sciences Cygnus Orb-1 Mission. This was made possible by close cooperation between the two companies. The satellites were manifest via the NanoRacks Space Act Agreement with NASA, and are scheduled for deployment using the self-funded NanoRacks CubeSat Deployer.

Spaceflight, with an extensive network of Launch Service Providers worldwide, was able to offer its customers the NanoRacks space station mission opportunity. The two companies have a joint teaming agreement to find the optimal launch and orbit for payload provider customers.

On January 9th, 2014, at 1:07 PM EST, the Orbital Sciences Antares launched the Orb-1 Mission to the International Space Station (ISS) commercial resupply mission from Wallops, Virginia. Cygnus docked with the ISS and the payloads were unloaded for deployment via the NanoRacks CubeSat deployers over a period of six weeks.

Adam Hadaller, Mission Manager at Spaceflight, commented, "It has been a pleasure to work on this mission with our launch partners and customers over the past year and half." Hadaller added, "Whether you are a well-funded start up, a university, or kick starter campaign, access to space for nanosats is steadily improving with each launch and deployment."

Jeffrey Manber, CEO of NanoRacks praised the teaming with Spaceflight as well as thanking "everyone at NASA and JAXA and throughout the ISS partnership that allowed our historic commercial ISS deployment to move forward." Added Manber, "Spaceflight is our largest partner in facilitating ISS satellite opportunities and we respect their expertise in the industry."

Spaceflight's next launch is slated for April of 2014 onboard the Kosmostras Dnepr launch vehicle. NanoRacks next launch is the Orb-2 mission to ISS slated for the spring.

Spaceflight—The Space Logistics Company—provides frequent, cost effective, and routine access to space for deployed and hosted payloads. Spaceflight specializes in the launch of CubeSats, nanosatellites and microsatellites with masses between 1 and 300kg.

Through its global network of launch vehicle providers, Spaceflight can deploy payloads

to Low Earth Orbit, the Moon, and beyond.

Additional information is available at: <http://www.spaceflightservices.com/>

NanoRacks LLC was formed in 2009 to provide quality hardware and services for the U.S. National Laboratory onboard the ISS. The company developed and has research platforms onboard the U.S. National Laboratory, which house plug-and-play payloads and a family of other research facilities.

The current signed customer pipeline includes domestic and international educational institutions, research organizations and government organizations, and has propelled NanoRacks into a firm position in the emerging commercial market for LEO space use and beyond.

Further details at: <http://nanoracks.com/>



### The Satellite Industry Association (SIA) has announced the election of its 2014 Executive Committee.

The SIA Board of Directors elected Bill Weller of Space Systems/Loral (SSL) to serve as Chairman for the coming year, joined by Stacy Fuller of DIRECTV, as Vice Chairman, and Jennifer Manner of EchoStar, as Treasurer.

"SIA is privileged to announce such experienced industry executives to lead its Board. The incoming Executive Committee reflects the diversity of the satellite industry businesses that SIA represents and demonstrates the strong commitment our members have made to the Association," said Patricia Cooper, President of SIA. "I would like to thank SIA's outgoing board for their service during the past year and we

look forward to 2014, poised to continue our role as the voice of the U.S. satellite industry."

Bill Weller is Vice President, Marketing and Sales at SSL, where he leads technical and business teams that work with U.S. and international satellite operators to design and procure customized new geostationary communications satellites. He also leads space policy efforts with the U.S. Government for SSL. Mr. Weller was named to this position in 2001 after serving as Director of Americas Marketing and Sales, and previously for the Asia-Pacific region. Prior to these positions he served as project manager for satellite ground-systems development and satellite operations programs and led new business development in these areas.

Stacy Fuller is Vice President, Regulatory Affairs at DIRECTV. In this position, she is responsible for overseeing DIRECTV's federal regulatory issues impacting DIRECTV. Prior to joining DIRECTV in 2005, Stacy was Media Legal Advisor to former FCC Commissioner Kathleen Q. Abernathy. Before serving in the government, Stacy worked at Skadden, Arps, Slate, Meagher & Flom, LLP, Discovery Communications, Inc., Alston & Bird, and Wiley, Rein & Fielding. Stacy is a graduate of Emory University School of Law and the University of Michigan.

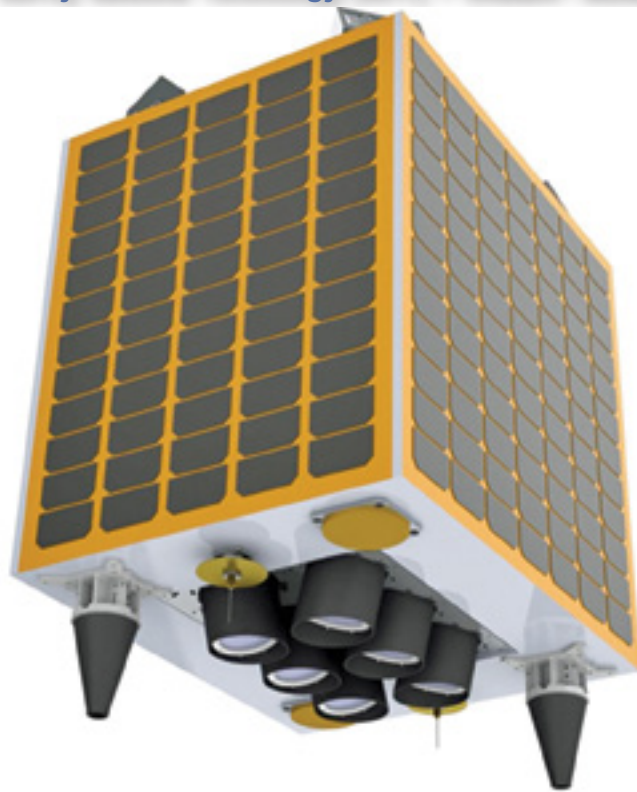
Jennifer Manner is Vice President, Regulatory Affairs at EchoStar. Prior to joining EchoStar, Ms. Manner served as Deputy Chief of the Office of Engineering and Technology and before that Deputy Chief of the Public Safety and Homeland Security Bureau of the FCC. Before that, Ms. Manner was Vice President of Regulatory Affairs at MSV. Previously she served as senior counsel to FCC Commissioner Kathleen Q. Abernathy, where she focused on international, satellite,

wireless, new technologies and consumer issues. She has also served respectively as Director of International Alliances and Associate Counsel for Foreign Market Entry and International Wireless Services at MCI WorldCom, Inc. Ms. Manner is an adjunct professor at Georgetown University Law Center. She has published numerous articles as well as books, including International Market Access (Artech House, 1999) and Spectrum Wars (Artech House, 2000).

SIA is a U.S.-based trade association providing worldwide representation of the leading satellite operators, service providers, manufacturers, launch services providers, and ground equipment suppliers. Since its creation more than eighteen years ago, SIA has advocated for the unified voice of the U.S. satellite industry on policy, regulatory, and legislative issues affecting the satellite business.

For more information, visit <http://www.sia.org/>

## Surrey Satellite Technology (SSTL) + Ghulam—Building KazSTSAT On A New Platform



Surrey Satellite Technology Ltd (SSTL) and Ghulam LLP (Kazakhstan) have agreed that SSTL's new X50 platform

design will deliver KazSTSAT, a small satellite mission announced under a contract signed last year.

KazSTSAT will be based on the SSTL-X50 Earthmapper variant and will carry an SSTL SLIM-6 imager, providing 22m resolution multispectral imagery with a swath width of more than 600km for global wide-area imaging.

The new SSTL-X50 Earthmapper variant combines a large volume of data storage, enhanced power generation capacity and high downlink availability to continuously image the sunlit land mass making it particularly suited to applications requiring a high temporal revisit rate, such as agricultural and flood monitoring, water quality assessment, forest monitoring and disaster management.

Luis Gomes, SSTL's Director of Earth Observation and Science, said, "It is very gratifying that less than three months after the public introduction of the X50 Earthmapper, one of our longstanding customers has decided to base its new satellite on this platform."

Under a joint development program 14 Kazakh engineers will work alongside SSTL engineers to design and build the KazSTSAT spacecraft. In addition to the SLIM-6 imager, KazSTSAT will fly a number of Ghulam LLP developed payloads, and will join the Disaster Monitoring Constellation,

which provides daily images for applications including global disaster monitoring. Environmental testing will take place at a new Ghulam LLP test facility being established in Astana, Kazakhstan.

SSTL has developed the new X50 satellite platform to provide a smaller, lighter, flexible spacecraft with enhanced systems capabilities and quality. With a mass of 50kg, the compact, highly integrated design baselines flight-proven heritage with next-generation avionics to incorporate fully dual redundant subsystems and scaled core platform services such as power, structure, data processing, communications and high-precision attitude control.

The new platform design allows SSTL to take advantage of automated batch avionics manufacturing and test processes, and aids rapid assembly and integration of the spacecraft, bringing customers the benefit of shorter order to orbit timescales and reduced fixed-price costs.

SSTL's infosite: <http://www.sstl.co.uk/>





## InfoBeam

### SMI—The Technology + Tools To Combat Interference

**Communication engineers face a number of challenges today, including maximizing the amount of information that can be communicated over the limited resources available.**

As the number of satellites increase, the spacing, or separation between satellites decreases, and the increase in demand for more and more content to be delivered from the same or multiple satellites, interference between the satellite signals has become an issue.

