Worldwide Satellite Magazine February 2013

# SatMagazine

## North American Satellite Markets

*Image: Artistic rendition, TDRS-M satellite*

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


## This Issue's Authors + Contributors

Jos Heyman
Hartley Lesser
Jose Del Rosario
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## Safe + Sound

**Space Systems/Loral (SSL) has announced that the Amazonas 3 multi-mission satellite, designed and built for HISPASAT Group, has arrived at the European Spaceport in Kourou, French Guiana.**

The satellite is scheduled to be launched aboard an Ariane 5 launch vehicle by Arianespace.

Amazonas 3, which was completed and delivered ahead of schedule, includes the first Ka-band payload for broadband service in Latin America.

Amazonas 3 is designed to provide a wide range of telecommunications services including DTH, corporate fixed and mobile telephone networks, and broadband in the Americas, Europe, and North Africa.

When launched, the satellite will be positioned at the orbital location of 61 degrees West longitude.

Amazonas 3 has 33 Ku- and 19 C-band transponders, and 9 Ka-band spot beams. The satellite is based on the highly reliable SSL 1300 space-proven platform, which provides the flexibility to support a broad range of applications and technology advances.

The spacecraft is designed to deliver service for 15 years or more.

#

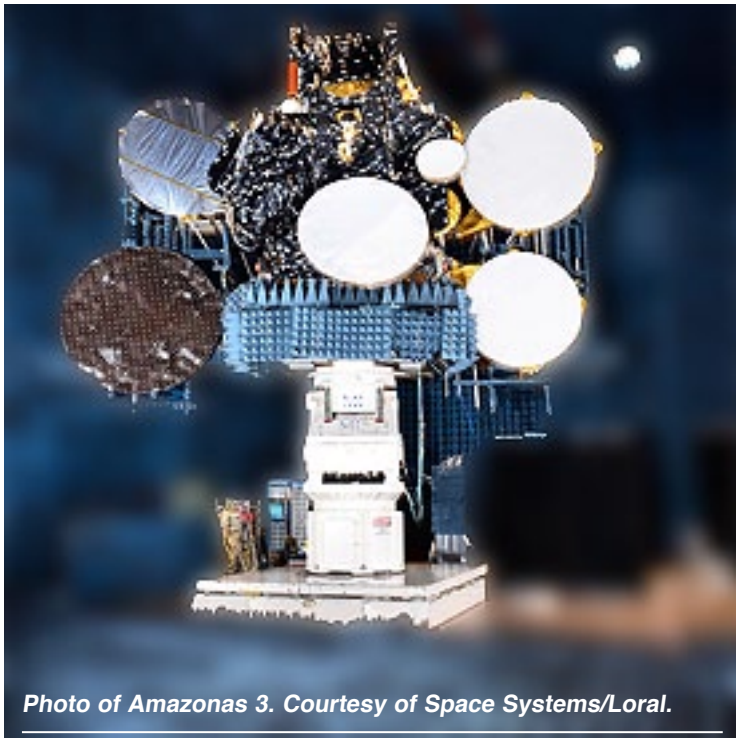

*Photo of Amazonas 3. Courtesy of Space Systems/Loral.*

## Tons O' Terminals

**Hughes Network Systems has now shipped more than 487,000 broadband satellite terminals in 2012.**

These are the most terminals shipped in a single year, bringing its cumulative number of satellite terminals shipped worldwide to more than 3.3 million.

Large and small enterprises across virtually all vertical sectors, along with government and multi-national organizations rely on Hughes for an ever-expanding range of broadband networking solutions.

Hughes' consumer high-speed satellite Internet service in North America is growing at an accelerated rate since the launch of HughesNet® Gen4 service in October of 2012, powered by the EchoStar XVII Ka-band satellite with JUPITER™ high throughput technology—with more than 200,000 HT terminals shipped in the last quarter of 2012.

"Every one of those 3.3 million terminals is a testament to the trust placed in Hughes by our customers for their communications solutions," said Pradman Kaul, president of Hughes. "It's what drives us to innovate and continually advance our satellite technology and services—ensuring they succeed, so we succeed. And that hasn't changed since we shipped the first VSAT terminal in 1986, nor has the pride in our people who make it happen." #

## Betterment Thru Backhaul

**Gilat Satellite Networks Ltd. (NASDAQ: GILT) has signed an agreement with Huawei for the delivery of its SkyAbis cellular backhaul solution to a leading Southeast Asian Mobile Network Operator (MNO).**

As part of the project, Gilat will supply and install a SkyEdge II hub, SkyEdge II Pro VSATs, and related services including remote site installation. The majority of the sites will replace older SCPC modems that are currently in use.

The SkyAbis network will support both 2G and 3G BTS/Node B sites as part of a major upgrade to the Mobile Network Operator's nationwide cellular infrastructure, and will provide improved bandwidth efficiency and higher throughputs.

The cellular backhaul solution enables the network operator to significantly save on satellite capacity through the use of the SkyAbis Dynamic Allocation Multiple Access (DAMA) capabilities, which allocate satellite capacity to the site, as and when required.

This also enables the operator to expand the network to additional sites, where previously it was not economically feasible.

#

# When It Matters Most
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## A Spatial Excursion Campaign

**Commercial spaceflight is entering the main stream and looking (and smelling) quite good!**

United Kingdom-based Unilever Group and Space Expedition Corporation (SXC) have announced a 22 flight purchase on XCOR Aerospace's Lynx® Mark II suborbital spacecraft for Unilever's space-themed AXEApollo™ campaign for the AXE® brand of men's cologne, body spray, shower gels and other personal care products.

Unilever will award the first flight to a lucky winner selected from a drawing just after the Super Bowl on February 3rd, and the 21 other winners are derived from a year long, 60 country, promotional campaign.

That larger campaign includes a 100+ person December 2013 space camp for early stage winners in Orlando called the AXE Apollo™ Space Academy (A.A.S.A.).

The campaign also includes legendary Apollo astronaut Buzz Aldrin and a 30 second Super Bowl advertisement. #

*Artistic rendition of XCOR's Lynx Mark II spacecraft*

## The Early Birds

**Northrop Grumman Corporation has completed early delivery of two Global Hawk unmanned aircraft to the U.S. Air Force.**

Global Hawk allows military commanders to receive high-resolution imagery, survey vast geographic regions and pinpoint targets on the ground. Both aircraft were delivered ahead of schedule.

In 2012, three new Global Hawks were delivered to the Air Force and five previously delivered aircraft completed installation of additional sensors that will allow them to gather multiple types of intelligence data during a single mission. A total of 37 Global Hawks have been delivered to the Air Force.

Global Hawk carries a variety of ISR sensor payloads that allow military commanders to gather imagery and use radar to detect moving or stationary targets on the ground. The system also provides airborne communications and information sharing capabilities to military units in harsh environments. Combined with Global Hawk's ability to fly for long periods, the aircraft's 12,300 nautical mile range makes the system ideally suited to take on many different ISR missions. Global Hawk has logged more than 80,000 flight hours and has been used over battlefields in Iraq, Afghanistan and Libya. #

## JPSS-1 Passes CDR

**Ball Aerospace & Technologies Corp. has successfully completed the delta Critical Design Review (CDR) for the Joint Polar Satellite System (JPSS-1) spacecraft.**

The four-day review was held December 10-13, 2012, and included more than 100 representatives from NASA's Goddard Space Flight Center, NASA Headquarters, the National Oceanic and Atmospheric Administration (NOAA), and JPSS instrument providers.

The review team congratulated the JPSS-1 team for demonstrating that the spacecraft's development is progressing well and will be ready to provide the nation with critical environmental data when launched no later than the first quarter 2017.

The CDR delineated the design differences between JPSS-1 and its predecessor, the Ball-built Suomi National Polar-orbiting Partnership (S-NPP) satellite to allow for full-scale JPSS-1 spacecraft production. Early Production on JPSS-1 has been underway since mid-2012.

The JPSS operational weather system includes the satellites and sensors that support civil weather and climate measurements in the afternoon orbit, as well as a ground system.

These satellites deliver approximately 90 percent of the information collected for numerical forecasting models that generate critical weather forecasts and convey warnings to the public about climate and weather events.

In addition to the spacecraft, Ball Aerospace will manufacture, test and deliver the Ozone Mapping and Profiler Suite sensor for JPSS-1. Both the JPSS-1 satellite bus and the OMPS instrument are similar to those for Suomi NPP, which successfully launched in October 2011 and is returning images and data that provide critical weather and climate measurements of the complex Earth system.

Ball Aerospace & Technologies Corp. supports critical missions for national agencies such as the Department of Defense, NASA, NOAA and other U.S. government and commercial entities. The company develops and manufactures spacecraft, advanced instruments and sensors, components, data exploitation systems and RF solutions for strategic, tactical and scientific applications. #

*JPSS-1 spacecraft artist rendering. Credit Ball Aerospace.*


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## Secures Beams

**NAGRA and HD PLUS GmbH, a subsidiary of satellite provider SES and operator of HD+ have launched HD PLUS' new, over-the-top (OTT) catch-up service of private channels (Mediathek), HD+ Replay, further extending the companies' content protection partnership from satellite to Internet TV.**

HD+ Replay will use NAGRA's multi-device and multi-network DRM solution, NAGRA MediaAccess PRM (Persistent Rights Management), to secure high-value content delivered "over-the-top" to consumers equipped with an HD+ SmartTV set-top box (STB).

HD+ Replay is based on the HbbTV standard enabling a rich and intuitive user experience. The first HD+ Replay enabled STB Inverto VOLKSBOX Web Edition+ is already on the market, with further set-top box manufacturers expected to be available soon.

HD+ Replay initially includes content from RTL NOW and VOX NOW, with SUPER RTL NOW having been added in December.

The HD+ satellite service had been using NAGRA's MediaAccess content protection since its launch in 2009 and has grown ever since. As of September 30, 2012, it served more than 2.8 million households in Germany, a 45 percent growth over the same period in 2011. #


## Kits + Phones

**Blue Sky Network and its reseller partner, S4A (Solutions For Aviation), have announced the issuance of a Supplemental Type Certificate (STC) for Blue Sky Network's voice system on C-212-200 Airbus military aircraft.**

The certification was supplied by the European Aviation Safety Agency (EASA), and specifically certifies deployment of Blue Sky Network's value-added aviation satellite phone system, the Kit 2.

Blue Sky Network's aviation products are based on voice communication and tracking solutions over the Iridium® satellite network.

The Kit 2 provides an FAA certified integrated single channel antenna and cable that can be connected with either the Iridium 9555 or Iridium Extreme® satellite phone, both of which can be plugged into the antenna outlet for use in the aircraft.

The Iridium 9555 offers a voice, two-way SMS, and short email communication solution for users. The Iridium Extreme is specifically engineered to withstand the toughest environments and enables voice communication as well as GPS tracking services via Blue Sky Network's New SkyRouter.

Through the Iridium satellite network, Blue Sky Network provides pole-to-pole voice communication on Airbus Military C-212-200 aircraft. #


## No Folding Required

**exactEarth's new Ship Maps site is designed to illustrate—in an interactive environment—the applications of S-AIS in solving real-world issues across the maritime industry.**

At the heart of each story, there's a simple map with sample ship traffic information collected from satellites.

More information can be overlaid using the various map layers, building greater context into the ship map and demonstrating how a combination of situational information and empirical satellite data can be combined to gain insight and knowledge about key maritime issues.

Each of these web-based map applications combines data delivered using standard information formats. Interoperability can often be a bottleneck, hampering the integration of disparate data sources, such as S-AIS, particularly in the geospatial world. By developing and using delivery methods that comply with the Open Geospatial Consortium (OGC), such barriers are removed. Web-based delivery of S-AIS data enables it to be embedded within existing workflows. Different types of filtering allow for dynamic and ad-hoc customization of data based on geography, time, and AIS message attributes.

The customization and combination of data sources with simple narrative and multi-media delivers an interactive map-based platform to explore the worlds of S-AIS. #

exactEarth® ship maps

## Turned On To Save Lives

**Four Galileo In-Orbit Validation satellites in medium-Earth orbit, the minimum number needed to perform a navigation fix.**

The first switch-on of a Galileo search and rescue package shows it to be working well.

Its activation begins a major expansion of the space-based Cospas–Sarsat network, which brings help to air and sea vessels in distress.

The second pair of Europe's Galileo navigation satellites—launched together on 12 October last year—are the first of the constellation to host SAR search and rescue repeaters.

These can pick up UHF signals from emergency beacons aboard ships and aircraft or carried by individuals, then pass them on to local authorities for rescue. Once the satellites reached their 23 222 km-altitude orbits, a rigorous test campaign began.

The turn of the SAR repeater aboard the third Galileo satellite came on January 17th.

"At this stage, our main objective is to check the repeater has not been damaged by launch," said ESA's Galileo SAR engineer Igor Stojkovic. "The first day was a matter of turning the repeater on and checking its temperature and power profiles were as predicted. The following day involved sending a signal to the repeater using the UHF antenna at ESA's Redu Centre in Belgium, then picking up the reply from our L-band antenna."

Redu's antenna is 20m in diameter, so the shape of the relayed signal was captured in great detail, out of all proportion to surrounding noise. "We can precisely measure its power, the time the relay took and so on," Igor added.

More detailed system testing will follow, to completely prove this new type of SAR payload in orbit. Galileo.

This international system has been taking the search out of search and rescue for more than three decades, saving some 31 000 lives along the way. Cospas is a Russian acronym for 'Space System for the Search of Vessels in Distress', with Sarsat standing for 'Search and Rescue Satellite-Aided Tracking'. #

*Artistic rendition of four Galileo In-Orbit Validation satellites in medium Earth orbit.*

## Uplinks, Satellites + Fly-Aways For Sports

**SIS LIVE has signed a new contract with European Tour Productions to provide worldwide satellite services for their golf coverage until the end of 2018.**

This coverage includes satellite services, uplink trucks and flyaway units for events in Europe and the Middle East, as well as co-ordination of local uplink providers and satellite services for events in South Africa, Asia and Australasia.

The agreement allows European Tour the flexibility to increase the coverage in Europe to five simultaneous HD feeds with redundancy; all from one of SIS LIVE's bespoke dual antenna uplink trucks.

Tony Coxon, Head of Production operations at European Tour Productions said "In conjunction with SIS LIVE we have moved our delivery from MPEG2 to MPEG4 over the last couple of years. This transition was made in practically seamless manner and we now deliver HD signals to Sky and the rest of the world. We, therefore, had all confidence in extending our contract with SIS LIVE to include our coverage up to the end of 2018. We will continue to use the excellent SIS LIVE team as well as the dual uplink truck, which underwent a refit as part of its MPEG4 upgrade, to help us deliver the forty or so live four day golf tournaments that we produce annually."

SIS LIVE has worked with European Tour Productions on all its golf coverage since January of 2004 and, since March 2008, SIS LIVE has also provided Internet access, ISDNs and telephone lines using its iDirect platforms on IS907 and IS905.

This move has given European Tour Productions and its clients a more consistent, flexible and cost effective solution. The system uses satellites, therefore, the remoteness of each location has no impact on the service.

SIS LIVE provides European Tour Productions with its own dedicated telephone numbers so as soon as the uplink dish is deployed, phones and Internet are immediately available for everyone in the TV compound. #


## Moving MUOS

**Lockheed Martin has successfully completed required system testing on the second satellite in the U.S. Navy's Mobile User Objective System (MUOS), designated MUOS-2.**

The satellite has been placed in storage to await its scheduled launch date in July 2013.

The MUOS constellation will provide significantly improved and secure communications for mobile warfighters, including simultaneous voice, video and data services—similar to the capabilities experienced today with smart phones.

The first MUOS satellite, launched February 24, and the associated ground system are currently providing legacy on orbit capability, followed by the launch of MUOS-2 in 2013.

The five-satellite, global constellation is expected to achieve full operational capability in 2015. In the spring of 2013, Lockheed Martin will remove the satellite from storage, perform final spacecraft component installations and conduct a final factory confidence test in Sunnyvale, California, prior to shipping MUOS-2 to Cape Canaveral Air Force Station, Florida, for its launch aboard an Atlas V rocket.

MUOS satellites are equipped with a Wideband Code Division Multiple Access (WCDMA) payload that provides a 16-fold increase in transmission throughput over the current Ultra High Frequency (UHF) satellite system.

Each MUOS satellite includes a legacy UHF payload that is fully compatible with the current UHF Follow-on system and legacy terminals.

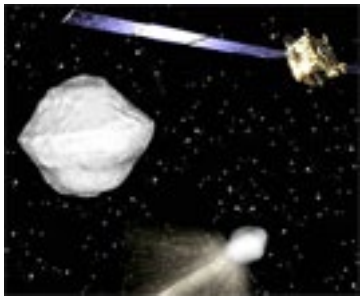
This dual-payload design ensures a smooth transition to the cutting-edge WCDMA technology while the UFO system is phased out. #

## Ideas Welcomed

**Hughes Network Systems, LLC has received an order from the U.S. Environmental Protection Agency (EPA) to provide satellite broadband services for the agency's "RadNet" program.**

Under the order, Hughes will provide 50 sites with 12 months of satellite broadband service.