Satellite services are widely used by the commercial sector and the military. Reliance on detecting minute signals in a fog of radio frequency "noise" interference, either unintended or deliberate, is a challenge for all trying to maintain assured and reliable communications links.

SMI's masterclass, which will be conducted on April 15th, 2014, in London will discuss the technology and tools used to mitigate interference through commercial sector initiatives and explore how interference is managed and reduced.

Presenters from the IRG, SAT Corporation and Newtec will look at the challenges posed by this important issue, identify current and potential solutions, describe what is being done within the satellite community to ensure that robust satellite communications can be sustained as services rapidly expand.

Key benefits to this masterclass:

- Gain a better understanding of the key causes of interference
- Understand how the external environment can impact operations and cause satellite interference
- Gain knowledge of the tools and technology available for mitigating satellite interference
- Gain a better understanding of the current global initiatives for satellite interference mitigation

The Masterclass Speakers...

- Martin Coleman, Executive Director, Satellite Interference Reduction Group
- Robert Rideout, Vice President of Sales & Marketing, SAT Corp.
- Thomas Van Den Driessche, COO, Newtec

Those who should consider attending this conference should be personnel within military or commercial organizations that...

- Uplink to satellites
- Operate/maintain satellite broadcasting and VSAT networks

Additionally, those involved with implementing interference initiatives should register to attend... they include professionals working on...

- Carrier/Spectrum Monitoring and Geolocation
- Implementing Carrier ID
- Improvement to

VSAT networks

- Military communications personnel—Ops + Eng
- Satellite operators (commercial, sales and marketing)
- Uplinkers (commercial, such as broadcasters and military service providers)
- Communication project managers

Register online at this direct infopage link:

<http://www.smi-online.co.uk/defence/uk/masterclass/satellite-interference>

### Arianespace—Cryogenic + Staging Elements' Trip Is Completed



Vega launcher elements to be used for Arianespace Flight VV03 are unloaded from the MN Toucan sea-going vessel's upper deck (at left) and roll-on/roll-off interior cargo bay (photo at right). Photo courtesy of Arianespace.

**[SatNews] Arianespace's "supply pipeline" is supporting the company's high-activity launch pace planned for 2014, with launcher elements arriving this week in French Guiana for its third flight of the lightweight Vega and another heavy-lift Ariane 5 mission.**

These components were delivered by the MN Toucan—one of two sea-going vessels performing rotations between Europe and South America, regularly transporting stages and other hardware for the Ariane 5, Vega and medium-lift Soyuz vehicles that compose Arianespace's launcher family.

Included in the MN Toucan's roll-on/roll-off interior cargo bay were the main cryogenic stage for an Ariane 5 to be launched this spring on a mission designated Flight VA218, along with its combined cryogenic upper stage/vehicle equipment bay unit.

Also carried in the cargo bay, as well as on the ship's upper deck, were components for the Zefiro 23 second stage and Zefiro 9 third stage to be used on Arianespace's next Vega mission—designated Flight VV03 in the company's numbering system.

This flight will be the third performed from French Guiana by the lightweight vehicle, and is to carry the DZZ-HR high-resolution observation satellite



The Ariane 5 main cryogenic stage for Arianespace's Flight VA218 emerges from the roll-on/roll-off interior cargo bay. Photo courtesy of Arianespace.

built for the Republic of Kazakhstan by Airbus Defence & Space.

This hardware was unloaded from the MN Toucan after it docked at the city of Kourou's Pariacabo Port, enabling the transfer by road to the nearby Spaceport.

For 2014, Arianespace's order book provides payloads for up to 14 launch opportunities, with the company's objective to perform 12 missions during the year—depending on the

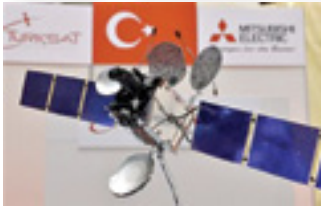
availability of satellites.

Based on current planning, this activity would be composed of six Ariane 5 launches, four Soyuz missions and two Vega flights.

The Arianespace infosite is located at:

<http://www.arianespace.com/>

## Türksat + Mitsubishi—A Model, For Now



**A scale model of a "Türksat-4A" communication satellite produced by Japan's Mitsubishi Electric was delivered to the Turkish space company Türksat.**

The model was displayed after a handover ceremony that was attended by Turkish Prime Minister Recep Tayyip Erdogan at Mitsubishi's Kamakura plant in Kamakura, in suburban Tokyo, in early January.

Turkish Prime Minister Recep Tayyip Erdoğan attended a delivery ceremony of the Türksat 4A satellite that was co-produced by Turkish and Japanese engineers in Tokyo.

As part of his official tour, Turkish Prime Minister visited the satellite production center of

the Mitsubishi Electric Company located in Tokyo, where the two satellites Türksat 4A and 4B were produced.

Erdoğan, in his speech at the center, stated that the project was a concrete indicator of the joint achievement of both countries in aerospace studies, aviation, science and technology. The satellite will enable Türksat to offer telecommunication and TV broadcasting services throughout Turkey, as well as in Europe, Central Asia, the Middle East and Africa, the company official said.

The Turkish prime minister confirmed that the satellite will be sent to the launch base in Kazakhstan and will be launched with a proton rocket on Feb. 15. He added that they have been planning to launch the second one (Türksat 4B) in the second quarter of 2014 after its test period completes. He said that this satellite would also provide television broadcast and satellite communication systems for the African continent.

## Saft—This Lion Roars w/9,000 Cells + 275 Million Hours

**Saft has now placed more than 9,000 battery cells into orbit and has logged 275 million hours, or 31,000 years, without failure or deviation.**

Saft, a designer and manufacturer of high technology batteries for industry, achieved a milestone when the 100th satellite to use the company's pioneering Li-ion battery technology launched this month. The firm's latest success was the Inmarsat 5 F-1 satellite that lifted off via a Proton M rocket from Baikonour, Kazakhstan, on December 8 of last year. The launch also marked the 75th GEO satellite in orbit using Saft batteries.

To date, Saft customers have launched Li-ion batteries valued at 120 million euros into space. The company's Li-ion technology is proven to last throughout the life of the satellite with up to 18 years of orbit, in most cases.

Saft's extensive list of partnerships with flight heritage includes space and defense industry leaders, such as Boeing, EADS Astrium, Thales Alenia Space, Orbital Sciences Corp,

NASA, the European Space Agency, CNES and many others.

Most of the company's batteries in orbit are within the GEO commercial or military telecommunication satellites, with the oldest, W3A manufactured by EADS AST, launched in 2004.

For these 100 launches, Saft provided long-life, high energy batteries, comprised of VES 140, VES 180, VL 48E and MPS cells, for the satellites. Saft's Li-ion battery packs supply a voltage range of 4V to 100V with a capacity from 5.8 to 52 Ah at the cell level and up to 625 Ah at battery level. The Li-ion battery system is lightweight, which reduces the overall mass of the satellite to improve efficiency.

Saft's infosite:  
<http://www.saftbatteries.com/market-solutions/space>

# What's This "Interference" I'm Always Hearing About? What Can Be Done About It?

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



**A**s we enter into 2014, there are, yet again, a number of important milestones for us to reach in the fight against satellite interference.

Upcoming are the first of the next round of global sporting events, with the Winter Olympics in Sochi, the World Cup in Rio and the Commonwealth Games in Scotland. With so much occurring, IRG will keep you updated as we move forward—this new column will include views, opinions, and updates from the IRG full members each quarter.

## IRG—What's It All About?

I'm sure many of you are already familiar with the issue of satellite interference and the formation of the Satellite Interference Reduction Group (IRG). For a recap, this organization was formed in 1997 as the Satellite Users Interference Reduction Group, then reformed with a new Executive Director (yours truly), a new board of Directors, and a new name (the word "Users" was dropped).

As the name suggests, the organization is all about reducing satellite interference, which is accomplished through improving technology and processes, informed debate and better understanding, which naturally leads to a reduction in satellite interference.

In reality, satellite interference only affects a small number of services. When it does occur, it can be extremely detrimental to those experiencing the interference. The IRG is working closely with the entire industry to reduce it.

On the other side of the coin, the work we are doing means greater efficiency, improvements for operators, manufacturers, and users across the board, whether they are experiencing satellite interference or not.

## Why Do We Need IRG?

The role of IRG is four-fold. First, as a forum for open discussion; secondly as a lobbying force; thirdly as a gatherer of information; and finally as an innovator and supporter of new technologies such as Carrier ID.

## Discussion Forum

IRG is able to serve as a unique industry forum, offering its members the opportunity to share information and drive change in a coordinated way. There is an annual conference, where experts from every sector of the industry discuss the most important trends, and, more importantly, actions are decided upon—such as, what do we do next?

The IRG also hosts meetings, often in

unison with the Global VSAT Forum (GVF) at major tradeshow throughout the year, including Satellite 2014, CommunicAsia, and IBC. This year, we are looking at hosting a second mini-conference, giving our members even more platforms to discuss with one another to gain further understanding of interference issues and thereby solving important issues.

At all of these meetings case studies are presented and they are always popular. These presentations reveal how instances of interference have been solved, often due to the collaboration among operators. Also brought to the forefront are issues that still require resolution. These are invaluable to those who are suffering similar instances of interference, and we encourage open discussions. Attendees can bring current issues to the table and receive assistance and advice.