The RadNet system monitors radiation levels of air, drinking water, pasteurized milk and precipitation across the United States. The EPA will upgrade its existing network with the addition of Hughes satellite broadband technology during 2013.



*AIDA mission concept*

The Hughes solution includes its HN9000 broadband satellite terminal and a dedicated Access Gateway, supporting expansion and potential conversion into a private network.

Hughes will install and deliver satellite broadband services at up to five RadNet locations each month.

"By providing a dedicated Access Gateway at the Hughes Network Operations Center in Germantown, Maryland, EPA will have improved manageability and visibility into the network about its health, and be able to operate their sites like a private network," said Tony Bardo, assistant vice president of government solutions at Hughes. "We're excited to begin work on this contract with our first order."

#

# One Gone, Two On Orbit, One Enroute

**On Friday, January 11, 2012, commercial operations of SPOT 4 satellite were terminated. The joint decision on the cessation of commercial satellite operations was made by the SPOT 4 owner—CNES (French Space Agency) and the satellite operator—Astrium GEO-Information Services.**

*Artist's rendition of the SPOT-6 & SPOT-7 satellite constellation. Image credit EADS Astrium.*

The satellite has been operating for almost 15 years (177 months) since its launch in March of 1998. More than 6.8 million images of the Earth have been acquired since operations began.

Nonetheless, the SPOT space program continues to develop. ScanEx Research & Development Center carries on direct reception and processing of SPOT 5 satellite data—satellite operations are estimated to be effective until 2015.

In addition, commercial operation of the new SPOT 6 satellite will start soon—its data was, for the first time in Russia, received and processed by ScanEx's specialists on October 17, 2012, using the UniScan ground station at the Moscow remote sensing center.

Now UniScan ground stations can be supplied to interested organizations for SPOT 6 data reception (and similar SPOT 7 satellite data—this satellite is to be launched in the first half of 2014), whereas already installed stations can be upgraded to support the new satellites. SPOT 6/7 data processing software has been developed by ScanEx RDC within the frames of the international cooperation agreement with Astrium GEO-Information Services company.

ScanEx company has exclusive rights to receive and distribute SPOT series satellites' data on the territory of Russia and Belarus. In addition to the SPOT program, Astrium GEO-Information Services is the worldwide commercial operator of the very high resolution satellites Pleiades-1A and Pleiades-1B. #

# DubaiSat-1's First Glimpses

**DubaiSat-1, the UAE-owned and operated Earth observation satellite, has relayed a high-quality image of the area in Dubai that will be developed into the recently announced Mohammed Bin Rashid City.**

The satellite, which was launched by the Emirates Institution for Advanced Science and Technology (EIAST), will monitor the MBR City project and provide images every month to highlight the project's progress.

The high-resolution images relayed by DubaiSat-1 are a valuable resource for infrastructure planning and development across the country.

These images provide spatial information essential to decision-making on urban and rural planning, transport and utilities development, mapping and environmental conservation initiatives.

EIAST, as part of its mandate of conducting research using satellite data, has been mapping some of the major construction projects in Dubai.

The satellite images also complement existing Geographic Information System (GIS) databases and enable more efficient monitoring of environmental changes and natural hazards in addition to identifying water quality in the Gulf.

"DubaiSat-1 is a key element in the development process taking place in Dubai. The satellite highlights the commitment of EIAST to create a knowledge-based economy by leveraging satellite technology" said Salem Al Marri, Head of Marketing and International Affairs at EIAST

MBR City, announced in November this year, will feature world-class leisure and retail facilities and provide an integrated environment for the development of entrepreneurship and innovation. The landmark project will be located between Emirates Road, Al Khail Road and Sheikh Zayed Road.

DubaiSat-1 was a joint project between the UAE and South Korea, developed with a focus on knowledge transfer to the UAE team that participated in building the satellite.

EIAST had launched DubaiSat-1 in July 2009, and since then, the satellite has been transmitting images that are of great value in several areas.

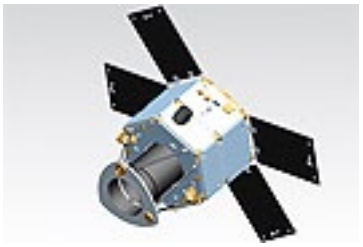
EIAST is currently working on the final stages of DubaiSat-2, a joint development programme with the Satrec Initiative of South Korea.

Sixteen UAE engineers, currently stationed in South Korea, have been working on the design, development, testing and manufacturing of the satellite.

The participation of UAE engineers in the project has increased by 100 per cent compared to DubaiSat-1 and it is hoped DubaiSat-2 will take EIAST to the next level in space research.

*DubaiSat-1 rendition*

Additionally, The Emirates Institution for Advanced Science and Technology (EIAST) showcased a model of DubaiSat-2 at The Dubai Mall in December of last year as part of the 41st UAE National Day celebrations to highlight the advances made by the nation in the space industry.



*Artist's concept illustration of DubaiSat-2*

EIAST has also launched a competition for students to design a logo for DubaiSat-2, its second satellite mission. The competition is open to students of all ages and nationalities studying at any school, university or college in the UAE. The designer of the winning logo will receive a Mac laptop.

His Excellency Ahmed Al Mansoori, Director General of EIAST, said, "Through our showcase of DubaiSat-2 at The Dubai Mall and the logo design competition, we are further strengthening awareness on the greatest achievements of EIAST, which reflects the significant strides that the UAE has made in space research. Our space initiatives are in line with the vision of the UAE leadership to strengthen knowledge about advanced technology among the UAE youth especially with DubaiSat 2 being developed by Emirati engineers."

The DubaiSat-2 project is a joint development program between EIAST and Satrec Initiative of South Korea.

Sixteen UAE engineers have been working on the design, development, testing and manufacturing of the satellite. #

## Anomaly Analysis

**Roscosmos management has reviewed and approved the report provided by the Russian working group investigating the Proton launch anomaly during the Yamal 402 mission and have provided the report to Khrunichev State Research and Space Production Center (Khrunichev).**

The findings on the identified most probable root cause of the anomaly and the required corrective actions will be released to International Launch Services (ILS) after the report clears Russian security during the week of January 21st.

The Russian working group, convened by Roscosmos, included independent experts from TsNIIMash (Central Scientific Research Institute of Machine Building), the leading institution of Roscosmos to support design, development and research into rocket and space articles, and M.V. Keldysh Research Center, the leading Russian entity for rocket engines.

ILS has formed a Failure Review Oversight Board (FROB) which will review the Commission's final report and corrective action plan, in accordance with U.S. and Russian government export control regulations.

The FROB will begin in Moscow on January 30th and consists of ILS customers, industry subject experts, and insurance industry representatives. The FROB will provide an independent review of the investigation, root cause and corrective actions required prior to return to commercial flight.

After the conclusion of the FROB, the FROB report will be briefed to ILS customers and the launch insurance industry.

The anomaly occurred during the fourth and final burn of the Breeze M engine during a planned 9 hour and 15 minute mission. The fourth burn ended about four minutes early and the spacecraft was subsequently separated.

The spacecraft, built by Thales Alenia Space for Russian satellite operator Gazprom Space Systems, was successfully maneuvered to its orbital position and was declared fully operational on January 8th, 2013, after completing its on orbit tests. #

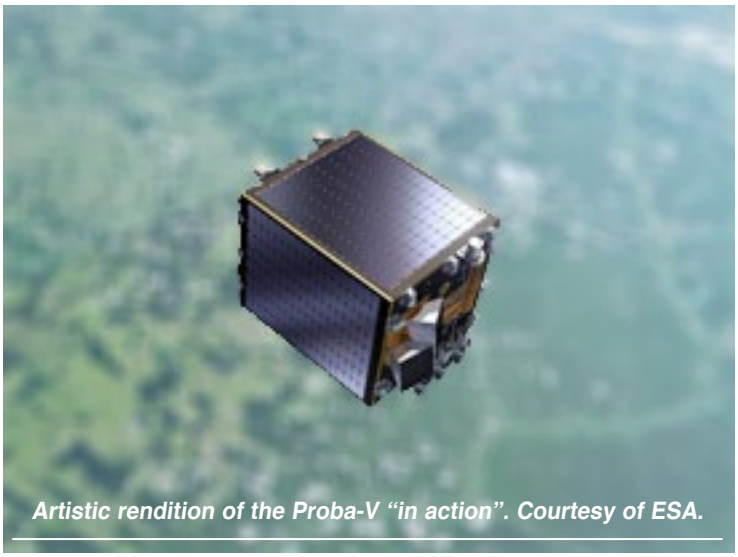
# Veggie Tracker Testing

**The European Space Agency's (ESA) Proba-V microsatellite is now assembled and is midway through testing to ensure it is fully spaceworthy.**

The miniature Earth-observer, designed to chart global vegetation every two days, will be launched in April.

The testing at the specialised Intespace facility in Toulouse, France, includes rigorous simulations of Proba-V's take-off conditions and the hard vacuum and temperature extremes it must endure in orbit.

It comes after Proba-V's assembly was completed by prime contractor QinetiQ Space at its facility in Kruibeke, Belgium last month.



*Artistic rendition of the Proba-V "in action". Courtesy of ESA.*

Building the satellite was a complex operation. Although smaller than a cubic metre, the satellites carries a wide-angle telescope for its main Earth-monitoring instrument, a pair of radiation sensors, a fibre optic connector experiment, a prototype radio transmitter based on the semiconductor gallium nitride, and a test receiver to track aircraft in flight all around the globe.

However, Proba-V also marks a departure from previous technology demonstrators Proba-1 in 2001 and Proba-2 in 2009. Both later became operational missions once the outstanding performance of their main instruments became clear.

This time, Proba-V has been conceived as a quasi-operational mission from the start, serving a waiting community of users.

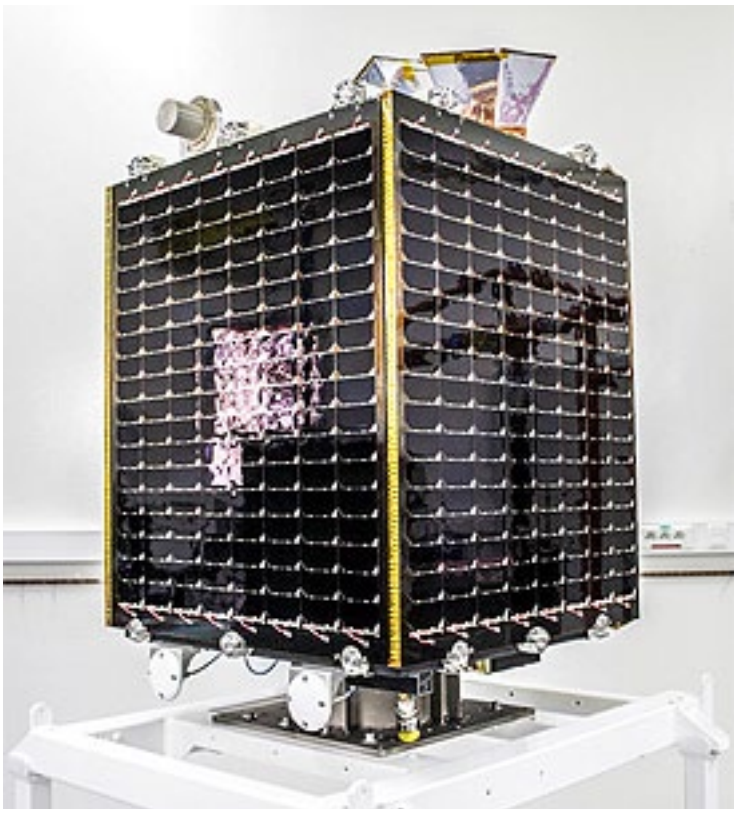
The small satellite is flying a miniaturised version of the Vegetation sensor on France's full-sized Spot-5 satellite, intended to extend its nearly 15-year continuous record of observations—dating back to the previous Spot-4 mission, launched in 1998.

There are more than 10,000 registered users of Vegetation products worldwide, and the data have contributed to hundreds of scientific papers.

Despite being much smaller than the original Vegetation instrument, Proba-V's version observes compatible spectral bands while delivering a spatial resolution three times sharper.

Among other firsts for the mission, Proba-V will fly a radio amplifier based on gallium nitride. Often described as the most promising semiconductor since silicon, gallium nitride offers higher power levels and radiation resistance.

Proba-V will also be the world's first space mission to detect Automatic Dependent Surveillance Broadcast signals from aircraft, building up a global overview of air traffic. #



*The fully-integrated Proba-V microsatellite at QinetiQ Space Belgium in December of 2012. Photo courtesy of ESA.*

# Taking Leave Of Thor II

**Telenor Satellite Broadcasting (TSBc) has successfully de-orbited Thor II to a "graveyard" orbit, after a six-day maneuver which was completed on January 10, 2013.**

TSBc chose to de-orbit Thor II, after more than 15 years of successful operation. Thor II completed its final journey to an orbit more than 350 km above geosynchronous orbit where satellites are intentionally placed at the end of their operational life.

Thor II was the first communications satellite that TSBc specified, commissioned and launched and was put into orbit by a Delta II rocket from Cape Canaveral in May 1997. #

# Testing A Mirror On A Webb

**The telescope is critical for future infrared observations and will serve as the premier observatory of the next decade.**

Since May of 2012, the AOS optical system for the James Webb Telescope has undergone a series of tests including thermal and vibration, followed by cryogenic testing to demonstrate that it can withstand the rigorous vibration environment of the rocket launch and remain precisely aligned in order to function at extremely cold temperatures in space.

The AOS will remain at Ball Aerospace to be used during integrated testing with the flight actuator drive unit and AOS source plate assembly. This AOS is the final optical subsystem of the James Webb Optical Telescope Element to complete integration and test activities at Ball Aerospace.

"Each optical element that Ball Aerospace is building for the Webb is extremely sophisticated and the successful completion of another milestone brings us one day closer to the launch of NASA's next major space observatory," said Ball Aerospace President and CEO David L. Taylor.

The AOS is a precision beryllium rectangular optical bench that houses the tertiary and the fine steering mirror installed at the center of Webb's primary mirror. The AOS is surrounded by a shroud that eliminates stray light, and two large radiator panels that keep the assembly cold. This subsystem collects and focuses the light from the secondary mirror and feeds it into the science instruments.

Ball is the principal subcontractor to Northrop Grumman for the optical technology and lightweight mirror system for NASA's Webb Telescope.

In total, Ball has designed and delivered the Webb's 18 beryllium primary mirror segments, secondary and tertiary mirrors, a fine steering mirror, and several engineering development units.

In September 2012, Ball began the process of shipping the finished Webb primary mirrors to Goddard Space Flight Center, Greenbelt, Maryland.

The remaining mirrors will arrive at Goddard this year, awaiting telescope integration in 2015. The Webb is on track for an October 2018 liftoff.

The Webb telescope is critical for future infrared observations and will serve as the premier observatory of the next decade. #

# *Satellite Spotlight: TDRS K, L + M — Pre-Launch*

**The next-generation series of *Tracking and Data Relay Satellites* (TDRS) provides NASA with crucial crosslink communications capability between Earth-orbiting spacecraft and control and data processing facilities on the ground.**

| Customer | NASA | NASA | NASA |
|---|---|---|---|
| Spacecraft | Boeing 601HP | Boeing 601HP | Boeing 601HP |
| Launch | TDRS-K | TDRS-L | TDRS-M |
| Date | 2012 | 2013 | 2015 |
| On-Orbit Life | 15 years | 15 years | 15 years |

**NASA** has returned to **Boeing** to build its next-generation series of ***Tracking and Data Relay Satellites*** (**TDRS**). Boeing was originally awarded a contract to build NASA's ***TDRS-K*** series in December of 2007. Previously, Boeing built the three satellites in the TDRS-H, I and J series for **NASA Goddard Space Flight Center** in Greenbelt, Maryland. Launched between 2000 and 2002, these satellites continue to provide excellent service. The newest TDRS award for Boeing continues its role supporting NASA's key programs over a period that spans more than four decades.

The new Boeing-built TDRS-K series spacecraft will augment the earlier TDRS constellation that serves as NASA's means of continuous, high-data rate communication with the ***Hubble Space Telescope***, the ***International Space Station*** and dozens of unmanned scientific satellites in low Earth orbit.

Boeing has teamed with **General Dynamics**, which will update and modify the existing TDRS system ground terminals. The ground terminals, known as the **White Sands Complex**, provide the primary two-way communications link between the TDRS satellites and the user control centers and data processing facilities.

## *General Characteristics*

The ***TDRS-K*** series of satellites will incorporate a modern design based on flight-proven performance. The Boeing 601HP model spacecraft includes ***Boeing 702HP***-class electronics, which are the standard for Boeing's current satellite product line. These new satellites will again provide high data rate Ka-band service capability.

Boeing will integrate its patented and innovative spring-back antenna design, first used and proven on the TDRS-H, I and J satellite series, into the new TDRS spacecraft. The 15-foot diameter antennae are designed with flexible membrane reflectors that fold up for launch, then spring back into their original cupped circular shape on orbit. The steerable, single-access antennas can simultaneously transmit and receive at S-band and either Ku- or Ka-band, supporting dual independent two-way communication.

Boeing will build the TDRS-K series of satellites at the Satellite Development Center in El Segundo, California. As of this writing, the TDRS-K is set for launch on January 29th, from NASA's Kennedy Space Center. The TDRS-L will be ready for launch this year and the TDRS-M will be ready for launch in 2015.

## *Launch Logistics*

**Cape Canaveral**'s 2013 launch season began taking shape as technicians started assembling the ***Atlas 5*** rocket for the year's first Space Coast mission—delivery of a NASA communications satellite into orbit.

The **United Launch Alliance (ULA)**-manufactured rocket will push the TDRS-K into space to reinforce NASA's communications network. Liftoff is targeted for January 29th

***The TDRS-K's fit-check... all test and fueling are completed prior to the satellite's enclosure in a protective, aerodynamic shell. Photo courtesy of Boeing + NASA.***

***Photo of an Atlas first stage hoisting operation. Courtesy of NASA.***

during a 40-minute launch window opening at 8:52 p.m. EST (0152 GMT) from the Cape's **Complex 41**.

Putting the two-stage rocket together got underway when ULA workers brought the bronze-colored first stage to the *Vertical Integration Facility* for stacking operations. The booster was secured aboard its mobile launcher, anchored on small supports that protrude from the platform. At liftoff, explosive bolts free the rocket and those supports will retract into the platform walls as the vehicle powers its way off the pad on 860,000 pounds of thrust.

Known as the *Common Core Booster*, the stage was pulled by a semi-truck up the road from the **Atlas Spaceflight Operations Center** high bay to the 30-story VIF building, where workers attached lifting cranes. The 106.6-foot-long stage was rotated vertically, then maneuvered into the building and stood upright on the mobile platform. The stage is equipped with a dual-nozzle ***RD-180*** main engine that will burn kerosene fuel and supercold liquid oxygen during the initial minutes of flight.

The interstage adapter installation is next, securing the 12.5-foot diameter first stage to the 10-foot-wide Centaur upper stage. When the cryogenic upper stage is hoisted atop the interstage, the basic buildup of the Atlas 5 is completed.

Centaur's single RL10 engine, fueled by liquid hydrogen and liquid oxygen, will perform the necessary burns to achieve orbital velocity and then shape the orbit for deployment of TDRS-K. The stage is 41.5 feet in length and also houses the navigation unit that serves as the rocket's guidance brain.

The rocket is known as the 401 configuration of the multi-varient Atlas 5 family, which is tailored with strap-on solid boosters and different sized nose cones to match the cargo's mass and size.

The spacecraft arrived from the Boeing factory on December 18th and has since undergone preflight electrical testing at the Astrotech processing facility in Titusville, Florida.

The satellite was encapsulated into the rocket's nose cone on January 15th in preparation for delivery to the VIF and mounting atop the Centaur was completed on January 17th, which completed the assembly of the 19-story-tall launcher.

ULA and its customers have opted to delete the countdown dress rehearsals for 401 vehicles at the Cape, condensing the prelaunch timelines for such rockets, except for planetary missions.

Rollout to the launch complex occurs the day before liftoff, as the 1.4-million pound platform rides the rail tracks 1,800 feet from the VIF to the pad.

The seven-hour countdown begins at 1:52 p.m. EST on launch day, leading to cryogenic liquid oxygen and liquid hydrogen fueling operations starting at 6:59 p.m. for a planned blastoff at 8:52 p.m. EST, as the launch window opens for the first Atlas launch of the year and the 35th overall since 2002.

For TDRS-K, the plain two-stage launcher with no solids will provide ample performance to carry the Boeing-built satellite to orbit.

## *25 Years Of TDRS History*

Twenty-five years ago, NASA inaugurated a new era in spacecraft communications with the launch of the first TDRS. This space-based system ultimately replaced an extensive network of ground tracking stations deployed for the ***Apollo*** missions and significantly increased the time available to mission operators to contact their flight vehicles.

Perched 22,300 miles above the Equator, the satellite rotated Earth at the same speed and direction that the Earth turns. Relative to a point on Earth, TDRS appeared to remain stationary. From that geosynchronous orbit, it beamed communications from Earth to other orbiting spacecraft and back, establishing itself as a reliable resource for NASA's space shuttle and other customers.

TDRS-1 provided a link for the first wireless phone call between the North Pole and the South Pole, and the first live webcast from the North Pole and was also the first satellite to connect to the Internet.

Soon, more TDRS satellites joined the Tracking and Data Relay Satellite System, forming a constellation of nine NASA satellites that, today, provides nearly continuous tracking and high-bandwidth communications with scores of Earth orbiting spacecraft, launch vehicles, long duration balloons, and a research station in Antarctica.

"When many people look at the TV and see beautiful pictures coming from the shuttle or International Space Station, they

***In April 1983, the first Tracking and Data Relay Satellite, TDRS-1, was launched from space shuttle Challenger's payload bay on mission STS-6. Image credit NASA.***

take communications for granted," said Badri Younes, NASA deputy associate administrator for Space Communications and Navigation. "They don't know the capabilities that NASA leverages in getting this data down to the ground."

Over the last 25 years, the TDRSS network has brought stunning images from the ***Hubble Space Telescope*** to Earth. It has delivered pictures, television, voice and data from more than 100 space shuttle missions and the International Space Station. The TDRSS network has delivered large volumes of Earth observation data in support of Mission to Planet Earth and investigations into global climate change.

Other TDRSS users have included the ***Automated Transfer Vehicle***, ***Solar Mesosphere Explorer***, ***Solar Maximum Mission***, ***Compton Gamma Ray Observatory***, ***Terra***, ***Landsat***, ***SWIFT***, ***Earth Radiation Budget Satellite***, ***Cosmic Background Explorer***, ***Extreme Ultraviolet Explorer***, ***Aqua***, and ***Aura***.

The TDRS system has evolved over the last 25 years to meet expanding user requirements and provide new services. Meanwhile, the very first TDRS satellite that was deployed by space shuttle Challenger in April 1983 is still on duty today, returning data from the **National Science Foundation** activities at the **Amundsen-Scott South Pole Station** in Antarctica.

***Artistic rendition of the Hubble Space Telescope***

# *Satellite Spotlight: TDRS K — The Launch*

**At the culmination of all of the trials and tribulations and the hard work involved in building a satellite and preparing the launch vehicle, that day finally arrives when all comes to successful fruition. Janury 30th was that date, and TDRS-K successfully launched from Cape Canaveral.**

# ULA's Atlas V Launches NASA Network Expansion

## A United Launch Alliance (ULA) Atlas V rocket successfully launched the first of three, nexgen, Boeing-built ,NASA *Tracking and Data Relay Satellite* (TDRS-K) payloads at 8:48 p.m., EST, on January 30th from Space Launch Complex-41 at Cape Canaveral. This was the first of 13 ULA launches scheduled for 2013, the 35th Atlas V mission, and the 67th ULA launch.

"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 Sponnick*, ULA vice president, Mission Operations.

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 **Pratt & Whitney Rocketdyne** (**PWR**) ***RL10A-4*** engine.

NASA established the TDRS project in 1973 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 science information from the ***Hubble Space Telescope*** and other orbiting spacecraft.

"With this team's innovative and ever-present focus on delivering mission success and best value through Perfect Product Delivery, final work at the Cape to prepare the Atlas V rocket that launched today was completed in record time—27 days from when the vehicle was first erected to launch," said *Sponnick*. "The ability for ULA to reduce its processing time both during manufacturing and at the launch sites, offers our customers added manifest flexibility as well as additional launch opportunities to ensure their payloads are delivered reliably and on-time." ULA's next launch is the Atlas V LDCM mission for NASA scheduled for Feb. 11, 2013 from Space Launch Complex-3 at Vandenberg Air Force Base, California.

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.

"TDRS-K bolsters our network of satellites that provides essential communications to support space exploration," said *Badri Younes*, deputy associate administrator for *Space Communications and Navigation* at NASA Headquarters in Washington. "It will improve the overall health and longevity of our system."

"With this launch, NASA has begun the replenishment of our aging space network," said *Jeffrey Gramling*, TDRS project manager. "This addition to our current fleet of seven will provide even greater capabilities to a network that has become key to enabling many of NASA's scientific discoveries."

The TDRS-K spacecraft includes several modifications from older satellites in the TDRS system, including redesigned telecommunications payload electronics and a high-performance solar panel designed for more spacecraft power to meet growing S-band requirements. Another significant design change, the return to ground-based processing of data, will allow the system to service more customers with evolving communication requirements.

The next TDRS spacecraft, ***TDRS-L***, is scheduled for launch in 2014. ***TDRS-M***'s manufacturing process will be completed in 2015.

NASA's *Space Communications and Navigation Program*, part of the *Human Exploration and Operations Mission Directorate* at the agency's Headquarters in Washington, is responsible for the space network. The TDRS Project Office at NASA's *Goddard Space Flight Center* in Greenbelt, Maryland, manages the TDRS development program. Launch services were provided by **United Launch Alliance**. NASA's *Launch Services Program* at the **Kennedy Space Center** was responsible for acquisition of launch services.

# *Missions To Mars*

*by Jos Heyman, Senior Contributing Editor*

**With the landing of the Mars Science Laboratory (MSL) on Mars, on 6 August 2012, it is appropriate to have a look at previous U.S. missions to Mars. Mars is relatively easy to study as it is close to the Earth and has no clouds which obscure its surface. Its generally red appearance led it to being associated with war and when its two tiny moons were discovered they were named Phobos (fear) and Deimos (terror). Mars is also of interest as it is possibly the only other planet in the solar system that may, once, have harbored forms of life.**

***Artistic rendition of the Mariner-4 approaching Mars***

## Mariner Series

The ***Mariner*** series of interplanetary spacecraft consisted of a number of essentially dissimilar spacecraft which explored the inner planets, Mercury, Venus and Mars.

***Mariner-3*** was the first U.S. Mars probe and was launched on November 5, 1964. However, the spacecraft disappeared into deep space. It was to perform a flyby of Mars during which it was to take photos of the planet, undertake occultation studies and carry out other interplanetary experiments.

After this initial failure, ***Mariner-4***, which had been launched on November 28, 1964, flew past Mars at a distance of 9789km on July 14, 1965, and transmitted 21 photos of the Martian surface back to Earth. Unexpectedly, these photos showed many craters, a feature which was later proven to be an exception.

There was no evidence of volcanic activity or water erosion. No magnetic field or a radiation belt was found while a very thin atmosphere, consisting of 95 percent carbon-dioxide, was detected. Both Mariner-3 and -4 carried a camera with transmission device, a solar plasma probe, an ionization chamber, a radiation detector, four Geiger-Mueller counters, a helium vector magnetometer, a cosmic ray telescope and two cosmic dust detectors.

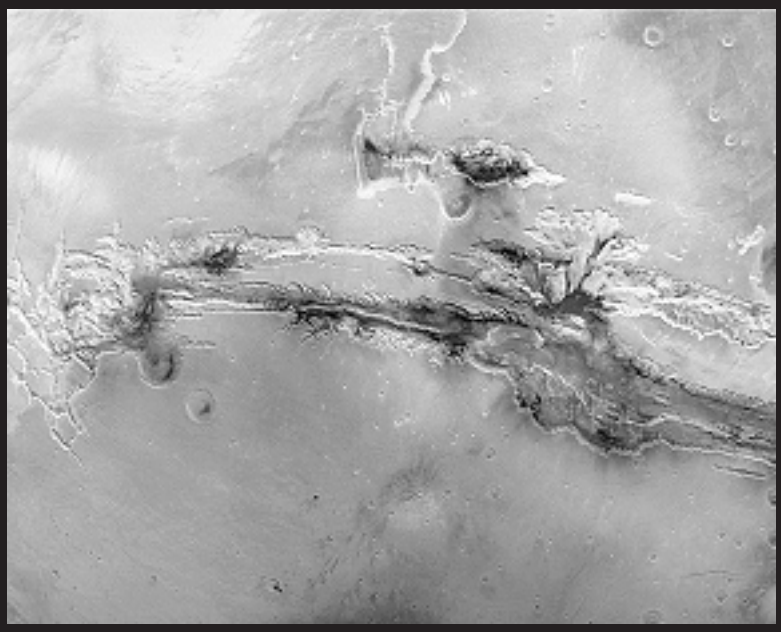
The success of the Mariner-4 mission was followed by ***Mariner-6*** and ***-7***, launched on February 24, 1969, and March 1969 respectively. They passed Mars on the 27th and July 31st respectively and August 5th, 1969, over the southern hemisphere of the planet and the Equator at distances of 3400 and 3500km. They returned, first 74 and then 126 photos of the planet. Instruments on board detected carbon-dioxide, carbon-monoxide, and atomic hydrogen, oxygen and carbon in the upper atmosphere. The surface temperature was measured as -50 to 13oC in the daytime and -103 to -52oC at night.

Both spacecraft carried two TV cameras, an infra-red radiometer for thermal mapping, an ultraviolet spectrometer to identify chemical constituents of the upper atmosphere, an infra-red spectrometer to measure the lower atmosphere and the surface composition and a celestial mechanics' experiment to determine the mass of Mars and the distance between Earth and Mars.

After the launch failure of ***Mariner-H*** on May 8, 1971, the ***Mariner-9*** spacecraft was launched on May 30, 1971, and was placed into an orbit around Mars of 1397 x 17,916km with an inclination of 64.3 degrees on November 14, 1971. The mission provided a wealth of data on the planet, although initially images offered little detail of the surface due to a prevailing dust storm. It was not until one year later that the spacecraft revealed the true surface of the planet: valleys of enormous size, 4000m deep, 5000km long and 150km wide, and the highest volcano known in the solar system, *Nix Olympica*, 25km high and 500km wide at its baseline. The photos also showed intriguing wind erosion patterns which kept scientists busy with analysis for years.

## Valles Marineris

It was apparent that the earlier Mariners happened to have observed very untypical regions of Mars. Now the hemispheres were seen to be quite different, although the dividing line was not at the equator but at a 50 degree angle to it.



***Valles Marineris***

The southern hemisphere was found to be heavily cratered, ancient and inactive and resembled the Moon. The northern hemisphere, on the other hand, appeared geologically active with lava fields, fractures, etc. The spacecraft also made observations of the two moons of Mars and the images obtained revealed them to be irregularly shaped.

The instrumentation of ***Mariner-9*** consisted of an infra-red interferometer spectrometer for studies of the planet's surface and composition, its atmospheric constituents, temperature, etc., an infra-red radiometer to measure the surface temperature, an ultraviolet spectrometer to study the atmospheric composition, structure and temperature, as well as two television cameras.

A total of 7329 pictures were transmitted until the instruments on the spacecraft were closed down on October 27, 1972. Mariner-9 is expected to burn up in the Martian atmosphere in 2025.

## Viking Series

The Viking program comprised of two spacecraft, each one consisting of an orbiter, to be placed in a Martian orbit, and a lander to land on the surface of Mars. The latter provided the most spectacular images of the planets surface following their landings on July 20th and September 3rd, 1976.

Each lander carried two camera systems, a meteorology boom, a surface sampling instrument, a seismometer, a biology instrument, a gas chromatograph/mass spectrometer and an X-ray fluorescence spectrometer.

The three life experiments were based on the assumption that life was carbon based and was probably in the form of microbes or bacteria. In one experiment, a sample of soil was incubated in simulated Martian sunlight for up to five days in an atmosphere of carbon-dioxide and carbon-monoxide labeled with a radioactive tracer. The unused tracer was then removed and the sample heated to 625 degrees C to vaporise any organic material, releasing any tracer that had been taken up. As a result, fixation of some tracer occurred, but the amount was such that it was probably due to chemistry rather than biology.

In another experiment, a sample of soil was fed liquid nutrients rich in vitamins and amino acids labeled with a radioactive tracer, then incubated at 10 degrees C for up to 11 days. Measurements were then made of any gases resulting from the consumption of the nutrients. An early release of carbon-dioxide was detected, probably due to biology rather than chemistry.