When we are not running events, IRG members can access this service on an ad hoc basis, emailing us with current challenges they are experiencing. We then push this information to other members to help find a solution. They also have access to our resource library, including presentations, and those all-important case studies.

## Lobbying Force

Over recent years, IRG has become recognized as a leading force for change in the industry. IRG is everywhere and we talk to people and get things done. The most significant example of this has to have been the Carrier ID (CID) in time for the 2012 London Olympics campaign.

IRG persuaded operators to make CID effective on video transmissions—the manufacturers came on board to ensure there would be equipment at the ready to handle CID and to test the equipment before the games themselves. IRG assisted with aggressive marketing and lobbying ahead of the Olympics, which ensured that broadcasters wanted CID and interference-free transmissions. The result was an interference-free Olympics with happy broadcasters, happy operators and happy viewers.

In parallel was our campaign to cement a standard into place for the new CID technology. The IRG promoted the new CID technology, which was developed by Comtech and organized a meeting of manufacturers to get that ball rolling. Manufacturers, with special efforts from Newtec and Ericsson and the DVB, led to this improved technology becoming a DVB Specification and an ETSI standard in May of 2013.

## Getting The Facts

This leads into another aspect of IRG's importance—information gathering. Being a neutral organization, the organization is in a unique position as it is able to gather vital information from different, often competing, organizations. This allows us to obtain an accurate snapshot of exactly what is happening, right now, to gain better trending analyses and evaluations, which ensure we focus on corrective remedies.

The chair of our VSAT working group, Thomas van den Driessche of Newtec has, for example, been gathering statistics specifically on VSAT interference. Also, in 2013, we teamed up with Newtec to conduct a survey about CID implementation, which led to some interesting statistics, including the fact that 93 percent of respondents do suffer from some form of interference. You can read more by accessing this infopage: <http://www.newtec.eu/article/release/93-of-the-industry-suffers-from-satellite-interference>

## New Technology

By helping to innovate and support new technologies to improve our industry, including technical ingenuity that helps form new standards, is how IRG can work on better reactive tools to deal with the various



# INTERFERENCE

forms of interference that affect transmissions around the globe.

We have implemented many achievements throughout the last couple of years.

However, all of these initiatives can only be successful if we can encourage widespread implementation of CID.

The new CID technology is a fantastic step in the correct direction, but now we need to get users to require it and put the processes in place between the satellite operators to handle the monitoring and operation of CID. We are beginning to see a number of products available that are able to handle CID and you can review the list on the IRG website at this URL: <http://satirg.org/resources/cid-ready-products/>

At the upcoming Satellite 2014 trade exhibition, we will be hosting a "Carrier ID Tour," taking attendees around the various stages of CID, from its transmission, monitoring, and detection to the resolution process. Hopefully this will help educate and inform those who wish to better understand the processes involved, the simplicity of CID, as well as highlighting the plethora of products already available with CID. If you are interested in taking part in this tour, please email [press@satirg.org](mailto:press@satirg.org)

My other goal for 2014 is to improve Geolocation technology and all associated processes. Ultimately, Geolocation is the most valuable offering within our toolkit, enabling operators to locate the source of all types of interference. Of course, for intentional interference, it is often the only method of determining the source. By developing new features for Geolocation, we will improve location of the interference source more efficiently and with better accuracy.

IRG is working with key Geolocation suppliers to standardize the procedures, data gathering and reporting, for all types of geo-located interference. The simpler process will reduce time to action and better records and, where necessary, better evidence. From this we hope to gain improved statistics that will help us understand the problem and be able spot interference patterns for speedier resolution and, perhaps, predict when incidents are likely to occur.

With that in mind, my goal for the next 12 months is for the industry to supply standardized Geolocation reports with the eventual inclusion for ITU submissions and to start the migration process to a formal ISO standard.



## Working Together

In 2013, I attended 16 events on five continents and beat the drum for IRG and all of our initiatives for reducing satellite interference. However, IRG is not just Martin Coleman.

IRG offers members a forum and support and we also rely on them to help make the organization relevant and important. Our Board of Directors, who are elected from the full members, often speak on our behalf at industry events, as well as support all of our many-faceted activities.

We also have the Chairs of our three working groups busy making things happen and obtaining positive results. With that in mind, and as mentioned above, the next column will feature opinions, comments, and updates from within our membership and from those around us on the ground—it's all about getting things done!

In the meantime, here is a list of the IRG membership:

- » **The Aerospace Group**
- » **AGI**
- » **Arabsat**
- » **ArSat-SOCC**
- » **CENG**
- » **Crystal Solutions**
- » **Es'hailSat**
- » **Eutelsat**
- » **Hispasat**
- » **Infrasat**
- » **Inmarsat**
- » **Integrasys**
- » **Intelsat**
- » **ISRO**
- » **Mitre**
- » **Newtec**
- » **NTA-India**
- » **SAT Corp**
- » **SatMex**
- » **Optimal SatCom**
- » **SES**
- » **Pasifik Satelit Nusantara – PSN – Indonesia**
- » **Siemens**
- » **SingTel**
- » **StarOne**
- » **Telenor**
- » **TeleSat**
- » **Türksat**
- » **YahSat**
- » **Zodiac**

The IRG is comprised of four main working groups that cover: Carrier ID (SCPC), Intentional Interference (Technology), VSAT (Statistics), and the End Users Initiative, addressing training, best practices and documentation. Each group is chaired by a key industry expert who is charged with the task of ensuring progress in each of those areas, in establishing the practical initiatives and obtaining the support of the entire industry.

- **VSAT (Statistics)**
- **Intentional Interference**
- **Carrier ID**
- **End Users Initiative**

Some of the latest efforts by IRG may be found their campaign to achieve Carrier Identification (CID) implementation on all video carriers are as follows:

*The Global VSAT Forum (GVF), Satellite Interference Reduction Group (IRG), and the Radio Frequency Interference – End Users Initiative (RFI-EUI) announced last November a launched, joint initiative to implement interference prevention measures more deeply throughout the broadcast sector.*

*The launch follows a number of important milestones, including meetings of the Arab States Broadcasting Union (ASBU) in Tunis, where a significant action plan was agreed upon. The action plan is aimed at establishing a public awareness campaign to highlight that intentional interference will not prevent the media message being delivered. The plan includes guidelines around training, Earth station approvals, and Carrier ID (CID), as well as regulatory and political actions.*

*The World Broadcasting Unions—International Satellite Operations Group (WBU-ISOG)—also issued a number of important resolutions that related to the implementation of Carrier ID. These resolutions support the requirement that by January 1st of 2015, all new model modulators and codecs with integrated modulators purchased by end users for video uplinking should contain a CID. They also stated that all uplinkers of SCPC and MCPC Video and Data should include CID functionality in the required specifications of all current and future Requests for Proposal, with immediate effect. The WBU-ISOG has also just approved and adopted the ASBU Action Plan, following its meeting in Rio de Janeiro.*

*Then there was the initiative for the Football World Cup in 2014 that was first announced during the IRG Annual Conference in Rio de Janeiro last October, where the group's Executive Director lay down the gauntlet to those present to make this happen. The announcement follows the success of a similar campaign leading up to the London Olympics, where half of the carriers had ID. This resulted in few instances of interference, and the hope is that the industry can take it one step further in time for the Football World Cup in 2014.*

*"We are entering the challenging part of implementing CID," commented Martin Coleman, Executive Director, IRG. "We have the ETSI standard, fantastic, but now the hard work begins! Building the system, databases and processes, and ensuring widespread implementation and getting the users to turn CID on!"*

*The Space Data Association and Analytical Graphics Inc. revealed the first demonstration of the prototype CID database at the IRG conference in Brazil. The creators are now encouraging feedback and input from the industry in order to build the final working database. The other part of this campaign is to educate users about CID and crucially, how to turn it on.*

To learn more about IRG: <http://www.satirg.org/>

## About the author

Martin Coleman is Executive Director, the Satellite Interference Reduction Group (IRG). Since taking on the position in 2011, Martin has been active in spearheading a number of significant initiatives, including a campaign to introduce Carrier ID across all SCPC transmissions from the 2012 Olympics through to being ready for full industry implementation by January 1, 2015. Martin regularly addresses the industry on the subject of satellite interference, at global industry events, on an individual basis, and at the IRG annual conference.

Martin is also the Director of his own monitoring and control company, Colem, as well as responsible for European Sales for Crystal Solutions, a leading provider of Network Management Systems plus automation control (NMS+) for the video distribution industry.





## Driving Communications On The Move

By Bob Gough, Managing Director, Carrick Communications, Ltd.

**M**edia, resources, maritime and aeronautical industry requirements from commercial and consumer perspectives are growing at an increasingly rapid rate. Global demand for Communications On The Move (COTM) is driving the evolution of the satellite industry to continue to provide fresh capacity and develop the associated technologies.

The globalization of content and data movement; emerging economies with rising middle class income; broadband connectivity with wireless and bandwidth heavy applications; mobility for broadband at sea, on land and in air; format proliferation from devices through to ultra HD—these all highlight the vital role of satellite communications and the importance of available satellite capacity around the world.

So noted Claude Rosseau, Senior Analyst for Northern Sky Research (NSR) recently, “As airlines continue to seek the best business models to offer connectivity during flights, it is not a question of if, but when will they provide Wi-Fi and data services via satellite.”