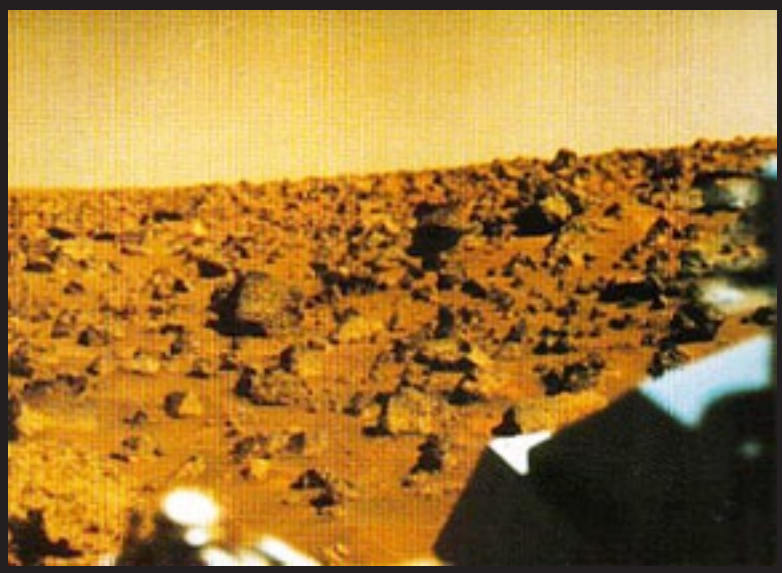
In the third experiment, a sample was put into a liquid nutrient of organic compounds and inorganic salts. It was then incubated for up to 12 days in an atmosphere of helium, krypton and carbon-dioxide. The atmosphere was sampled at intervals for hydrogen, nitrogen, oxygen, methane and carbon-monoxide. It was found that carbon-monoxide and oxygen were expelled, which was probably due to chemistry. The overall conclusion of the life science experiments was that the results were ambiguous and could be explained either by chemical reactions or by primitive life forms.

Data collected by the landers also showed that the winds were generally less than 20km/h but that, during storms on the southern hemisphere, they could exceed 180km/h. Little seismic activity was found. The surface is red in color and has a wide variety of rocks. Analysis of the surface samples resulted in a 21 percent silicon content, 13 percent iron as well as aluminum, magnesium, calcium, sulphur and other elements. It was estimated that 42 percent of the oxygen was bound up in compounds, such as iron oxides, which accounts for the red color.

The two cameras provided images over 350 degrees from the spacecraft to the horizon. Images were in black/white, color and in three infra-red bands. Stereo images were also produced. Each image required 20 minutes to build up—moving objects were recorded as a line, and there were no lines found on any of the images.

## Viking-1 Landing Site

The orbiters carried two narrow angle television cameras for high resolution imaging, an atmospheric water detector to map the atmosphere of Mars and to detect any water, an infra-red thermal mapper, and radio equipment to be used in occultation experiments to provide data on the planet's size, gravity, mass, density and other physical characteristics. The



***The Viking-1 landing site***

results obtained by the orbiters showed dense carbon-dioxide clouds over the poles during the summer. In the winter, these condensed as ice causing a drop in the atmospheric pressure. It was found that the polar caps have water ice as well as the seasonal carbon-dioxide ice. The ice cap extends as far as 50 to 60 degrees latitude in winter.

Imagery revealed large surface channels scoured by flooding and many smaller channels apparently caused by past water flows. Huge canyons indicated substantial surface movement.

The entire surface of Mars was mapped with resolutions ranging from 200 to 8m. The study of the atmosphere revealed that the constituents were the same at high altitude as at the surface, indicating efficient mixing by the winds. No ozone was detected so that the solar ultraviolet radiation reached the surface, breaking water down into HO and O.

Both *Phobos* and *Deimos* were examined by the orbiters. The moons are probably former asteroids that came near Mars and were captured by the planet. In particular, Phobos was mapped using high resolution and was found to be quite dark and may consist of carbonaceous chondrite with an outer layer of rock.

## Mons Olympus

***Viking-1*** attained an orbit of 1500 x 50,600km with an inclination of 37.8 degrees on June 19, 1976. The lander separated on July 20, 1976, and landed at 22 degrees 18' N, 48 degrees 0' W.

***Viking-2***'s orbit was attained on August 7, 1976, and was 1502 x 35,728km with an inclination of 55.6 degrees. Its lander

***Mons Olympus***

separated on September 3, 1978, and landed at 47 degrees 14' N, 135 degrees 18' E.

Although the design life of the Vikings was three months, the Viking-1 orbiter was not shut down until August of 1980, after an operational life of 49 months. The Viking-2 orbiter remained operational until July of 1978 (a period of 22 months), while its lander functioned until April of 1980 (45 months). The Viking-1 lander was kept operational by public subscription until it ceased to function in November of 1982, after 76 months of operation.

## Mars Observer

The Mars Observer was a 2487kg spacecraft that was launched on September 25, 1992, and was to be placed in a Martian orbit of 380,000 x 550km, later to be modified to 375 x 350km with an inclination of 92.8 degrees. The spacecraft was to undertake a mapping mission of the planet, which would have lasted for the duration of a Martian year, i.e., 687 days.

***Artistic rendition of the Mars Observer***

The spacecraft was nicknamed the USS Thomas O. Paine.

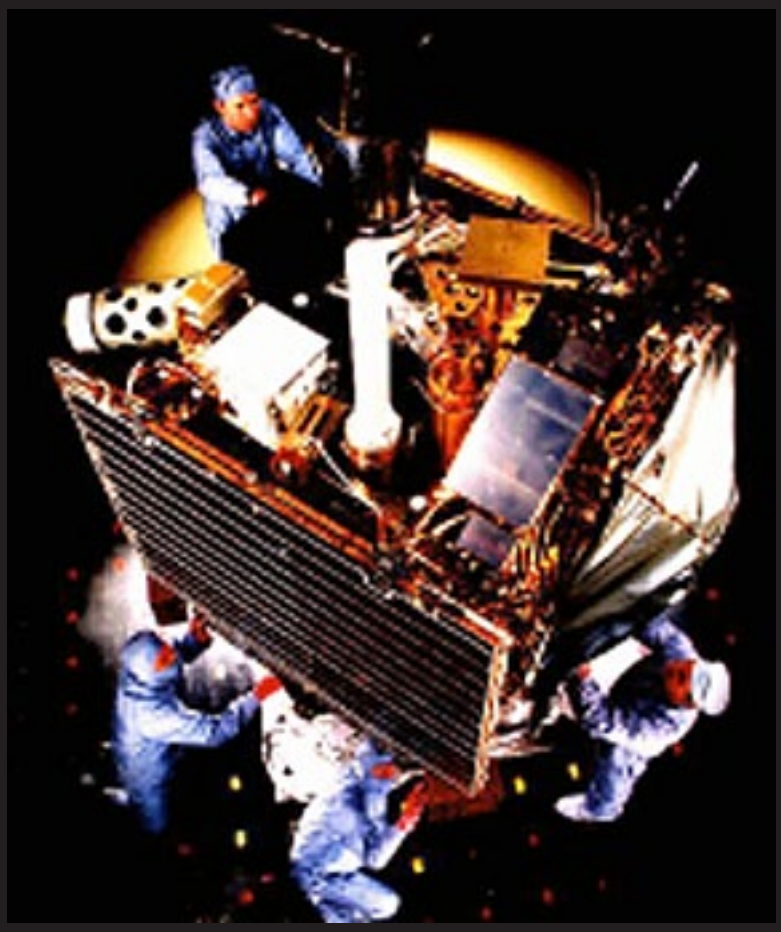
Contact with the spacecraft was lost prior to the Martian orbit insertion, which was planned for August 24, 1993. It is not known if orbit insertion was achieved, or if the spacecraft flew past Mars into a solar orbit.

## Mars Global Surveyor

Launched on November 7, 1996, the ***Mars Global Surveyor***, with a mass of 1060kg, reached Mars on September 11, 1997, and the intention was that, by January of 1998, it would have been in a Martian polar orbit of 350 x 410km, with an inclination of 93 degrees. However, during the aerobraking phase of the spacecraft's flight around Mars, one of the large solar panels suffered too much stress. The aerobraking phase was amended and the desired orbit was finally achieved in February 1999.

Due to the delay in the aerobraking phase, the scientific program was delayed by one year. In July of 1998, the alignment of the Sun was incorrect for mapping and it was necessary to wait until March 9, 1999, before mapping could start. Budget restrictions, at that point in time, prevented the extension of the observation program beyond the one year time period. However, following excellent results, the mission was extended to February of 2001. The program was subsequently extended to April 2002.

# Missions To Mars (Cont.)

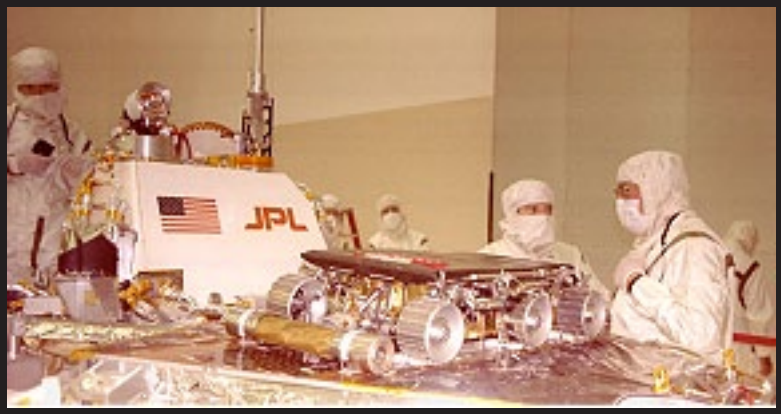


***Mars Global Surveyor***

After the observation program, the satellite continued to be used as a data relay station for subsequent lander craft until, on November 5, 2006, contact with the spacecraft was lost.

## Mars Pathfinder

Launched on December 4, 1996, the ***Mars Pathfinder*** was a 890kg Mars exploration spacecraft consisting of a cruise vehicle, an entry vehicle and a lander. The lander included the ***Mars Pathfinder Microrover***, named ***Sojourner***, a 11.5kg vehicle which was 63cm long, 48cm wide and 31cm high.




***Mars Pathfinder pre-launch preparation***

The 890kg spacecraft made a successful landing on Mars on July 4, 1997. The landing site was at *Ares Valles*, at approximately 19 degrees 20' N, 33 degrees 55' W, an area that was initially targeted for the landing of Viking-1, whose schedule 21 years ago called for the event to occur on July 4, 1976.

## Sojourner + Yogi

After the landing, the Mars Pathfinder was renamed the Carl Sagan Memorial Station. The next day, the Sojourner was released. Although intended to operate only for one week, Sojourner continued to operate until September 27, 1997, when contact was lost. The mission was formally terminated on November 4, 1997.

***Sojourner and the rock "Yogi"***

## Mars Climate Orbiter

The Mars Climate Orbiter was launched on 11, December 1998, and was to be placed in an orbit around Mars to observe climatic changes in the martian atmosphere.

***Mars Climate Observer***

## Mars Climate Observer

The Mars Climate Orbiter reached Mars on September 23, 1999, and was to achieve an operational orbit of 373 x 437km and an inclination of 92.9 degrees by November 23, 1999. However, a navigation error brought the spacecraft in at a distance of 60km and it is believed to have burned up and been destroyed by the Martian atmosphere.

## Mars Polar Lander

Launched on January 3, 1999, the ***Mars Polar Lander*** was to touch down in the south polar region of Mars between the 75 and 80 degrees South latitudes on December 3, 1999. The 560kg probe would have landed suspended from a parachute, to conduct a primary mission, which was to last three months.

The spacecraft reached Mars on December 3, 1999, and the lander separated as scheduled, however, contact was lost. Using images provided by the ***Mars Global Surveyor***, the Mars Polar Lander was eventually located on the surface of Mars.

## 2001 Mars Odyssey

Originally referred to as the Mars Surveyor 2001 Orbiter, the 2001 Mars Odyssey was launched on April 7, 2001, and placed in an orbit around Mars on October 23, 2001. Using aerobraking, the 379kg spacecraft maneuvered into a Martian orbit of 419 x 450km with an inclination of 93.1 degrees, which was reached on January 17, 2002.

During its primary mission, which lasted a full Mars year (23 months), it provided scientists with the most detailed and complete global maps of Mars to that date, with daytime and nighttime infra-red images at a resolution of 100m revealing details of frozen water deposits and surface textures and minerals. It also provided a communications relay for the ***Spirit*** and ***Opportunity*** Mars rovers.

In August of 2004, **NASA** approved an extension of the mission until September of 2006 to provide an additional Mars' year of information. In addition, the spacecraft assisted in March 2006 with the ***Mars Reconnaissance Orbiter*** mission by monitoring atmospheric conditions at the arrival of that spacecraft. Odyssey also analyzed potential landing sites for the ***Phoenix*** mission.

## Mars Explorer Rover

On June 10 and July 8, 2003, the two ***Mars Explorer Rover*** missions were launched. The two spacecraft were similar to that used for the Mars Pathfinder mission and a similar landing technique was adopted, using a parachute and airbags to cushion the impact. The spacecraft had a total mass of 365kg.

Each rover, with a mass of 174kg, carried five instruments, all designed to analyze rocks and soils.

The ***MER-A***, also named ***Spirit***, landed on Mars on January 4, 2004, at *Gusey Crater* at 14.6 degrees S, 184.7 degrees W, a site which was later named as the ***Columbia Memorial Station***. Spirit's primary mission started on January

*Mars Polar Lander*

15, 2004, and was completed in May of 2004. The mission was subsequently extended to September of 2006.

In 2006, one of the rover's six wheels stopped working but, using the remaining five wheels, the vehicle carried on. In March 2009, while traversing a low plateau called Home Plate, the rover became stuck in the sand. Efforts to get the rover moving again failed and, in November 2009, another wheel failed. Using the remaining wheels, Spirit was moved to angle in such a way that it would get the maximum amount of solar energy during the Martian winter in order to continue as a stationary science platform.

NASA decided in May of 2011 to cease attempts to establish contact with vehicle. Last contact was on March 22,

*2001 Mars Odyssey*

*Mars Explorer Rover*

2010, and it is believed that the robot's internal components and electrical connections had all been damaged by the cold temperatures of the Martian winter. It had traveled a total of 7.7km.

MER-B carried the Opportunity rover and landed at Meridiani Planum at 2.1 degrees S, 6.0 degrees W on January 25, 2004. On January 31, 2004, the rover craft left the landing platform. Its primary mission was completed in May of 2004. The mission was subsequently extended to September of 2006 when the rover reached Victoria Crater, about 10km from the landing site. As at April 2012, the rover was still operational, having traveled a total of 34.3km.

## Mars Reconnaissance Orbiter

The Mars Reconnaissance Orbiter (MRO) was launched on August 12, 2005. It was a 1900kg spacecraft built by Lockheed Martin. It was placed in an orbit around Mars to search for evidence that water had persisted on the surface of Mars for a long period of time. It also zoomed in for extreme close-up photography of the Martian surface, analyzed minerals, looked for subsurface water, traced how much dust and water are distributed in the atmosphere, and monitored daily global weather.

Other experiments scanned underground layers for water and ice, identified small patches of surface minerals to determine their composition and origins, tracked changes in atmospheric water and dust and checked global weather every day. As the spacecraft approached Mars in March of 2006, it passed under the southern hemisphere at an altitude of about 300km. It then performed a maneuver on March 10, 2006, to slow the orbiter down to achieve its capture orbit of 300 x 45,000km. The orbiter's primary mission ended in November of 2009. Following that, the spacecraft continued to be used as a communications relay.

*Phoenix*

## *Phoenix*

Launched on August 4, 2007, ***Phoenix*** was a Mars lander built for NASA by **Lockheed Martin Space Systems**. The objectives of the mission included the study of the history of water in the Martian polar regions and to search for evidence of a habitable zone as well as to assess the biological potential of the ice-soil boundary.

The spacecraft made use of a lander structure, subsystem components and protective aeroshell originally built for the ***Mars Surveyor 2001 Lander*** spacecraft that had been cancelled. Before re-entry, flight path data was sent to the on-board computer, which controlled descent and landing and guided the spacecraft to its landing site. A cruise assembly, carrying flight control systems and solar arrays necessary for the trans-Martian flight, was jettisoned five minutes before entry into the Martian atmosphere, at an altitude of about 125km. The spacecraft then slowed itself down by means of friction—a heat shield protected it from the high temperatures.

When the lander's speed was about Mach 1.7, a parachute deployed, followed with the jettisoned heatshield. The landing radar was activated and the spacecraft's legs extended. At an altitude of about 1km, the lander separated from the parachute and then used its thruster to decelerate further. When Phoenix was at an altitude of 12m or traveling at 2.4 m/s, the spacecraft began traveling at a constant velocity. The landing engines were turned off when sensors located on the footpads of the lander detected touchdown. The landing took place on May 25, 2008, at 68.2 degrees N, 125.7 degrees E. After the landing, the robotic arm of the lander collected Martian arctic soil and dropped it into the *TEGA* to vaporize any water that would be in the sample. Baking at lower temperatures did, however, not indicate any water. The temperature was later increased to search for minerals that decompose at different temperatures. As the oven could only be used once, there were no further experiments of this nature.

Phoenix successfully accomplished its primary three-month mission and two bonus months of operations before contact was lost in November of 2008. Images taken by the ***Mars Reconnaissance Orbiter*** indicated that carbon dioxide ice deposits had settled on the lander's two circular solar panels, which caused the panels to snap off or bend. The mission was formally closed in May 2010.


***About the author***

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

# *Executive Spotlight: Andrew Matlock, NewSat Limited*

**Andrew Matlock has a work history that spans 25 years across the telecommunications and technology sectors. He has worked as Regional Manager for Calcomp Inc, (a division of Lockheed Martin), was CEO and co-founder of Inspar Pty Ltd and co-founded successful start-up ventures in the United States of America and in Australia.**

**Andrew joined NewSat in 2007, becoming Vice President of Sales in June of 2008. Through strong leadership, effective communications and genuine interpersonal skills, Andrew has built a successful, process-driven and scalable global sales team to support NewSat's future growth.**

### *SatMagazine (SM)*

*You have been involved in telecommunications and technology sectors for over 25 years and have spent the last seven years working in the satellite industry. What do you think the biggest change in the industry has been so far?*

### *Andrew Matlock*

Over the last decade, I have seen how global demand for satellite capacity has grown exponentially, far outstripping supply. The market is currently experiencing a transformation, similar to what happened 20 years ago when C-band spectrum filled up and the industry needed to move on to Ku-band. For this reason, demand for next generation Ka-band satellite capacity is expected to grow, especially across high demand regions, such as the Middle East, Asia and Africa.

### *SM*

*How did you decide that NewSat was where you wished to develop your career?*

### *Andrew Matlock*

**NewSat** is such a dynamic, growth-driven organisation and its Founder and CEO, *Adrian Ballintine*, is a visionary entrepreneur who is dedicated to growing and transforming NewSat into a global satellite operator.

I joined NewSat because I saw an opportunity to become involved in the development of its teleport business and, later, in the ***Jabiru Satellite Program***. Upon the acquisition of its teleports in *Perth*, *Western Australia* and *Adelaide*, South Australia, NewSat had two great assets which needed to be developed. I wanted to progress the teleport business and build a successful team which understood the products we were dealing with inside out.

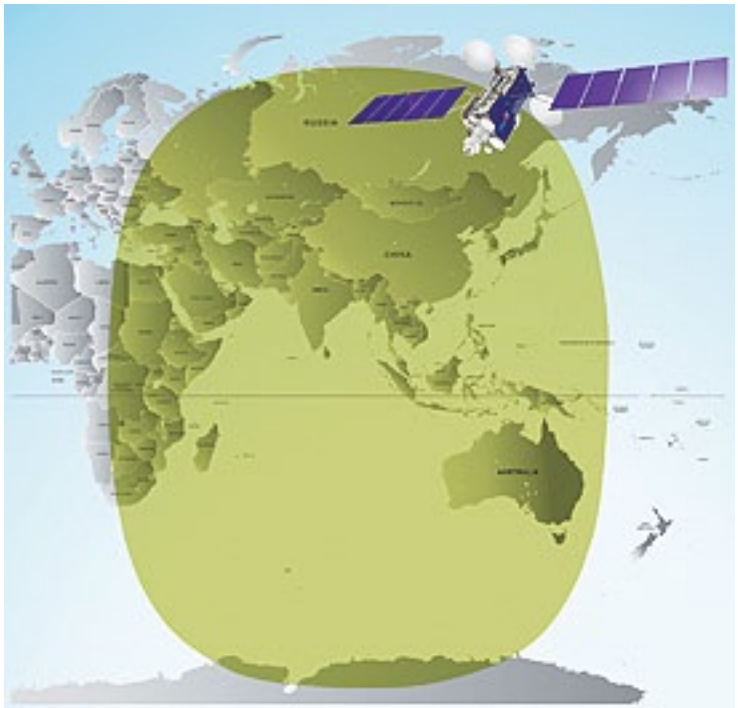
Now, NewSat is expanding its satellite capabilities with the Jabiru Satellite Program, starting with the launch and operation of ***Jabiru-1***, Australia's first Ka-band satellite. This has given me the opportunity to work on and grow this new and very exciting side of the business. NewSat is a truly customer-focused business, which I enjoy. I expect to work at NewSat for many years to come.

### *SM*

*Looking over your career at NewSat, what would be some projects that have brought you the most satisfaction?*

### *Andrew Matlock*

One of the projects which has brought me great satisfaction was the redevelopment of our sales team and building an understanding of our services and products in the market in order to develop NewSat's business. Our journey spans from acquiring teleports in Adelaide and Perth to establishing a reputation as the partner of choice for governments,



***Coverage map: Jabiru-1, image courtesy of NewSat***

corporations and private enterprise. NewSat's teleport business has recorded year-on-year record growth over the last several years and it has been fantastic to be an integral part of it. Being involved in the development of the Jabiru Satellite Program is another great aspect of my job. Taking it from a concept into now having sold US$601 million of pre-launch customer contracts has been a very exciting and rewarding journey.

### *SM*

*2012 has been an exciting year for NewSat—can you tell us a bit about what has been happening?*

### *Andrew Matlock*

Throughout 2012, NewSat's core teleport business continued to grow, starting with the signing of new "blue chip" customers across the Middle East, Asia, Australia and the USA, which were incremental to NewSat's existing revenue base. Focusing on customers across resources, construction, maritime, military and government verticals, combined with high levels of customer retention, NewSat's world acclaimed teleport business has been very profitable. The teleport business kick-started the 2013 financial year with the signing of its largest individual contract, US$8.59 million, for the **Wheatstone Project**, one of the world's largest *liquid natural gas* (**LNG**) projects located off the North West coast of Western Australia. In addition, NewSat's Adelaide and Perth teleports were rated Top 3 in the world at the **2012 World Teleport Association's** *Awards for Excellence*. NewSat experienced 29 percent revenue growth and high customer retention rates, with 100 percent of the top 30 customers remaining with the company. We have also acquired the rights to an additional orbital slot, taking the total to eight premium orbital slot assets.

### *SM*

*Jabiru-1 is Australia's first Ka-band satellite—how is this critical project progressing?*

### *Andrew Matlock*

NewSat's strategic growth project, the Jabiru Satellite Program, continued to achieve key milestones towards the launch


*Coverage map: Jabiru-2, image courtesy of NewSat*

of Jabiru-1. To date, NewSat has signed US$601 million pre-launch customer contracts for Jabiru satellite capacity across enterprise and government customers, including a US$180 million contract with leading Asian satellite operator, **MEASAT**.

NewSat also secured the services of Lockheed Martin and Arianespace to construct and launch the Jabiru-1 satellite. Lockheed Martin completed Preliminary Design Review (PDR,) confirming that Jabiru-1 is on track for its end of 2014 launch. NewSat also received final approval from Ex-Im Bank for a ~US$280 million direct loan and received a promesse de garantie of ~US$102 million from COFACE for Jabiru-1.

Jabiru-1, a large next generation Ka-band satellite, will provide superior coverage over North Africa, the Middle East and South Asia. The satellite will provide much needed "new" capacity to these high demand regions, through a range of multi-spot, regional and steerable beams.

**SM**
*What is the current Americas market like for NewSat? What will be the growth drivers for the future?*

**Andrew Matlock**
Clients in the Americas continue to be strong contributors to NewSat's business. In particular, the re-alignment of U.S. troops to the Pacific fits in perfectly with our position in the Asia Pacific market. Specifically, our two teleports are well situated geographically to continue supporting requirements in Africa, Europe and the Middle East and support the upcoming communications needs within PACOM's area of responsibility We are also experiencing a surge in *Communications-On-The-Move* (**COTM**) requirements and our clients continue to expand their existing networks by leveraging our teleport infrastructure.

Jabiru-1's steerable beams are also drawing a great deal of interest from users in the maritime and aeronautical communities, particularly to augment capabilities in high areas of interest. NewSat's access to satellites with coverage that spans from Europe to the USA's West coast in Ku- and C-band allows us to support growing needs in various regions and markets. Additionally, we are seeing an increase in requirements from the video community. The wide reach of our teleports allows us to help clients redistribute content across a variety of markets and regions.

**SM**
*How will Jabiru-1 assist the Americas market?*

**Andrew Matlock**
Jabiru-1's Ka-band payload is ideally suited to support the expansion of U.S. clients in the commercial and military sectors. The fixed beams are over areas demonstrating increased bandwidth needs from enterprise clients and will allow the growth of existing networks restricted today by the lack of clean Ku-band. The U.S. **Department of Defense** (**DoD**)'s satellite bandwidth consumption continues to grow and the launch of the WGS fleet certainly assists in meeting this demand. However, even with this expansion, predictions are that a shortfall in the next few years will allow Ka-band capacity providers such as NewSat to complement the WGS fleet with commercial capacity. Jabiru-1 was designed with tremendous flexibility, with regard to beam connectivity which will allow NewSat to configure bandwidth as needed by various user communities.

There is already a significant amount of pre-launch commitments which will position certain clients to have significant advantages to compete for the Ka-band requirements that cannot be met by WGS. Australia's position as a strong U.S. ally puts us in a better position than other providers of Ka-band capacity in the region.

**SM**
*What do you believe are three growth areas in the global satellite industry?*

**Andrew Matlock**
A major growth area is Ka-band. The increased spectrum available at Ka-band when compared to C-and Ku-band makes the move to Ka-band a natural decision given the strong demand for connectivity.

As mentioned earlier, mobile VSATs with high capacity requirements will be a huge growth area in the next decade. The volume of HD Video required for the growing number of UAVs alone is expected to greatly outstrip demand.

We have also seen an increase in customer demand for content distribution over satellite. This is because satellite has a competitive advantage over point to point terrestrial distribution, specifically due to its ability to distribute content from one point to many.

**SM**
*What is in store for NewSat in 2013?*

**Andrew Matlock**
2013 will revolve around realizing NewSat's vision of becoming a global satellite operator. We will continue to work closely with Lockheed Martin every day as the Jabiru-1 satellite is being built and will focus on achieving further key milestones for the Jabiru Satellite Program.

The launch of NewSat's Jabiru-2 at the end of 2013 will provide some much needed Ku-band capacity over Australia, Timor Leste and Papua New Guinea. We will continue to grow our teleport business and reach out to high demand markets around the world across oil and gas, mining, maritime, aeronautical, military, government and enterprise. Our sales team is constantly expanding and we have a strong sales pipeline for 2013.

***More info at the NewSat website***
***http://www.newsat.com.au/***

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# *Is Ka-Band The Ku- Killer?*

*by Daniel Welch, Senior Consultant, Valour Consultancy*

**Approximately 18 months ago, I had the opportunity to work a research project that looked at cellular and WiFi connectivity onboard commercial aircraft. With a number of solutions available to allow connectivity in the skies, many airlines were understandably confused as to which of these they should adopt in the future, especially given the unmitigated disaster that was Connexion by Boeing. Retrofitting just one aircraft with the necessary equipment to enable passengers to wirelessly connect to the Internet is very costly and it is therefore imperative that the right decision is made—even more so in these austere times.**

Taken as a percentage of the world's total active global fleet, Aircell's highly-successful air-to-ground (ATG) technology—Gogo Inflight Internet—currently dominates the industry with around 1,500 aircraft retrofitted to date. However, as the name suggests, ATG networks are only feasible over heavily-travelled land masses making satellite solutions a necessity on transoceanic routes. As such, long-haul airlines have had to decide whether to invest in L- or Ku-band based systems if they want to offer in-flight connectivity.

However, long-haul airlines are not the only ones in a quandary. **Southwest Airlines**, which would, at first glance, be a prime candidate for the Gogo solution given that it operates domestic routes in the U.S., has opted for a Ku-band system provided by **Row 44**.

While each technology inevitably has its pros and cons, there is no doubt that the major talking point when it comes to *connectivity on the move* surrounds coming Ka-band capacity, which was, and probably still is, widely-perceived to be a *Ku-killer*. Indeed, **JetBlue Airways** is collaborating with **ViaSat** to offer a Ka-band based service in 2013.

In the maritime industry, Ka-band has been hailed as a game changer, offering ship operators a higher bandwidth service and potentially, data transmission costs that are much lower than their current solutions. However, Ka-band is not a cure-all wonder solution that will make high-speed satellite capacity available, affordable and practical to all vessel operators. In fact, one could argue that its emergence has been overhyped and that Ku-band remains just as viable, if not more viable than Ka-band in a number of instances. Because of this is a summary of the advantages and disadvantages of Ka-band systems and highlight scenarios where it may not prove to be the optimal solution.

## Disadvantages

In a break with tradition, let's start with the disadvantages—mainly because the reader is likely to be more familiar with the advantages.

### Rain Fade

The term rain fade is, in fact, a bit of a misnomer as atmospheric snow or ice, in addition to rain, absorbs any radio frequency above 11GHz. The Ka-band frequency ranges between 26-40GHz and systems using this satellite technology suffer from more signal degradation, or fade, than other technologies. Note that as Ku-band is in the 12-18GHz frequency range, it, too, is vulnerable to rain fade, although less so than Ka-band.

To counter signal losses, Ka-band systems, such as **Inmarsat**'s ***Global Xpress*** (**GX**), tend to use multiple focused spot beams to cover an area, rather than rely on a single wide beam to blanket an entire continent.

In the aeronautical world, rain fade isn't an issue as aircraft typically spend the majority of their time above the clouds and above the rain.

### Coverage

Ka-band satellites currently in operation are regional in nature and only cover specific continents. For example, ***ViaSat-1***, which launched in October of 2011, has a capacity of more than 140GBit/s spread over the North American continent.

Likewise, ***KA-SAT***, a *high throughput satellite* (**HTS**) owned by **Eutelsat** that launched in December of 2010, provides more than 70GBit/s to the majority of mainland Europe, the Mediterranean basin, and a small area of the Middle East.

***To provide the space infrastructure for the Global Xpress network, three new Inmarsat-5 satellites are under construction at Boeing, based on its flight-proven 702HP platform.***

Clearly, none of these are really viable options for ocean-going vessels. On the other hand, ***GX***, as its name suggests, will provide global coverage when full operations commence in 2014 and could revolutionize broadband services in the maritime world—except, GX isn't truly global. In fact, all satellites operated by Inmarsat are in a fixed geostationary (GEO) orbit tens of thousands of kilometres above the Earth's surface, providing an orbital period equal to the Earth's period of rotation. Because of this, GEO satellite footprints do not cover the Earth's polar regions.

Vessels taking advantage of receding arctic ice and traversing the now more navigable Northwest and Northeast passages may not benefit from continued coverage in these regions. Such vessels will need backup communications. **Iridium**, with its *Low Earth Orbit* (**LEO**) L-band satellites, fits the bill perfectly. The company's next generation of satellites, called I***ridium NEXT***, slated for launch in 2015, promise speeds of up to 1.5Mbps and could provide a path to enhanced bandwidth at the poles.

# Is Ka-Band The Ku- Killer? (Cont.)

***Photo of KA-SAT undergoing electromagnetic testing in Astrium facilities.***

### *Lack Of Backup*

In the Ku-band world, there are multiple satellite operators. Should something go wrong, finding a backup satellite is not normally a problem. As Inmarsat is (or will be) the only feasible maritime Ka-band provider for the time being, there is not likely be a back-up Ka-band satellite to rely upon and maintain continuity of service. Back-up connectivity will surely be provided by the company's lower bandwidth L-band satellites.

### *Cost Of Satellites*

Ka-band satellites tend to be more expensive than Ku-band satellites. To recoup the higher CAPEX involved with launching these birds, will the operator be tempted to charge more for the service?

## Advantages

### *Unused Spectrum*

Unlike lower frequencies such as Ku- and C-band, Ka-band satellite services are not yet heavily subscribed. One of the biggest selling points, therefore, is this unused spectrum and this coupled with the use of multiple spot beams allows for much higher frequency reuse, multiplying the data throughput that can be achieved.

Essentially, frequency re-use consists of the ability to use the same frequency band more than once in any given geographic location. As these beams cover a small area, with little overlap, providers can re-use frequencies in each individual beam to provide greater total capacity, without the need to increase allocated bandwidth.

Another upside of this approach is that spot beams can be aimed wherever they are needed. On the downside, multiple spot beams can create operational issues. For one, uplinking data from one spot beam and then downlinking it via another requires signal switching which adds to the complexity and cost of the satellite.

### *More Bandwidth = Cheaper Service?*

With Ka-band, there will be more available bandwidth. More bandwidth is essential for implementing and operating data-intensive applications like enterprise resource planning systems, remote IT solutions and video conferencing. The potential for Ka-band to drive efficiency and operational savings across all areas of the business is important to note when quantifying the ROI from installing a new satellite system.

However, while proponents of Ka-band systems have come to the conclusion that more bandwidth equates to less expensive capacity that can be sold to a greater number of users at a lower cost, the economics do not stand up to scrutiny (in the maritime world) according to others.