### Current Australian Assessment

Communications play an integral role in the information society in which we currently live, whether it be in-flight entertainment and connectivity for airline passengers or executive transport operations and maritime patrol and troop missions.

With the geographical constraints of a large continent such as Australia, the consideration of travel time and schedules within and outside the country is vital for real-time decision making, employee productivity and operational efficiency. Internet access employing satellite broadband enables true mobility and satisfies the demands from government, enterprise and consumer markets for constant access to the flow of information with reliable, secure connectivity anytime, anywhere.

For example, by June of 2013, 19.6 million subscribers had Internet access via a mobile handset in Australia. That's an increase of 13 percent from the end of December 2012. The volume of data downloaded via mobile handsets between April and June 2013 was 19,636 Terabytes, a 43 percent increase from the period October to December 2012, according to the Australian Bureau of Statistics.

In Australia, airline activity has undergone an increase, according to the Bureau of Infrastructure, Transport and Regional Economics (BITRE). In September of 2013, 2.681 million international passengers, and in October of 2013, 5.24 million domestic passengers boarded aircraft, leading to a 5.8 percent and 2.2 percent increase, respectively, compared with the same months a year earlier.



Artistic rendition of the MEASAT 3b satellite, which hosts NewSat's Jabiru-2 payload providing focused coverage in and around Australia. Image courtesy of Astrium.

Australia has 91.5 percent of cargo transported by sea, 1,068,000,000 tons by Australian vessels.



Additionally, shipping has seen 130 percent growth over the last 10 years to a level of 52,206 voyages annually. In June of 2012, the Office of the Inspector of Transport Security also reported that Australia is currently the fifth largest LNG exporter in the world and the industry is developing projects that will make Australia the world's first or second largest LNG exporter by 2018.

At the same time it reported that Australia's offshore LNG projects are extending further northwards, with major developments underway in the JPDA between Australia and Timor Leste and closer to Indonesia. From another maritime perspective, the unique requirements from government and military, particularly in relation to maritime intelligence, surveillance and reconnaissance (ISR), are also key demand drivers.

### The Role Of SATCOM

With the abundance of enterprise, government, maritime, aeronautical and consumer demand for anywhere-anytime broadband around the globe, satellite communications is the technology to cater for bandwidth demand and information sharing on the move. With the infrastructure, technology and capacity for two-way communication between air, land or sea vessel and head office, satellite provides time critical Internet, voice, video and data for mobility, maritime and aeronautical markets.

The seamless integration of enterprise networks which ensure that every remote employee can communicate, whether they are sitting at the next desk on land, on the other side of the world at sea or in the sky, is among the vital roles played by satellite communications in today's bandwidth dependent, mission critical, information society.

### Bandwidth Availability

In response to requirements for high bandwidth for fixed and broadcast services, together with more targeted coverage, Ku-band satellites provide capacity to supplement the saturated C-band, as well as to complement Ka-band capacity—their use has spawned a range of innovative satellite applications.

Ku-band was initially adopted for satellite communications exclusively, eliminating competition and signal interference from other communications systems. It enabled high-speed uplinks and downlinks using smaller, end-user antennas. Ideal for deploying services to multiple users, Ku-band enables focused bandwidth and high-quality communications across larger geographical regions.

It's all about meeting the growing demand from remote sites, virtual employees and exploration teams requiring real-time data transfer and video conferencing to onsite office services, remote asset monitoring, and workplace health and safety. These high bandwidth mobility applications will continue to require "new" capacity to function effectively.

### Fresh Capacity

It is the capacity from satellites such as NewSat's Jabiru-2 that will ensure the bandwidth required for innovative mobility applications is available upon demand, providing highly targeted Ku-band coverage in and around Australia. Set to launch in early 2014, Jabiru-2's high bandwidth connectivity in the Australasia region is opening up new satellite

their international equating to carried annually and foreign

possibilities for oil & gas, mining, maritime, aeronautical, media and carrier-grade telecommunications markets in the area.

The highly focused capacity across Australia, Timor Leste, Papua New Guinea and the Solomon Islands will deliver to enterprises and governments the network cohesion of communications across large geographical territories and the knowledge that, wherever they are, reliable and secure communications are available.

### The Countdown Begins

The MEASAT 3b satellite which hosts the Jabiru-2 payload was built using the Astrium Eurostar 3000 platform. NewSat Chief Technology Officer, David Ball, noted, "We are pleased Jabiru-2 construction is complete and look forward to working with MEASAT as we continue to prepare for launch."

NewSat Chief Commercial Officer, Scott Sprague, said, "There is a lot of interest in Jabiru-2. Jabiru-2 will further facilitate NewSat's services across the emerging and growth regions of Australia, Papua New Guinea, Timor Leste and the Solomon Islands. With high intensity zones and its focused capacity, Jabiru-2 will enable NewSat to deliver the high-quality, exceptional services our customers expect."

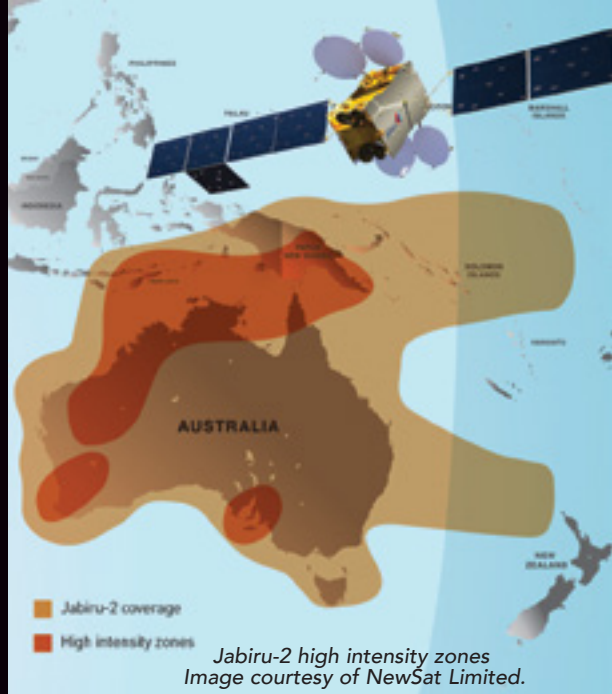
Jabiru-2 is currently in storage at Astrium's Toulouse site in France and, once a launch date in H1 2014 is confirmed, the satellite will be securely transported from Toulouse to the European spaceport at Kourou, French Guiana.

Jabiru-2 will be launched by Arianespace on the industry leading Ariane 5 launch vehicle and reside in the orbital slot at 91.5 degrees East. The satellite will have a 15-year contractual in-orbit mission life, a launch mass of approximately six tons, a wingspan of 40m (once its solar arrays are deployed in orbit), and spacecraft power of 16 kW.

### About the author

Bob Gough is a communications systems engineer who has spent over 35 years in the satellite communications business, with the European Space Agency and in the Industry. During seven years at ESA Bob worked on a number of communication satellite projects, and was involved in spacecraft and Earth station development as well as end-to-end SATCOM system design. Bob worked as part of the team that developed the very first European Ku-band and Ka-band satellites. Mathematical modeling and computer simulation of FDMA, TDMA and CDMA signal transmission through end-to-end nonlinear satellite links is a specialty.

Upon leaving ESA, Bob founded a successful satellite communications equipment manufacturing company with an international customer base. Tracking systems, VSATs and digital modems were specialties. He subsequently held senior management positions in publicly listed defense, computer and communications companies. Now based in Australia, Bob runs an independent satellite communications consultancy, Carrick Communications Ltd. Bob Gough, BSc (Hons), PhD, MIET, CEng is a Chartered Engineer and a Member of the Institution of Engineering & Technology.





## Setting The Table To Shake Up The Components

By Bill Perry

**A**long a neatly landscaped road in Mountain View, California, sits an understated industrial building. The building houses a newly installed Moog electrodynamic shaker table.

Moog engineers anchor satellite parts atop the table to detect the minutest failure stemming from vibration. Customers are paying Moog to do this work to be certain satellite components can withstand the vibration a rocket creates while pushing a payload into orbit. Test specimens range from light-gauge pyrotechnic systems for initiating self-destruct commands to reaction wheels for attitude control.

To trim the cost of vibration tests, experts say some test firms tap technicians who have carried out shock tests or structural analysis, instead of engineers with a deeper technical background. According to the experts, a few years ago, one company in the business of shock-testing satellite components learned it had been acquiring data without anti-aliasing filters in its data acquisition system. An alias signal is a false image or low frequency error indistinguishable from valid data. Aliased signals led to the de-qualification of more than one launch vehicle, as the test firm's technicians had overstated the qualification loads of many tests.

"Aliasing of digital data is rampant in shock and pyroshock testing," said Vesta Bateman, a contributing editor to Sound & Vibration magazine.

According to Bateman, "Data acquisition system makers are building and selling systems that allow aliasing. The aliasing phenomena may artificially increase, or decrease, the measured shock level," Bateman added.

"Although this problem was identified and addressed in the 1980s, there is a severe loss of this knowledge in U.S. commercial labs," said Bateman. "Not only is corrupted, aliased data widespread, but it is part of the qualification of equipment operated by people."