For example, ViaSat's aforementioned Ka-band satellite can rely upon large numbers of subscribers in each spot beam as it is focused over a heavily-populated land mass. On the other hand, focusing spot beams over parts of the world with little ocean-going traffic is inefficient, as the operator still has to provide service, but to a much smaller number of subscribers. Does that mean Ka-band be less expensive? Perhaps not.

### *Less Interference*

Ka-band typically has the upper hand over Ku-band when it comes to interference. This is because Ku-band satellites are often spaced as little as two degrees apart from one another and antennas have to be designed so that they do not transmit to non-target satellites. Ka-band satellites are positioned further apart and are less susceptible to adjacent satellite interference (ASI).

### *Less Expensive Antennas/Installations*

A common rule of thumb is that as frequency bands increase, antenna sizes go down. It is estimated that a Ka-band antenna will be around half the cost of a Ku-band satellite, while occupying a much smaller footprint. This means that a large fleet can be retrofitted relatively quickly, while the ship is in motion.

Ku-band antennas are more complicated to fit and vessels will need to be dry-docked before a system can be installed. Ka-band systems will, therefore, be smaller in size, less expensive, easier and quicker to install, resulting in a lower overall CAPEX than is the case with Ku-band systems.

## What Is Most Important?

Is the buzz around Ka-band justified? Perhaps. It really does depend on the unique requirements of the end-user. Quite frankly, I do not believe that the end-user cares too much whether their system is L-, C-, Ku-or Ka-band. What is most important is the quality and cost of service.

In some instances, Ka-band may not be the optimal solution. What is likely is that vessel operators will need to rely upon multiple connectivity technologies. This could bode well for Intelsat and its upcoming EpicNG system which will support C-, Ku- and Ka-band frequencies in wide and spot beam configurations. Although the beams will deliver similar capacity to GX, the system is not going to be a global one. In fact, only the satellite at 29 degrees East will cover the North Atlantic shipping routes. The satellite covering Europe, Middle East and Africa is likely to be used for land mobile and aeronautical business.


***About the author***

Daniel Welch is a Senior Consultant and possesses several years of research experience on both the client and agency sides. He most recently spent two years working the client side, analyzing and interpreting complex data runs to provide key strategic insight to high profile stakeholders within the media sector. Has an additional two years experience in the market research industry covering the industrial automation market, with a key focus on operator terminal products (HMI devices). Dan holds a BA (Hons) Business Studies degree from Leeds Metropolitan University and is an all round sportsman.

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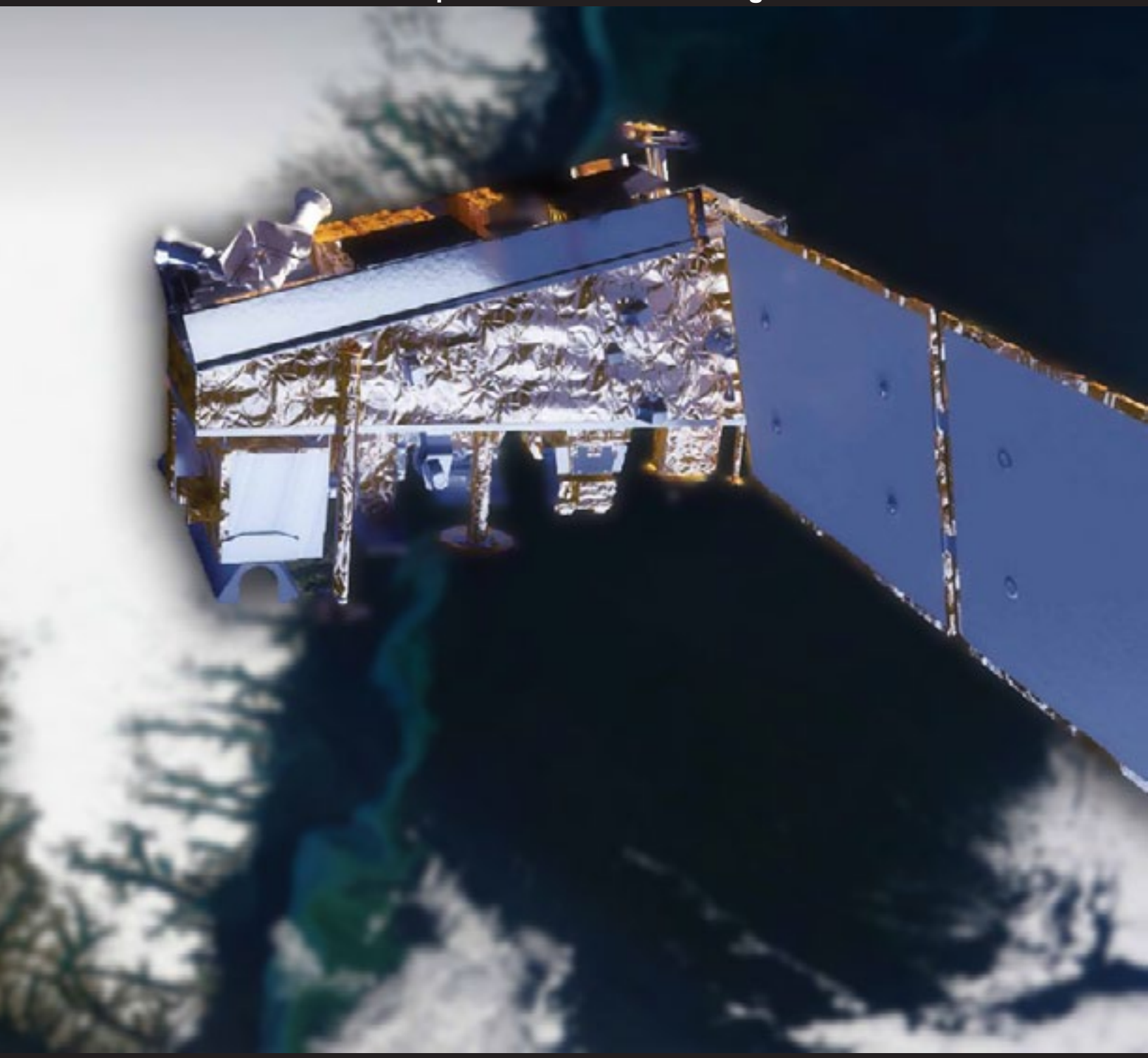
# *Satellite Spotlight: Suomi National Polar-Orbiting Partnership*

*by NASA' Sumoi NPP Science Team—Aries Keck, writer—Ellen Gray, Patrick Lynch, Cynthia O'Carroll, Adam Voiland, editors—original website design by Debbi McLean + Kevin Miller—intro illustration by Ryan Zuber*

**Suomi NPP is building a bridge to a new era of Earth Observations (EO). Understanding, monitoring and predicting the course of long-term climate change and short-term weather fluctuations remain tasks of profound importance. Economic competitiveness, human health and welfare, and global security all depend in part on our ability to understand and adapt to environmental changes.**



Over the last dozen years, NASA has launched a series of satellites—including those known collectively as the Earth Observing System (EOS)—that provide critical insights into the dynamics of the entire Earth system including clouds, oceans, vegetation, ice and the atmosphere.

Now NASA is helping to create a new generation of satellites to extend these global environmental observations. A critical next step in this transition is the Suomi National Polar-orbiting Partnership (Suomi NPP). This Earth science satellite began in a partnership between NASA, the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Air Force. That partnership, the National Polar-orbiting Operational Environmental Satellite System (NPOESS) was reorganized and part of the system became the Joint Polar Satellite System (JPSS), which NASA is developing for NOAA.

Suomi NPP is a satellite that carries five very different instruments to monitor the environment on Earth and the planet's climate. Suomi NPP measurements will be used to map land cover and monitor changes in vegetation productivity. The satellite tracks atmospheric ozone and aerosols as well as takes sea and land surface temperatures. Suomi NPP monitors sea ice, land ice and glaciers around the world. In addition to continuing these data records, Suomi NPP is also able to monitor natural disasters such as volcanic eruptions, wildfires, droughts, floods, dust storms and hurricanes/typhoons.

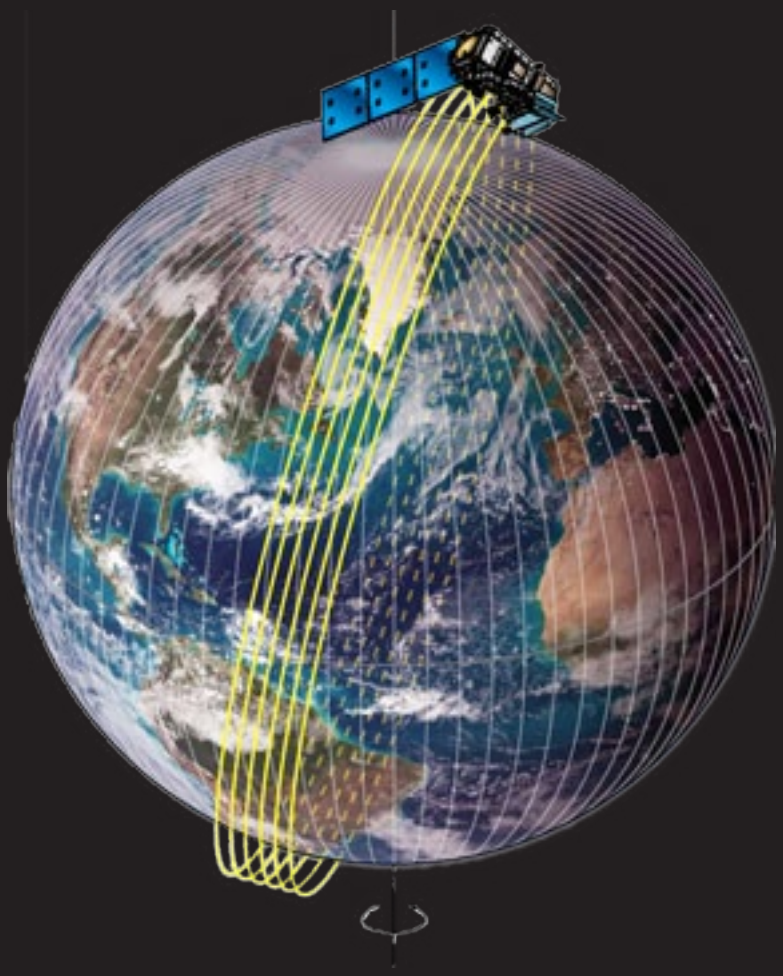
In all, Suomi NPP monitors the health of Earth from space—providing continuity to decades-long records and setting the stage for future Earth science missions.

*Suomi NPP. Photo courtesy of Ball Aerospace.*

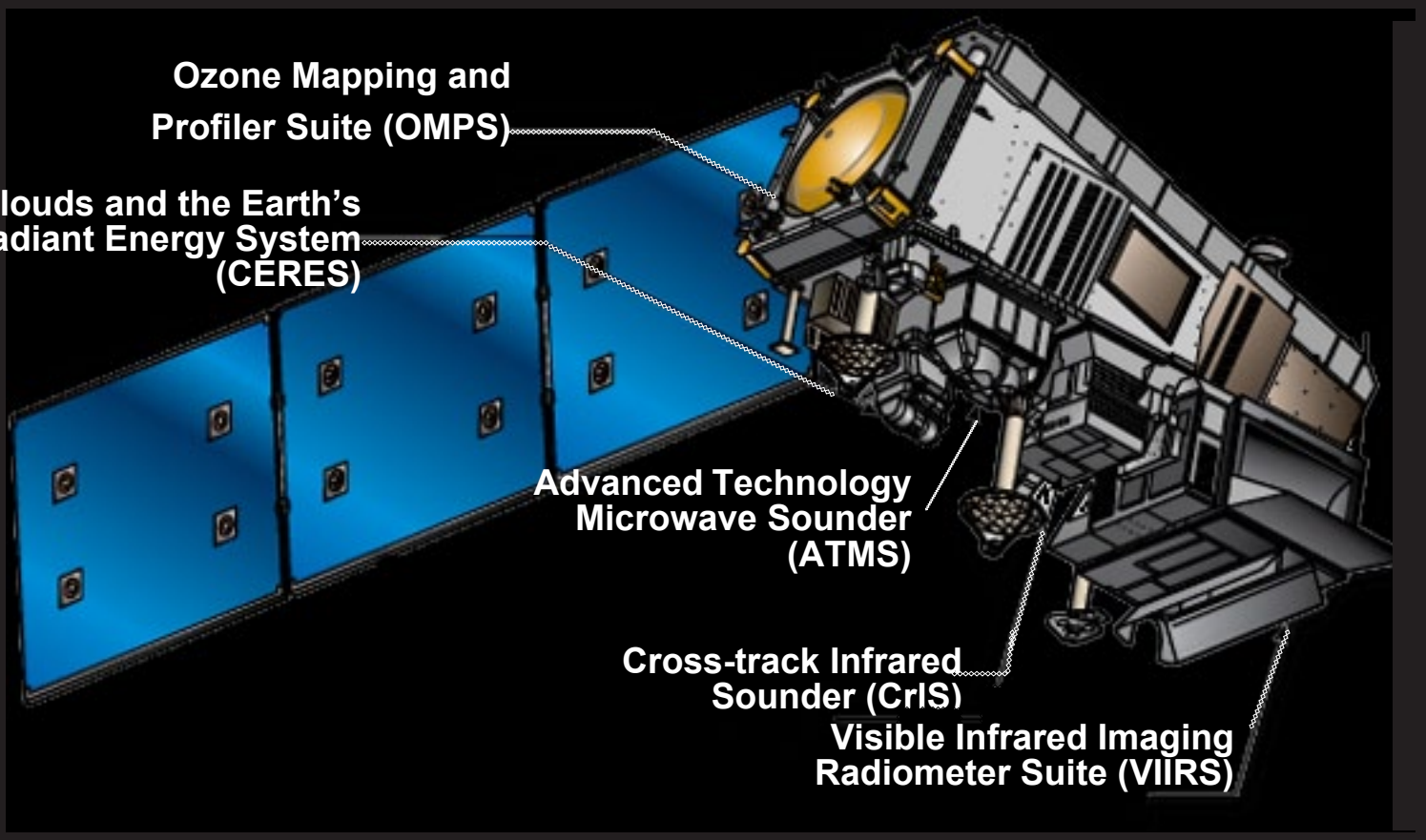
## Change + The Earth's Climate System

Over the last 100 years, the average global temperature has increased more than one degree Fahrenheit, nearly one degree Celsius. The timing of this increase coincides with human activities that release unprecedented amounts of carbon dioxide, methane, and nitrous oxide—gases referred to as greenhouse gases because they are known to trap heat. Climate models show that over the next 100 years, it is likely worldwide temperatures will increase at least two degrees Fahrenheit.

This change in average temperature over such a short time period is very unusual. Long-term records found in tree rings and ice cores show that the global average temperature is usually stable over periods of time that can be thousands of years long. A change of a degree or two may seem small, but incremental increases in the overall temperature of the Earth's surface can have profound effects. For example, long-frozen sea ice in the Arctic is melting and glaciers are getting smaller all over the world. Another result of warmer temperatures may be that, because warmer air holds more moisture, storms could become fiercer and may also become



*Suomi NPP is in a polar orbit—circling the Earth from the North Pole to the South Pole and back, about 14x per day*




more frequent. That being noted, it's important to keep in mind that climate and weather are how the entire Earth system behaves over both short time scales (weather) and long time scales (climate). The difference between weather and climate is time. Climate is defined by consistent patterns over long periods of time, while weather consists of daily fluctuations and extremes. Beyond daily weather changes, there can be multi-year events that affect our climate, for example El Niño and La Niña oscillations, and so that's why studying change in our climate requires consistent and reliable monitoring over decades-long timescales.

Suomi NPP extends decades-long records of climate data. Suomi NPP's Visible Infrared Imaging Radiometer Suite (VIIRS) continues critical data records of vegetation, clouds, aerosols, sea and land surface temperature, the productivity of the biosphere and changes in land cover. Scientists want to observe these major climate drivers and responses to understand how these interconnected Earth system components affect one another and how climate change may be affecting them both individually and in combination.

NASA satellites have been making key cloud measurements for three decades. Since the composition of clouds can vary greatly, they can have a strong positive or a strong negative impact on climate. For example, some clouds reflect sunlight, keeping solar radiation from heating the Earth, yet others acts like a blanket, trapping heat near the Earth's surface. This variation in cloud effects combined with their ephemeral nature means that quantifying climate change's impact on cloud cover and clouds' impact on climate remains one of the most difficult challenges in climate science. VIIRS measures cloud-top height, cloud temperature, and water and ice content in clouds. It also measures how clouds absorb or scatter light; an important factor in determining how much solar radiation is either absorbed by the atmosphere or reflected back to space.

VIIRS tracks land cover changes and vegetation productivity, extending the successful and widely used data records of NASA's Moderate Resolution Imaging Spectroradiometer (MODIS), a similar instrument launched aboard NASA's Terra and Aqua spacecraft in 1999 and 2002. VIIRS measurements of land surface reflectance feed vegetation indices and are used to estimate leaf area and the sunlight absorbed for photosynthesis. These data products have become indispensable inputs for climate, hydrologic and biogeochemical models, land cover and land cover change detection, agricultural and ecological research and applications, drought monitoring, and assessment of public health risks. For example, VIIRS will ensure continued monitoring and analysis of recently observed decadal-scale trends of increased vegetation productivity in the northern hemisphere when compared to the southern hemisphere. These trends may be caused by a lengthened growing season over the past two decades and widespread drought during the past decade that decreased productivity in the southern hemisphere.

VIIRS's sea surface temperature measurements contribute to research of multi-year climate oscillations such as El Niño and La Niña, long-term climate trends and hurricane/typhoon formation. VIIRS's land surface temperature records track the temperature of the Earth's surface, also called "skin temperature," a measurement useful in climate, hydrological and ecological models and as an indicator of trends in the Earth system. VIIRS also provides a vertical profile of atmospheric temperatures from near the Earth's surface through the stratosphere.

In addition to VIIRS, Suomi NPP's Clouds and the Earth's Radiant Energy System (CERES) instrument continues the Earth radiation budget data record started by the Earth Radiation Budget (ERB) instrument on the Nimbus-7 satellite in 1978 and continued through a series of NASA satellites including CERES instruments on the satellites Terra and Aqua,

among others. CERES focuses exclusively on the balance of sunlight and heat in the Earth system and its change over time.

## A Sentinel When Disaster Strikes

When the Icelandic volcano Eyjafjallajökull erupted in 2010 it released a massive plume of ash and sulfur dioxide. NASA satellites tracked the ash cloud as it swept across the Atlantic Ocean toward Europe, providing crucial data to airlines on when it was safe to fly. In 2011 record rainfall led to the largest and most damaging flooding along the Mississippi River in over a century. NASA satellites provided detailed records of when and where the river flooded thousands of acres of farmland. The Wallow Fire, also in 2011, was the largest fire in Arizona history, burning over half-a-million acres in the American Southwest. NASA satellites measured drought conditions, tracked smoke clouds and recorded the burned areas it left behind.

For these events and many, many more, Earth system satellites, like Landsat and the three NASA Earth Observing System (EOS) flagship satellites—Terra, Aqua and Aura—contribute a wealth of data for monitoring disasters, providing crucial information to both first responders and research scientists.

One striking example of how data from satellites assisted with disaster recovery was in the response to the 2010 BP Deepwater Horizon oil spill in the Gulf of Mexico. The spill was the largest accidental marine oil spill in the history of the petroleum industry. NASA's Moderate-Resolution Imaging Spectroradiometer (MODIS) made daily quantitative measurements of the region impacted by the spill. Using MODIS instruments aboard NASA's Terra and Aqua satellites, scientists tracked the slick as it changed due to the amount of oil spilled, the use of oil dispersing chemicals and changes in weather, water currents and other events.

Suomi NPP now extends our ability to track similar disasters and acquire data that are crucial to design responses. For example, many MODIS records are extended by Suomi NPP's Visible Infrared Imaging Radiometer Suite (VIIRS) instrument. VIIRS collects environmental data records including imagery, cloud and aerosol properties, albedo, land surface type, vegetation index, ocean color and land and sea surface temperatures extending important long-running data records. VIIRS data will also be used to identify immediate disaster effects and recovery processes from such events as fires, volcanoes, floods, hurricanes and blizzards.

VIIRS also has a day/night band to detect low levels of visible/near-infrared radiance at night from sources on or near the Earth's surface, such as low clouds, fog and snow cover illuminated by moonlight and lightning flashes. This marks a significant advance over current imagers ability to aid recovery efforts. For the first time, there will be calibrated visible observations of clouds and other phenomena at night. Suomi NPP's Clouds and the Earth's Radiant Energy System (CERES) instrument uses events like a volcanic eruption or a massive wildfire to help researchers understand how the overall Earth's radiation budget responds to short-term events. The Ozone Mapping and Profiler Suite (OMPS) tracks emissions from events like volcanic eruptions by measuring not only ozone, but also sulfur dioxide and airborne particles called aerosols. The combination of two Suomi NPP instruments, the Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) instruments, monitors storms like hurricanes/typhoons.

Just a few degrees can make a big difference.For example, at the end of the last ice age, when the northeastern portion of the United States was covered by more than 3,000 feet of ice, average temperatures were only 5 to 9 degrees Fahrenheit cooler than today.

***When will the Antarctic ozone hole recover?*** *Scientists think the ozone layer over Antarctica could return to 1980 levels by about 2070. Significant improvement isn't expected until about 2025, but the ozone hole isn't getting larger.*

## Suomi NPP's Eyes + Ears: The Instruments

Suomi NPP's five instruments retrieve data about land surfaces, ocean and atmosphere and, as a result, Suomi NPP serves as an important link between the current generation of Earth-observing satellites and the next generation of climate and weather satellites.

Suomi NPP observes the Earth's surface twice every 24-hour day, once in daylight and once at night. In its orbit Suomi NPP flies 512 miles (824 kilometers) above the surface in a polar orbit, circling the planet about 14 times a day. Suomi NPP sends its data once an orbit to the ground station in Svalbard, Norway and continuously to local direct broadcast users.

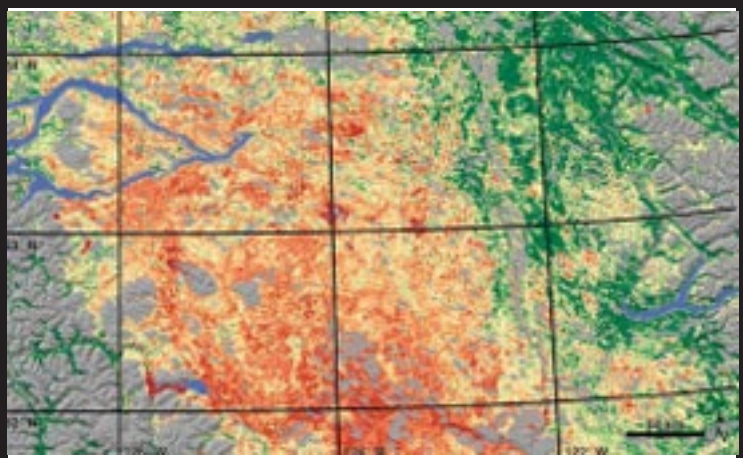
During the ICESCAPE mission's first field campaign in summer 2010, scientists collected optical and chemical data during a stop amid sea ice in the Chukchi Sea. Researchers returned in 2011 for another look at how climate change is impacting Arctic ecosystems.

# Satellite Spotlight: NPP (Cont.)

Vegetation across the United States as viewed using the Normalized Difference Vegetation Index (NDVI), a tool that scientists use to measure productivity, vegetation health, land cover and other aspects of vegetation on land. This is one part of a model used to predict mosquitoes and will assist in tracking West Nile Virus. Image by NASA/Goddard Space Flight Center—Scientific Visualization Studio

### *VIIRS*

The largest instrument aboard Suomi NPP is the Visible Infrared Imaging Radiometer Suite (VIIRS). It collects radiometric imagery in visible and infrared wavelengths of the land, atmosphere, ice and ocean. Data from VIIRS, collected from 22 channels across the electromagnetic spectrum, are used to observe active fires, vegetation, ocean color, sea surface temperature and other surface features. A variety of scientists study VIIRS data, much of which is used in monitoring the pace and impacts of climate change. Atmospheric scientists use some of these channels to observe clouds and small airborne particles called aerosols. Oceanographers use VIIRS to monitor phytoplankton and sediment in the seas. Terrestrial ecologists use it to monitor forest cover and productivity and ice experts use it to track changes in polar sea ice.



Pine Beetle damage to forests in British Columbia, Canada June 26 - July 11, 2006. Red indicates the most severe damage, green indicates no damage and gray indicates non-forested areas. Milder winter temperatures and drier summers are among the factors in increasing rates of pine beetle infestation in North America. Image created using NASA data and MODIS measurements.

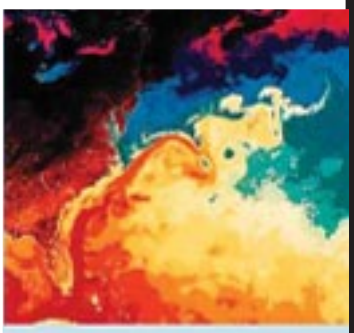
VIIRS has similarities to the Moderate Resolution Imaging Spectroradiometers (MODIS) currently operating on two NASA satellites, Terra and Aqua.

### *CERES*

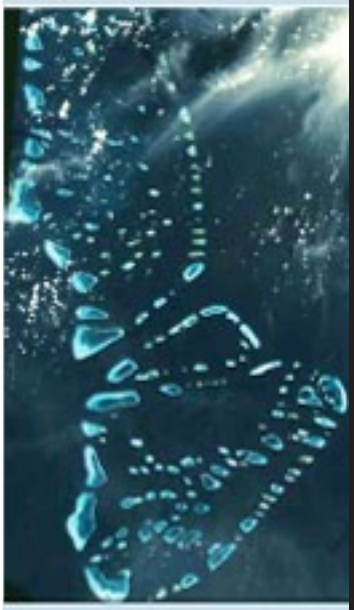
The Clouds and the Earth's Radiant Energy System (CERES) measures both solar energy reflected by the Earth and heat emitted by our planet. This solar and thermal energy are key parts of what's called the Earth's radiation budget. When sunlight hits Earth and its atmosphere, they warm up. Clouds and other light-colored surfaces like snow and ice reflect some of the sun's heat and light, cooling Earth, while additional cooling comes from heat that the Earth radiates to space. It's crucial for scientists to understand this complex Earth radiation budget system. The changing role of clouds in this system is one of the biggest unknowns in climate science. So scientists need long-term, stable data sets to make accurate projections of global climate change. Suomi NPP's CERES instrument continues a multi-year record of the amount of energy entering and exiting from the top of Earth's atmosphere. A total of four other CERES instruments fly on the EOS satellites Terra and Aqua.

### *CrIS*

The Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) work together, providing global high-resolution profiles of temperature and moisture. These advanced atmospheric sensors create cross-sections of storms and other weather conditions, helping with both short-term 'nowcasting' and long-term forecasting. CrIS measures continuous channels in the infrared region and has the ability to measure temperature profiles with improved accuracy over its predecessor instruments on operational satellites, and comparable accuracy to the Atmospheric Infrared Sounder (AIRS) on Aqua. NOAA will be using CrIS for numerical weather prediction and, because it is a brand new instrument, its use on Suomi NPP provides



This image from the Coastal Zone Color Scanner depicts ocean temperatures in the Atlantic Ocean off North America. Reds are the warmest, and blues and violets are the coolest. Swirls indicate eddies in the Gulf Stream.



The Maldives Islands are a chain of 1,192 small coral islands in the Indian Ocean. Arguably the lowest-lying country in the world, its elevation is about 3 feet (1 meter) above sea level putting its population of about 330,000 people at serious risk for rising sea levels and storm surges. Image by NASA's ASTER instrument, December 22, 2002.

First responders and air quality experts used satellite data to track the record-setting 2011 Wallow Fire in the American Southwest that burned more than 700 square miles (about 1,800 square kilometers) and resulted in the evacuation of 6,000 people.

a real-world test of the equipment before NOAA's upcoming Joint Polar Satellite System (JPSS) missions.

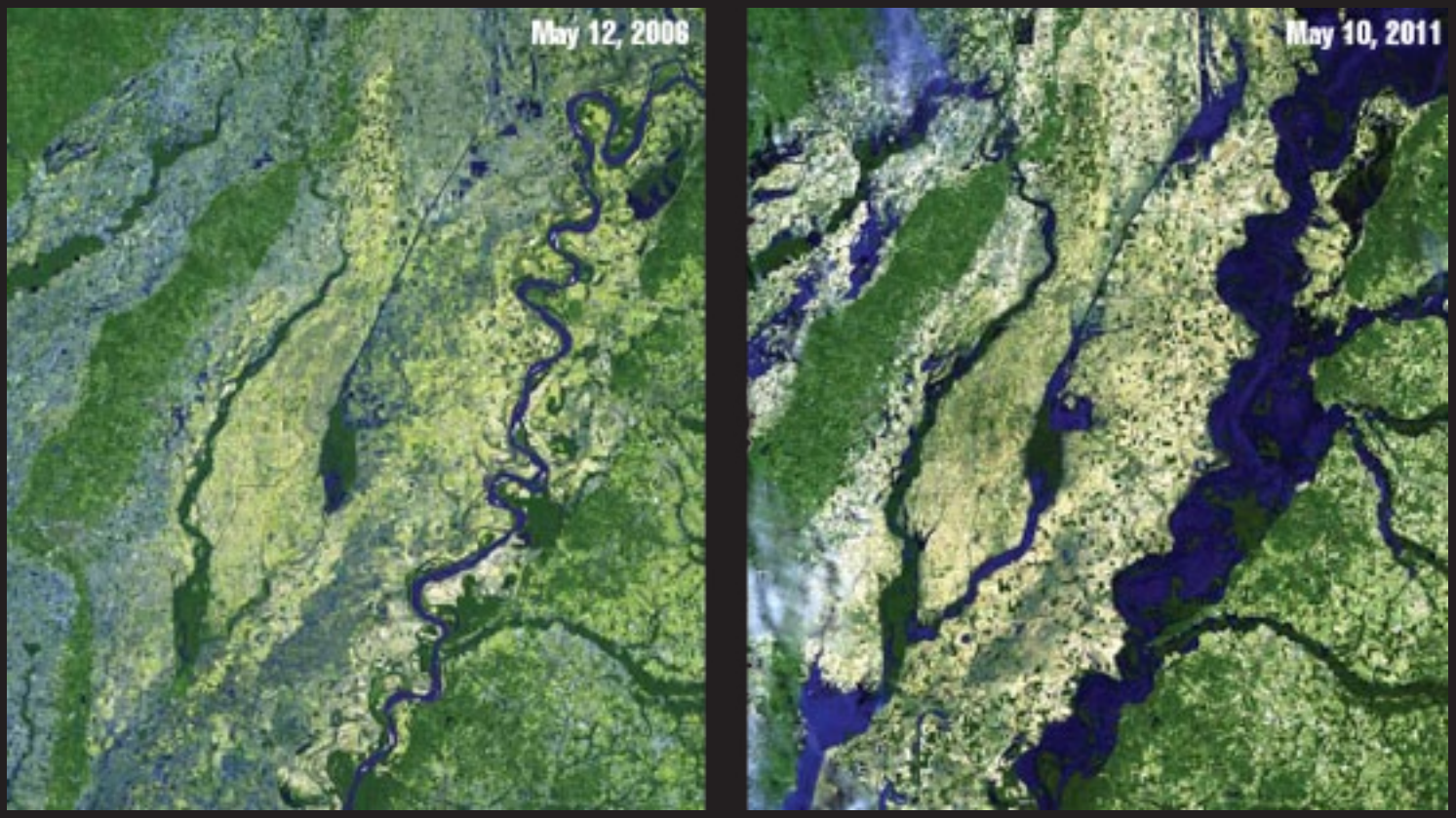
### *ATMS*

The Advanced Technology Microwave Sounder (ATMS) works in both clear and cloudy conditions, providing high-spatial-resolution microwave measurements of temperature and moisture. ATMS has better sampling and two more channels than previous instruments like the Advanced Microwave Sounding Units (AMSU), and it combines all of their abilities into one instrument. Working in concert, CrIS and ATMS together comprise the Cross-track Infrared Microwave Sounding Suite (CrIMSS).

### *OMPS*

The Ozone Mapping and Profiler Suite measures the ozone layer in our upper atmosphere—tracking the status of global ozone distributions, including the 'ozone hole.' It also monitors ozone levels in the troposphere, the lowest layer of our atmosphere. OMPS extends out 40-year long record ozone layer measurements while also providing improved vertical resolution compared to previous operational instruments. Closer to the ground, OMPS's measurements of harmful ozone improve air quality monitoring and when combined with cloud predictions; help to create the Ultraviolet Index, a guide to safe levels of sunlight exposure. OMPS has


***Charred land and smoke plumes from the Wallow fire are visible in this image acquired by MODIS aboard the Aqua satellite on June 8, 2011***




***Above: Severe flooding along the Mississippi River. Landsat 5 image of the borders of Tennessee, Kentucky, Missouri and Arkansas on May 12, 2006. (Right) Landsat 5 image of same area on May 10, 2011.***

two sensors, both new designs, composed of three advanced hyperspectralimaging spectrometers.