Bateman advocates for higher standards vis-à-vis pyrotechnic shock. However, vibration tests are also vulnerable to anti-aliasing errors. As part of her work, she's been revising MIL-STD-810G—the world standard for environmental testing (e.g., vibration, shock, pyroshock, ballistic shock, etc.)—to ensure people correctly measure shock to prevent mission failure. Working with experts on the three shock methods in MIL-STD-810, Bateman has offered requirements that prevent aliasing and allow use of a wide variety of data acquisition systems.

### An Engineer's Eye View Of Testing

"Engineers perform our vibration tests," said Bradley Allen, Test Department Head at Moog in Mountain View. "If we detect a problem with a component, we have the background to solve it."

Moog runs its vibration tests on an electrodynamic shaker table capable of single-axis control in each of three directions. The table weighs approximately five tons and has a footprint measuring roughly 5' x 7', neglecting power and cooling units.

The engineers rely on the table to replicate controlled wave forms such as shaped random spectra, sine and arbitrary inputs, as well as low-level shocks up to 2kHz. Moog performs pyrotechnic shock simulation to 10,000Hz in a separate facility immediately situated next to the vibration test system.



Moog's tests focus on simulating the environments experienced during launch and in space to verify the integrity of components. A typical vibration test specimen could be a satellite component that Moog has already tested for shock. The customer, such as Aerojet Rocketdyne or Lockheed Martin, wants the satellite's precision components to undergo vibration testing and often other environmental loads as well.

Moog has performed contract testing for shock and vibration since the early 1980s. Moog says its engineers also design vibration isolation systems, tuned-mass dampers and absorbers, active attenuation systems and other forms of vibration dampers. According to Moog, clean dampers for space and launch applications are one of its core technologies. The company says it can also design damping using a wide variety of technologies.

The bulk of the testing on the new shaker table is for vibration. This is because the shaker table cannot move at cyclic rates high enough to replicate the extremely high-rate oscillatory speeds caused by, for example, pyrotechnics on a launch vehicle.

However, Moog does employ its table for vibration testing of small pyrotechnic systems that carry several grains of charge, often weighing about 1.5kg total. It's critical to know if the pyrotechnic initiators will survive a rocket launch so they can function on the mission, if needed. Moog engineers can also use the new shaker table to qualify, for instance, a valve the satellite would use to deliver propellant to its thrusters.

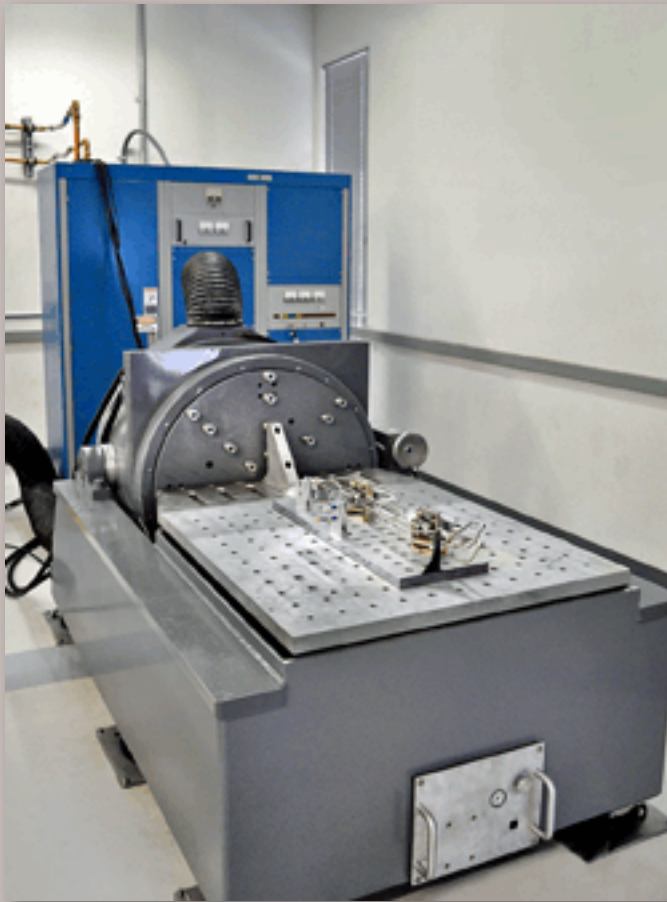
The vibration testing Moog undertakes is typically completed in four to eight hours depending on scope. In some cases, the tests require only one engineer to complete them. Once Moog completes a vibration test, the engineers create a test report that includes:

- A list of recorded sensors, locations and directions
- Plots of levels imposed on the test hardware, and
- Data file exports of levels measured during the test

According to Moog, one of its most unusual vibration tests so far has been measuring how much cyclic force a reaction wheel generates. A customer wanted to ensure that it could limit the amount of excitation the

- A description of the test article
- Pictures of the test assembly





*The new Moog electrodynamic shaker table in the company's Mountain View, California, location with a vibration-isolated Moog latch value affixed for testing. Photo courtesy of Moog.*

wheel generates in orbit. The engineers set up an ultra-quiet test table for the job, a table quite different than the newly installed shaker table.

"Some of these forces in orbit can be a fraction of a Newton," said Allen. "It's bad if the satellite wiggles, so we identify how much force the reaction wheel reacts back into the satellite and determine whether the test specimen passes or fails the test."

According to Allen, on one form of test, a customer will give Moog a time domain waveform of acceleration. The controller will send a wave form of voltage that regenerates the acceleration history on the new shaker table. Engineers will also focus on how much vibration occurs as a spectrum of frequency. The test engineer commands and controls the vibration levels for a set period of time. The component receives a failing grade if it no longer works after the test. For example, propellant valves that fail a vibration test will commonly leak afterwards.

Allen said it takes education to understand industry practices and measurement methods, and, often, that's something an engineer is better equipped to tackle with regard to vibration testing, especially with critical flight hardware.

"As engineers, we're used to going back and forth readily between time and frequency domains," said Allen.

Moog's goal is for customers to continue to return to have satellite components tested on its newly installed shaker table.

Watch the vibration and shock testing video to learn more about the company's capabilities:

<http://www.moog.com/sdg-pr/satnews/vibration-testing/csa/>

Moog's infosite for additional information:

<http://www.moog.com/sdg-pr/satnews/vibration-testing/space>

#### **About the author**

Bill Perry has written for the manufacturing, financial services and software industries for 20 years. He lives in upstate New York and may be reached at [bperry@march24media.com](mailto:bperry@march24media.com).

#### **About the company**

Moog possesses a strong reputation for engineering and product dependability, which has been further strengthened by recent growth. With an emphasis on product development and a commitment to heritage components, Moog is supporting commercial to human rated missions.

Recent additions to the company include:

Moog Broad Reach is a leading designer and manufacturer of spaceflight electronics and software for aerospace, scientific, commercial and military missions. Also provided is ground testing, launch and on-orbit operations.

Moog ISP, formerly AMPAC In-Space Propulsion, is a United States and European developer and manufacturer of liquid propulsion systems, engines and components for satellites and missile defense systems.

Moog Bradford, formerly Bradford Engineering B.V., is a European developer and manufacturer of satellite equipment that includes satellite attitude and orbit control systems, propulsion and thermal subsystems and components.

Moog CSA Engineering is a recognized world leader in the field of vibration suppression, providing unparalleled experience in the analysis, design and production of a wide array of leading edge, high precision systems. Delivered are innovative products and engineering services to control motion precisely and develop systems that combine vibration and motion control for aerospace and commercial applications.

Moog has 16 manufacturing and sales facilities across the United States, Europe and Asia dedicated to our space business. Facilities are equipped with complete test capabilities, class 10,000 clean rooms, electronics manufacturing facilities, integration capabilities, and ground to launch to on-orbit support and test.



## New Space Technology— Electric Propulsion For Satellites

By Marc Fichou, General Manager, Morgan Advanced Materials

**W**hen researchers at the Australian National University (ANU) started their search for a material from which to make a custom-made plasma cavity for a new gas plasma space engine, they were directed to Morgan Advanced Materials, a world leader in high purity Alumina custom-made, high precision ceramic components.

After providing design feedback and a review of tolerances, Morgan developed a prototype of the cavity, made of a high purity alumina known as AL300, a 97.6 percent pure alumina, which has the electrical properties needed for the application. After developing an in-house process to produce the components, Morgan was able to achieve first pass success, getting prototypes into ANU's hands with an extremely short lead time so the finished prototypes could be used for the space-qualification testing.

### Moving Toward Electric Propulsion

For more than 15 years, the Space Plasma, Power and Propulsion laboratory at the Australian National University (ANU) has been conducting research on developing the Helicon Double Layer Thruster (HDLT), a new gas plasma space engine for use on satellites.

Gas plasma engines are used in electric propulsion, a technology becoming more and more popular, because it uses "greener" propellants, rather than more toxic chemicals. Most existing satellites use chemical thrusters or chemical rockets, and they often leave propellant residue at the end of the satellite's lifetime. Currently, about 200 orbiting satellites use electric propulsion; the plasma engine would be used in a new generation of satellites that function with safer propellants. Figure 1 is a generalized illustration of the concept.

The project is funded by the Australian Space Research Program, Astrium, an aerospace manufacturer that is a subsidiary of the European Aeronautic Defence and Space Company (EADS), the Surrey Space Centre, the ANU and Vipac, a multi-disciplinary technical consultancy specializing in mechanical and systems engineering, testing and instrumentation.

According to Christine Charles, ANU Professor and head of the Space Plasma, Power and Propulsion Laboratory, the researchers will be conducting space qualification and prototype development at ANU's new Advanced Instrumentation Technology Centre.

"In our laboratory, we have a small space simulation chamber where we can conduct tests," said Professor Charles. "In the much larger Advanced Instrumentation Technology Centre we can combine research and development, in cooperation with a number of industrial partners."

Rod Boswell, a professor in the Space Plasma, Power and Propulsion laboratory at ANU, explained that aerospace manufacturers are actively sponsoring the project because they want to be ready to respond to the recent move towards safer propellants. They also need systems for addressing existing and expected requirements to move older satellites to their "graveyard orbit," which lowers the probability of collisions with operational spacecraft and minimizes generation of space debris. Figure 2 on the next page shows the testing set up for the gas plasma engine.

"These newer, greener space applications are being seriously considered by manufacturers such as Astrium-EADS, similar to how designers are continually looking to develop better electric engines for cars."

### Plasma Engine Basics

The plasma technology being developed uses a small cup and a closed end into which a gas is injected. Most commonly used is argon gas, but the device has also successfully used a Hydrazine simulant, composed of ammonia and nitrous oxide (N<sub>2</sub>O). A metal coil generates an RF field that heats up the gas so it becomes ionized. The other end of the cavity is open, and the plasma is emitted through this opening into space.

Professor Boswell explained, "It's essentially a rocket that provides thrust to move satellites around, but the innovative part is that it can use almost any propellant. If you could obtain enough solar power to run the radio frequency (RF) system, you could just keep using this forever, so long as you have a propellant."

Figure 3, also on the next page, illustrates the HDLT. The coil shown generates an RF field that turns the gas into a ball of plasma within the ceramic cavity supplied by Morgan Advanced Materials. The ball of plasma then expands out of the open end, and by so doing, creates an electric field that accelerates the ions up to about 10 kilometers a second to provide the thrust.

The simple and robust system contains no moving parts, would be quite inexpensive to produce for use in space, and can operate with any propellant. While not providing a large enough thrust to get a rocket away from Earth and into orbit, it provides sufficient thrust once in space to accommodate most situations.

The HDLT can be scaled up or down. The thruster shown was made to be contained within a 25x10x10 centimeter box, with the ceramic cavity about the size of a grapefruit.

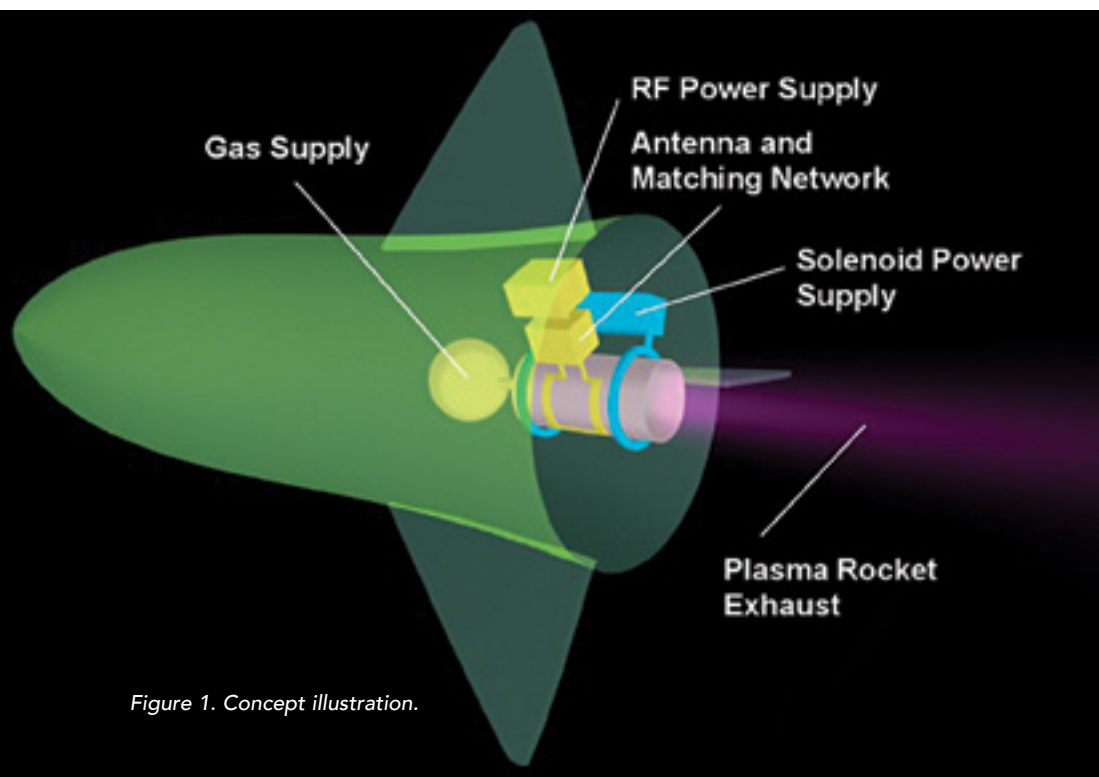


Figure 1. Concept illustration.



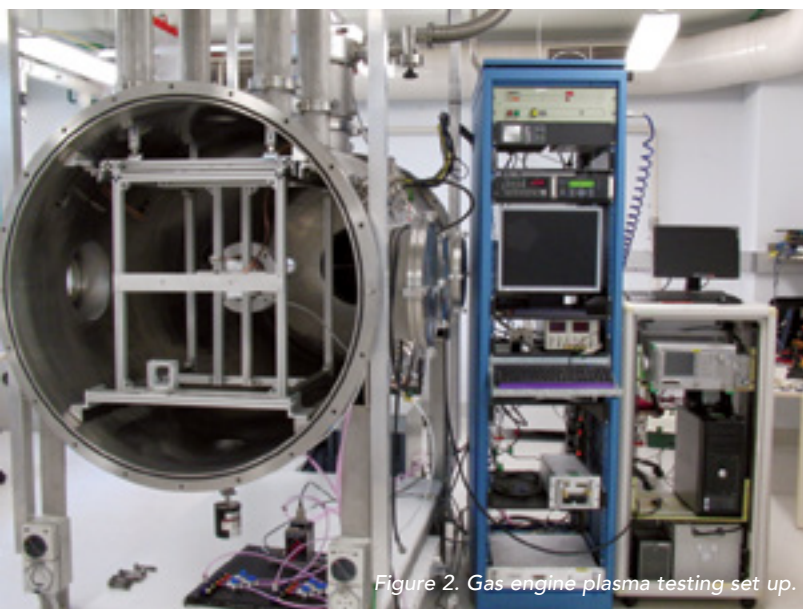


Figure 2. Gas engine plasma testing set up.

### Plasma Cavity Needs

As the HDLT will eventually be attached or mounted to a spacecraft, researchers were seeking custom made, high-quality components. Among the most important of those was the plasma cavity, which needs to withstand the heat that creates the plasma.

The ANU researchers had tried a variety of materials for the plasma cavity, including Pyrex, and knew they needed some kind of ceramic material. The cavity could not be metal because heat from the radio frequency must be able to pass through into the plasma—with metal, the heat would just have been reflected.

The researchers had trouble sourcing the material from Australian ceramics manufacturers and found Morgan Advanced Materials via a recommendation from a U.S. company with whom they were familiar.

Morgan specializes in manufacturing high purity Alumina components and metalized assemblies that are used in sensing control systems and in such applications as aircraft landing gears, doors, flight control surfaces,

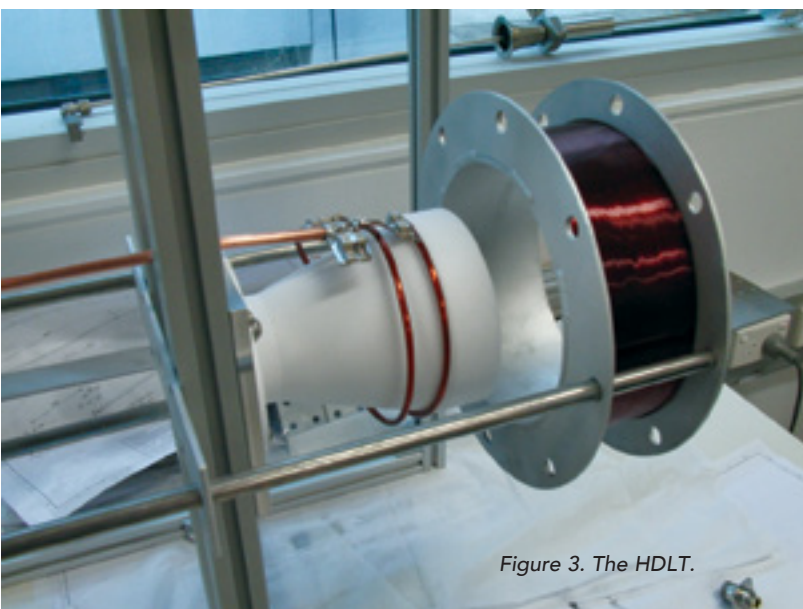


Figure 3. The HDLT.

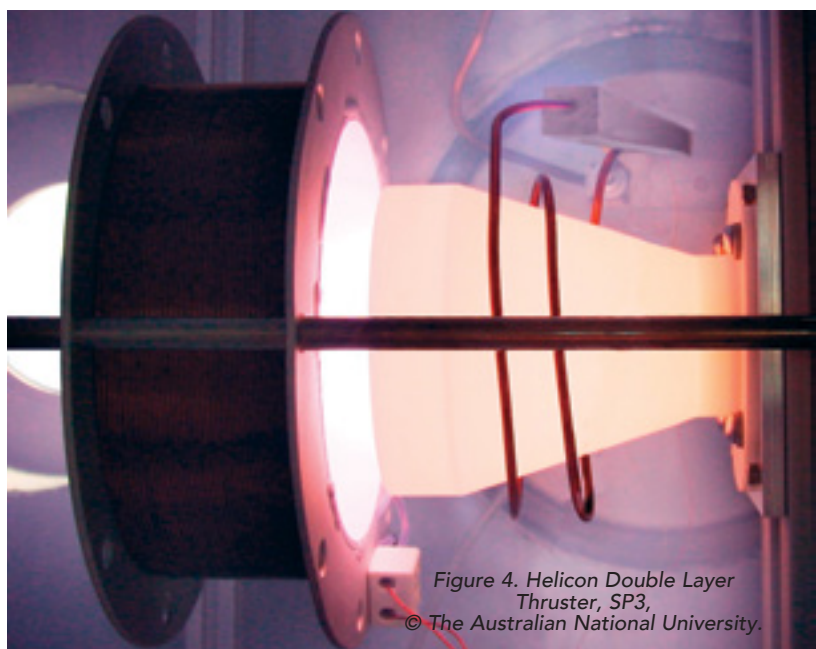


Figure 4. Helicon Double Layer Thruster, SP3,  
© The Australian National University.

thrust reversers actuators, and many other non-aerospace applications. Their high purity Alumina material enables these components and brazed assemblies to be machined to exact tolerances and finished to ensure they perform consistently to the highest specification possible.

After receiving the inquiry from the ANU researchers, Zachary Waddle, an engineering manager at Morgan, suggested the use of AL300 Alumina for the cavity. According to Waddle, the material has been used for decades in high-voltage applications, as well as RF applications, and is known for its excellent electrical properties. "I knew the material had been successfully used in the manufacture of components generating plasma and also for high voltage insulation used in new and emerging scanning electron microscopes, so I thought it would be an excellent match for this project," said Waddle.

He began by reviewing drawings provided by Professor Charles. The concept was relatively simple, with the cavity designed to attach easily to the chassis for all the tests that had to be conducted. Waddle provided design feedback on how to make the geometry robust and also offered a tolerance review to help the researchers get the most affordable part.

Morgan then developed an in-house process to make the parts, which have a thin wall and a long aspect ratio. Figure 4 is an image of the thruster in use.

"We had to be careful to fire to size," said Waddle. "Once fired, we only had to grind in one dimension. We had first pass success on the parts and were able to meet ANU's short lead time." Morgan then provided several of the finished prototypes to be used for the space-qualification testing.

The ANU researchers have been extremely pleased with the result, finding the ceramic cavities to be extremely sturdy, and well within the tolerances they required. "In fact, it turned out to be the best material we have ever tested," said Professor Charles.

Morgan Advanced Materials is especially pleased to be called upon for this cutting edge research and development project, and excited to be part of new 21st century space technology. Said Waddle, "it was very gratifying to be able help a customer with such a unique requirement, and to collaborate on the technical specification to get prototypes into their hands quite quickly."

Morgan Advanced Materials infosite:  
<http://www.morganadvancedmaterials.com/>

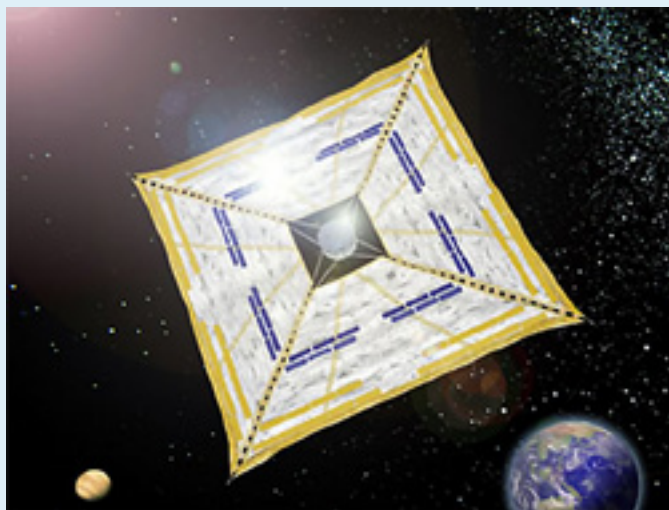


# The Forefront Of Space Science

## Deep Space Navigation Technology Via Solar Sail... The Realization...

By Yuichi Tsuda, Assistant Professor, Department of Space Flight Systems at the Institute of Space and Astronautical Science (ISAS), JAXA

**T**he small solar-power sail demonstrator IKAROS launched in May 2010 has achieved all of its technological goals and is still cruising in the solar system. Its total flight distance as of June 2013 was about 3 billion km. Accelerated by solar radiation pressure, its velocity increment reached 400 m/sec over the three-year flight.



A small size powered-solarsail experimental spacecraft, "IKAROS" (Interplanetary Kite-craft Accelerated by Radiation Of the Sun)—Image is courtesy of JAXA.

In this article, I look back at the research, development, and operation of solar-sail technology from the standpoint of my specialty, astrodynamics.

In view of my research background, I wanted to realize a solar-sail flight mission in outer space. First, I had to figure out how to make and deploy a solar sail. What awaited me at that time was a profound world of material, structural, and dynamic sciences.

Regarding deployment, from the start our research focused on using only centrifugal force generated by the rotation of the entire sail. Most other solar-sail researchers in the world use extendable sail trusses. In contrast, the centrifugal deployment system has merits such as lightweight structure and great flexibility in design and sail size. In addition, our choice of a different system from others is based on our strategic concept to bring originality to our research.

Our sail research emphasized understanding and control of deployment behavior. The sail must be very thin and large, so we inevitably face hard-to-predict wrinkling and folding.

Figure 1 at the top of the next column shows the transition profile of the strain energy (in this article, referred to as "internal energy") stored in the wrinkles and folds of the sail at the centrifugal deployment event. Pattern A in Figure 1 shows ideal deployment, where the internal energy monotonously decreases by the effect of centrifugal force. In this case, the sail surely and fully deploys with the minimum energy.

Reality is not that simple, however. Other cases such as B and C in Figure 1 can occur easily. Case B is a fold pattern where a minimal point occurs during deployment, while case C shows an abnormality during dynamic deployment where exchange between kinetic energy and internal energy is too great. How can we realize an ideal deployment such as Case A? This was the question that we had to answer.

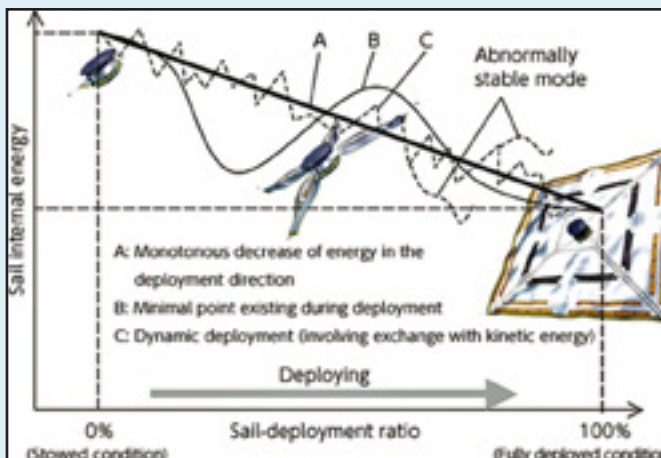


Figure 1. Profile of energy transition in centrifugal deployment

Very thin film flutters lightly with faint airflow in the atmosphere and hangs immediately and loosely in a gravity environment. The enemies of our experiment were air and gravity. In order to eliminate these two effects and verify sail deployment, we conducted numerous experiments in the first five years.

Our experiments included the deployment of the sail: By revolving it in a vacuum chamber, at high-altitude using a balloon, and in a revolving closed container. A critical step in our experiments was the successful centrifugal deployment of a 10m-class sail in space using the sounding rocket S-310-34 in 2004. In 2007, we also successfully deployed a 20m-class sail using a scientific balloon.

Feedback from these experimental results improved our numerical-simulation technology. Consequently, we established an environment where we could design large sail, which was too large to experiment, relying only on calculation.

The sail-folding method adopted for IKAROS was initially called the "Tsuda fold." Later, various ideas from project members were incorporated and finally it was named "square-type sail." Since its fold lines are all straight, this method has many advantages such as easy manufacturability and a good fit for centrifugal deployment. Its most popular feature is that it requires no cutting.

One of the beauties of Japanese origami (paper folding) is that it allows us to create various shapes without using scissors. Our folding method is entirely appropriate for Japanese solar sail technology. Thus, Japanese aesthetics also contributed to the selection of the sail-deployment method.

After the inauguration of the IKAROS project, a number of folding methods including the square-type sail were proposed. We founded two research groups, "sail structure group" and "sail material group," with respective experts from inside ISAS and outside. They evaluated and examined various methods in detail from various aspects.

One candidate method showed a remarkable mathematical beauty far exceeding the square film. In order to select a single method, we scrutinized according to hundreds of evaluation criteria and had intensive discussions. It is my unforgettable memory (bad dream?) we had discussions all night through almost every week with experts joining the groups.

### **Development: Realization Of IKAROS As A System**

To complete IKAROS as an exploration spacecraft system actually flying in outer space, we needed to overcome a number of challenges in addition to sail deployment. The reasons why such a small team could successfully complete IKAROS include: excellent communications between development team members, active and voluntary contributions outside their own specialty, and good teamwork based on strong trust with dedicated subsystem staff and hardworking manufacturing companies' staff.

The biggest challenge of the spin-type solar sail as a navigation system is how to flexibly manage and control its angular momentum generated by the rotation of the large-area film. We had to solve the following problems:

- (1) predict and manage wrinkles arising on the sail after deployment and the disturbance in solar-light pressure caused by the wrinkles; and
- (2) control of the large angular-momentum and elastic sail to realize fuel-saving and keep it stable. *Please refer to ISAS News, 2011 January edition (No. 358), for details on many technological ideas to solve problem.*

Problem (1) was difficult. It is, in fact, impossible to predict what wrinkles would emerge on the flexible sail after deployment. Furthermore, the impact of the disturbance torque generated by solar-light pressure varied greatly depending on the shape and condition of the wrinkles. After the launch of IKAROS, a great discovery was made.

### **Operation: Discovery Of Spiral Motion**

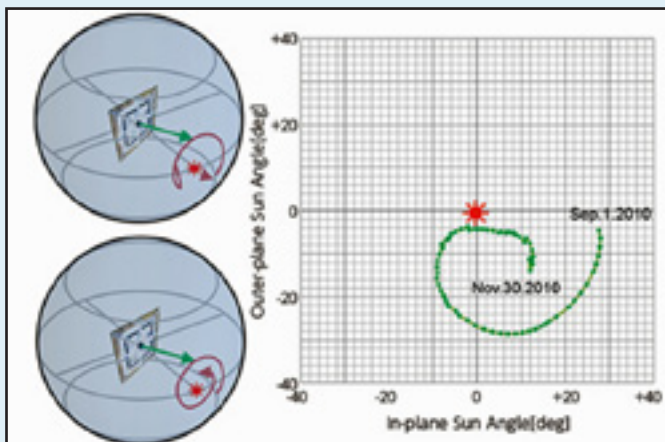
In addition to the structure and material groups, we initiated an "acceleration research group" to evaluate IKAROS's solar-sail navigation after deployment. The group consisted of a dozen specialists and students in orbital mechanics from inside ISAS and outside.

The group examined solar radiation pressure acceleration performance based on data obtained from the actual operation. Further, it worked on a wide range of related research in solar-sail orbit, guidance, and navigation.

In solar-sail navigation, "orbital control" means control of the sail orientation and also attitude control. Understanding attitude motion is critical. The acceleration research group anticipated two properties of IKAROS's attitude motion before launch: the "windmill effect" and "Sun-tracking property of spin axis."

The windmill effect is a behavior where the spin rate changes as sunlight collides with the wrinkled sail surface. This is just like windmill rotation by receiving wind. The effect was observed immediately after IKAROS's sail deployment.

On the other hand, the Sun-tracking property of spin axis is a behavior whereby light pressure on spin satellite causes the axis to track the Sun by plotting arc. Using this property, we can keep the spacecraft pointing at the Sun without fuel. This technique was used to help the asteroid explorer HAYABUSA when it lost fuel.



**Figure 2. "Spiral Motion" of IKAROS**  
 Upper left: Originally predicted arc motion of spin axis  
 Lower left: Spiral motion of spin axis  
 Right: History of actual attitude of IKAROS

The attitude profile observed in actual IKAROS operation, however, was not an arc with a constant radius, but a "spiral" motion with gradually decreasing radius (please see Figure 2 above).

Initially, it was believed to be simply the difference between the ideal mathematical formula world and the real world. However, as the phenomenon was very systematic, we discussed it intensively by examining formulae, even in the control room(!), while simultaneously operating IKAROS.

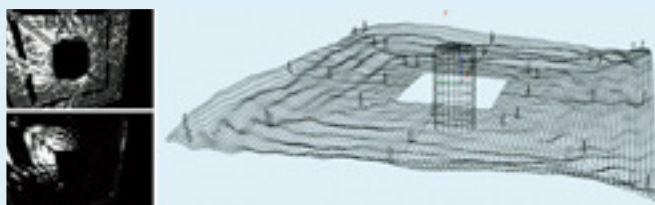
One month later, the acceleration research group came up with an answer to the mystery. The cause was wrinkles on the sail surface. The group showed a clear formula demonstrating the relationship between the wrinkle patterns and the attitude motion. The formula correctly suggested the spiral motion (lower left of Figure 2).

We immediately incorporated the new attitude-motion model into the operation system and revised the orbital and attitude-control plans.

The sail was originally designed to receive solar radiation pressure efficiently. Rather than considering the torque generated by light pressure as a disturbance, we had better to utilize it. By positively using spiral motion, we were able to prolong fuel storage more than twice as long as expected.

Our research on this phenomenon has advanced greatly, eventually enabling us to discuss the relation between solar-sail navigation performance and optical property distribution on the sail surface or the manageable accuracy of wrinkles (please see Figure 3 below). Thus, we are writing the world's most advanced "design theory" for solar sail.

Before IKAROS, our research level was about the same as the rest of the world. Now, from our experience and data gained developing and flying an actual solar-sail vehicle, we have the most knowledge compared to any research team in the world. I believe the utilization of this knowledge will lead to superiority and originality of Japanese deep-space exploration.



**Figure 3. Wrinkles on the sail surface estimated by the spiral motion.**  
 Upper left: Real image shot by a deployable camera (DCAM)  
 Lower left: 3D rendering result of shape motion  
 Right: Sail shape estimated by attitude control (spin axis direction is shown exaggerated).

## In Conclusion

Currently, IKAROS's attitude and orbital motion rely entirely on solar radiation pressure because of its fuel depletion. As its downlink signal is extremely faint because it lacks an onboard high-gain antenna, we are unable to conduct ranging to determine its orbit.

Thanks to the success of modeling the spiral motion, however, we can still predict IKAROS's attitude and orbit correctly and obtain the data of its solar-sail navigation. We expect to continue to break records of light-pressure acceleration day by day and to operate IKAROS as long as possible.

IKAROS was a mission to perform a technological demonstration. With its success, we gained a foothold to travel to the outer-planet region far distant from the Sun.

Our next target is exploration of the Jupiter and Trojan asteroids. We will continue our research toward travel to this uncharted area, which must be made by the combination of large-area-film sail technology obtained through IKAROS and high-specific impulse ion engine.

I was delighted to receive the Fifth Space Science Encouragement Prize. This award honors the R&D activity of our entire team. Taking this opportunity, I would like to express my sincere thanks to all members of IKAROS development and research teams who have shared the same dream.

## About the author

Yuichi Tsuda is the Assistant Professor of the Department of Space Flight Systems at the Institute of Astronautical Science, JAXA.

## About JAXA

On October 1, 2003, the Institute of Space and Astronautical Science (ISAS), the National Aerospace Laboratory of Japan (NAL) and the National Space Development Agency of Japan (NASDA) were merged into one independent administrative institution to be able to perform all their activities in the aerospace field as one organization, from basic research and development to utilization. The independent administrative institution is the Japan Aerospace Exploration Agency (JAXA.)

Research and development in space and aviation areas as well as its mission to advance space science in Japan, mainly through collaboration with universities. ISAS also actively contributes to JAXA's and Japan's entire space development. ISAS focuses on the following activities: astronomical observations from outer space to study the structure and origin of the universe; solar system science to elucidate the history of the Earth and the solar system; use of space environment for microgravity experiments of various kinds; and space engineering to support these activities and pave the way for new possibilities in space.

2013 was an important year for JAXA as the organization celebrated its 10th anniversary—renewed was their corporate slogan, becoming "Explore to Realize."

## About ISAS

ISAS has become one of four principal sections within JAXA, with its mission to advance space science in Japan, mainly through collaboration with universities. ISAS also actively contributes to JAXA's and Japan's entire space development. ISAS focuses on the following activities: astronomical observations from outer space to study the structure and origin of the universe; solar system science to elucidate the history of the Earth and the solar system; use of space environment for microgravity experiments of various kinds; and space engineering to support these activities and pave the way for new possibilities in space.

The 21st century is the century when the human quest for knowledge challenges the new world - space. By challenging space, ISAS will make the greatest possible efforts to help Japan's space science take another large step forward and to support JAXA's great progress. ISAS publishes a monthly magazine, ISAS News, which includes topics and regular activities at ISAS, serialized lectures on a variety of themes in space science and technology, space essays, and so on. ISAS News has a circulation of 3,000.

Additional information regarding ISAS is available at:  
<http://www.isas.jaxa.jp/e/forefront/2013.shtml>

## Editor's note

Our thanks to the Japan Aerospace Exploration Agency (JAXA) in allowing us to reprint Professor Tsuda's article from ISAS News (<http://www.isas.jaxa.jp/e/about/public/public.shtml>).

For further information regarding JAXA, their infosite is located at:  
<http://www.jaxa.jp/>