## Watching The Weather

Hurricanes, tornadoes, Nor'easters, typhoons; snow, rain, sleet and clear bright sunny days. What we call 'weather' is actually how our atmosphere behaves at a certain time and place. The atmospheric factors that make up weather include temperature, moisture, atmospheric pressure and wind, and they change from minute-to-minute, hour-to-hour, day-to-day and season-to-season.

The information Suomi NPP collects on atmospheric conditions, hurricanes/typhoons, snowstorms and other weather events will be sent very quickly to forecasters for immediate inclusion into numerical weather models.

The Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) aboard Suomi NPP produce global sets of high-resolution temperature and moisture profiles that are used for forecasting and studying weather. CrIS focuses on measurements in clear conditions, while ATMS is a passive microwave radiometer that can collect data even when it is cloudy.

These measurements of moisture and temperature around the world refine short-term weather 'nowcasting,' i.e. tracking storms as they are happening, and long-term weather forecasting, i.e. predicting possible weather events a few days in advance. Additional infrared sensors on CrIS provide the high-resolution data scientists use to understand major climate drivers that affect the world's weather, like El Niño and La Niña.

Clouds and the size of the water, dust and other particles inside the clouds are measured by Suomi NPP's Visible Infrared Imaging Radiometer Suite (VIIRS). This information can be used to help characterize the amount of water held within clouds, a feature that can lead to better predictions of rainfall.

In addition, Suomi NPP data help us plan responses to weather events. For example, Suomi NPP's VIIRS instrument tracks flooding and drought events as they happen while also collecting long-term data of land vegetation. Combining these data records can help scientists predict and plan for famine relief efforts, disease outbreaks or track changes in which crops are planted when. Another example is that VIIRS data on hurricanes, combined with CERES, ATMS and CrIS data, give scientists better weather prediction ability, as well as great insight into how these storms affect the overall Earth system.

## A Vigilant Eye On Ozone

Ozone is an atmospheric gas that plays two very different roles on Earth. In our upper atmosphere, ozone forms a shield that blocks dangerous ultraviolet radiation coming from the sun. In our lower atmosphere, ozone is a harmful air pollutant.

Suomi NPP's Ozone Mapping and Profiler Suite (OMPS) continues decades-long ozone records and consists of two separate instruments. The first is a downward, or nadir-viewing, instrument that looks beneath the satellite and maps the total amount of ozone between the ground and the top of the atmosphere. The second is a newer and more experimental instrument called a limb profiler. It views the edge of the atmosphere from an angle thus giving scientists more detail about the vertical distribution of ozone.

Scientists in the 1970s recognized that the human-produced chemicals called chlorofluorocarbons (CFCs) had the potential to deplete the protective ozone layer. CFCs are chemical compounds of chlorine, fluorine and carbon and were common in refrigerants and certain spray cans.

This destruction of the ozone layer is most extreme over the South Pole where there's an actual 'ozone hole' in springtime. In the late-1980s, a worldwide agreement restricted production of CFCs and other chemicals and thus led to the protection of the ozone layer.

OMPS's ability to take accurate, long-term measurements of ozone allows it to play a key role in tracking the evolution of the ozone layer, as it builds on the legacy of decades of ozone observations pioneered by NASA in the 1970s and continued by NASA and other agencies, most recently the Ozone Monitoring Instrument (OMI) launched aboard NASA's Aura spacecraft in 2004.

## Tracking Changes

Earth science can be seen as studying a system of systems—all overlapping and interconnected. Because Suomi NPP includes a range of observations, it helps us get a sense of the bigger picture. For example, the study of sea surface temperatures not only provides details about the ocean itself, it also helps us understand the amount of moisture in the atmosphere, which then can change the amount of rain, which then can change land use and vegetation productivity, which then can change the amount of fires or dust in our atmosphere —and so on.

Suomi NPP's instruments observe the entire globe twice every 24-hour day and record many different environmental systems. CERES tracks the Earth's overall radiation budget. OMPS tracks ozone. VIIRS collects visible and infrared radiometric imagery of the land, atmosphere, ice and ocean. VIIRS also characterizes the properties of clouds and aerosols—including changes in cloud shape and reflectivity, the particles that make up clouds and the concentration of those particles. Clouds and aerosols remain two of the most difficult climate influences to characterize and model.

ATMS and the CrIS work together to provide high-resolution profiles of atmospheric temperature and moisture during both cloudy and clear conditions. Continuing the data record of the Atmospheric Infrared Sounder (AIRS) on Aqua, CrIS will also add to its ability to collect high-resolution data that are used to understand major climate features like El Niño and La Niña.


These two climate features are called Southern Oscillations and are characterized by changes in the temperature of the surface of the tropical eastern Pacific Ocean, combined with changes in the surface air pressure in the western Pacific. El Niño corresponds with warmer oceans and high pressure; La Niña with cooler waters and low pressure. Both occur roughly every five years and often cause extreme weather events like floods and droughts in other parts of the world. El Niño's warmer waters feed thunderstorms and increase rainfall, while they also suppress the upwelling of the cold, nutrient-rich waters that sustain large fish populations.

Generally, La Niña has the opposite effect, resulting in drier conditions in some areas, but La Niña has also been behind increased snowfalls in the Northern United States and Canada. In the winter of 2007-2008 La Niña caused a 'never-ending winter' in Eastern Canada in which snow fell nearly every single day, setting many seasonal snowfall records.

Understanding the connections between weather, climate drivers and the worldwide climate requires a vast amount of continuous and reliable scientific data. Suomi NPP contributes to these long-term records while also providing the type of immediate data that meteorologists use to create weather forecasts. The information it collects on hurricanes/typhoons, snowstorms and other weather events also is used by researchers to create long-term records of extreme weather events.

These long-term records of the strength and frequency of extreme weather events provides crucial information to scientists looking to establish a connection between them and climate change.

One use of that data is evaluating the performance of computer models of weather and climate. For example, a model created after the fact by scientists at Goddard Space Flight Center—the Goddard Earth Observing System Model, Version 5 (GEOS-5)—closely reproduced the actual satellite imagery of a massive snowstorm that dumped about two feet of snow on Washington, D.C. in 2010.

This 'hindcast' shows how satellite observations can help us better understand what weather conditions create a storm and shows how NASA computer modeling efforts can use detailed satellite information to improve weather and climate prediction. In addition, NASA scientists work with colleagues at NOAA through the Joint Center for Satellite Data Assimilation to accelerate

Roughly the size of a minibus, the NPP spacecraft is a modified BCP 2000 bus built by the Ball Aerospace and Technologies Corporation in Colorado.

VIIRS is a multi-spectral scanning radiometer that scans a 1,889-mile wide swath of the Earth (3,040 kilometers). Built by Raytheon Space and Airborne Systems in El Segundo, California.

CERES is a 3-channel radiometer measuring reflected solar radiation, emitted terrestrial radiation and total radiation. Built by Northrop Grumman Aerospace Systems of Redondo Beach, California.

the use of SuomiNPP data in weather forecasting.

In all, Suomi NPP is a powerful tool that will assist us to enhance the data that underlies our nation's weather forecasting system as well as help us to comprehend, track and forecast the course of long-term climate change and improving our knowledge of how the entire Earth system works.

## Glossary + Resources

**aerosols** – Aerosols are tiny solid or liquid particles that are suspended in the air. They include dust, smoke, salt and sea spray, and air pollution. Air Quality Index (AQI) – The Air Quality Index is a daily report on local air conditions. In the U.S. it's produced by the Environmental Protection Agency. It calculates air quality based on five air pollutants: carbon monoxide, sulfur dioxide, nitrogen dioxide, particle pollutants (aerosols) and ground-based ozone. The AQI is measured on a scale of 0-500 where higher numbers mean a higher health risk.

**Aqua** – A NASA Earth Observing System (EOS) satellite that collects information on the Earth's water cycle, including evaporation from oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice and snow cover. Aqua also takes measurements relating to radiative energy fluxes, aerosols, vegetation, land cover, phytoplankton and dissolved organic matter in the oceans, and temperatures of the land, air and ocean. It launched on May 4, 2002.

**ATMS** - The Advanced Technology Microwave Sounder (ATMS) instrument aboard Suomi NPP provides high-spatialresolution microwave data to take measurements of temperature and humidity in both clear and cloudy conditions.

**Aura** – Aura is an NASA Earth Orbiting satellite that studies ozone, air quality and climate and is designed exclusively to conduct research on the composition, chemistry and dynamics of the Earth's atmosphere. It launched on July 15, 2004.

**CALIPSO** – The Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) satellite that studies clouds and atmospheric aerosols and the role they play in regulating the Earth's weather, climate and air quality and weather monitoring. Launched on April 28, 2006, CALIPSO is a joint NASA and French mission.

**CERES** – The Clouds and the Earth's Radiant Energy System (CERES) is an instrument aboard Suomi NPP that measures solar energy reflected by the Earth and heat emitted by our planet.

**CloudSat** – A satellite that uses radar to observe clouds and precipitation from space. It launched with CALIPSO on April 28, 2006.

**chlorofluorocarbons (CFCs)** – Chlorofluorocarbons are chemical compounds of chlorine, fluorine and carbon previously used in spray cans, fire-fighting tools and refrigerants. Partially as a reaction to the discovery of the 'ozone hole' in 1987, 197 nations signed an international treaty called the Montreal Protocol to phase out their use.

**CrIS** – The Cross-track Infrared Sounder (CrIS) is an instrument aboard Suomi NPP that produces high-resolution, three-dimensional temperature, pressure and moisture profiles.

**Earth Observing System (EOS)** – The Earth Observing System is a major part of NASA's Earth Science Program. It's composed of multiple satellites designed to make long-term global observations of the Earth's land surface, oceans, biosphere and atmosphere.

**El Niño** – A climate pattern that occurs across the Pacific Ocean roughly every five years in which often ocean temperature are warmer than usual.

energy budget – Earth's 'energy budget' is an accounting of all the heat, light and other energy as it moves into and out of our planet. This includes the heat and light from the sun that hits the Earth's atmosphere, oceans and land, as well as the energy reflected back out into space from the Earth's atmosphere, snow and ice.

**geostationary orbit** – An orbit around a body, in this case Earth, that is directly above its equator and one that goes the same speed as the body's rotation so that the position of the satellite relative to the Earth's surface remains constant.

**ground stations** – A series of facilities around the world that will provide command, control, communications, data processing and operations for satellites. Suomi NPP uses the world's largest commercial ground station, the Svalbard Satellite Station (SvalSat) in Norway.

CrIS is a Michelson interferometer that scans about 1,367 miles (2200 kilometers) of the Earth's atmosphere. Built by ITT Corporation in Fort Wayne, Indiana.

ATMS is a 22-channel passive microwave radiometer with a swath width of 1,429 miles (2300 kilometers). Built by Northrop Grumman in Azusa, California.

OMPS is an advanced suite of three hyperspectral instruments that measure ozone. Built by Ball Aerospace in Boulder, Colorado.

**infrared** – Light that has a wavelength longer than visible light and shorter than microwave radiation. This form of electromagnetic radiation is between 0.74 micrometers and 300 micrometers and includes most thermal or heat radiation, thus measuring infrared light can measure heat.

Joint Polar Satellite System (JPSS) —The next generation of U.S. polar-orbiting environmental satellites. Suomi NPP is the forerunner to this satellite system. JPSS will do both climate and weather monitoring.

La Niña – A climate pattern that occurs across the Pacific Ocean roughly every five years in which often ocean temperatures are cooler than usual.

microwave – A type of electromagnetic wave whose wavelength is as long as one meter or as short as one millimeter. On Suomi NPP the ATMS instrument uses and measures microwaves. Suomi NPP I Building a Bridge to a New Era of Earth Observations

Moderate-Resolution Imaging Spectroradiometer (MODIS) – A key instrument aboard the Terra and Aqua satellites. Each MODIS instrument images the entire Earth every one to two days in visible and infrared wavelengths, one in a morning orbit and the other in an afternoon orbit.

OMPS - The Ozone Mapping and Profiler Suite (OMPS) is a suite of instruments aboard Suomi NPP that measures the ozone in the Earth's atmosphere.

ozone – A chemical compound made up of three oxygen molecules, O3. It forms in the upper atmosphere where it's protective against the sun's rays and in the lower atmosphere where it's an environmental and health hazard.

ozone hole – An opening in the protective ozone layer that occurs above Antarctica from September to December. The cause of the hole and other losses of ozone in the upper atmosphere, the stratosphere, are due to man-made compounds like CFCs (chlorofluorocarbons) whose by-products can lead to very efficient destruction of ozone under the unique conditions of the Antarctic stratosphere in the springtime.

polar orbit – The curved path around a body that moves from pole to pole. For the Earth, this means an orbit that travels from the North Pole to the South Pole and back. Satellites in polar orbits, when combined with the Earth's rotation, result in viewing the entire planet's surface. Radiation Budget – Also known as the Earth's 'energy budget' this is a physical system that includes all the incoming energy from the sun, mostly in the form of light and heat, and the outgoing heat and light that's emitted and reflected back from the Earth.

radiometer – A device that detects the amount of energy given off by an object in the form of electromagnetic radiation. Satellites monitor specific wavelengths of light depending on what they want to measure, from microwave to infrared to visible light to ultraviolet radiation.

sounding – A way of investigating an environment by measuring a stimulus, often an electromagnetic wave or a sound wave, emitted by a source, whether naturally-occurring or intentionally created, and then measuring what is reflected or scattered.

stratosphere – The stratosphere is a layer of the atmosphere above the troposphere. Its lower boundary lies between 10 to 15 kilometers (6 to 9 miles) above the Earth's surface and its upper boundary lies around 50 kilometers (30 miles) above the Earth's surface.

Sulfur dioxide (SO2) – A chemical compound that's released by industrial processes and by volcanoes. It's a major air pollutant in the Earth's lower atmosphere, the troposphere.

swath – A long but narrow strip, usually of the surface of something. Because Suomi NPP travels around the Earth from pole to pole as the planet rotates, it measures large swaths of the Earth beneath it.

Terra – the oldest of the three Earth Orbiting System satellites, a group that also includes Aqua and Aura. Terra launched in 1999 with a 6-year mission life, but it continues to operate. Instruments aboard Terra include MODIS and CERES.

troposphere – The troposphere is the layer of atmosphere that runs from the ground to about 10 to 15 kilometers (about 6 to 9 miles) above the Earth's surface.

Ultraviolet Index (UI) – A standard measurement of the strength of ultraviolet radiation that's coming from the sun. It's a part of daily weather forecasts to help people protect themselves from excessive exposure.

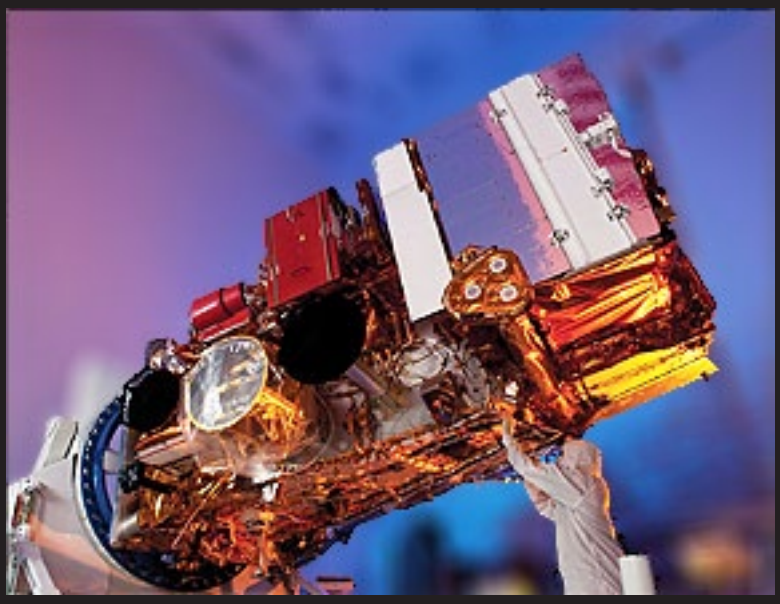
ultraviolet – Ultraviolet radiation is light that is just beyond the short wavelength side of the visible spectrum and has high energy. It's the radiation that drives atmospheric chemistry and causes sunburns, among other biological effects.

VIIRS – The Visible Infrared Imaging Radiometer Suite is the largest instrument aboard Suomi NPP and it collects visible and infrared images of Earth in 22 different spectral bands.

visible light – Light that humans can see. Human eyes perceive light that's in the portion of the electromagnetic spectrum from about 380 to 780 nanometers.

volatile organic compounds – Volatile organic compounds are chemicals made up of hydrogen, oxygen, and carbon that evaporate from liquid to gas very quickly. They include paints and solvents, and are associated with health problems when breathed in unventilated areas. VOCs react with nitrogen oxides (NOx) in the presence of sunlight to produce ozone, an air pollutant at ground level.

***Suomi NPP websites***
***http://science.nasa.gov/missions/suomi-npp/***
***http://jointmission.gsfc.nasa.gov/***



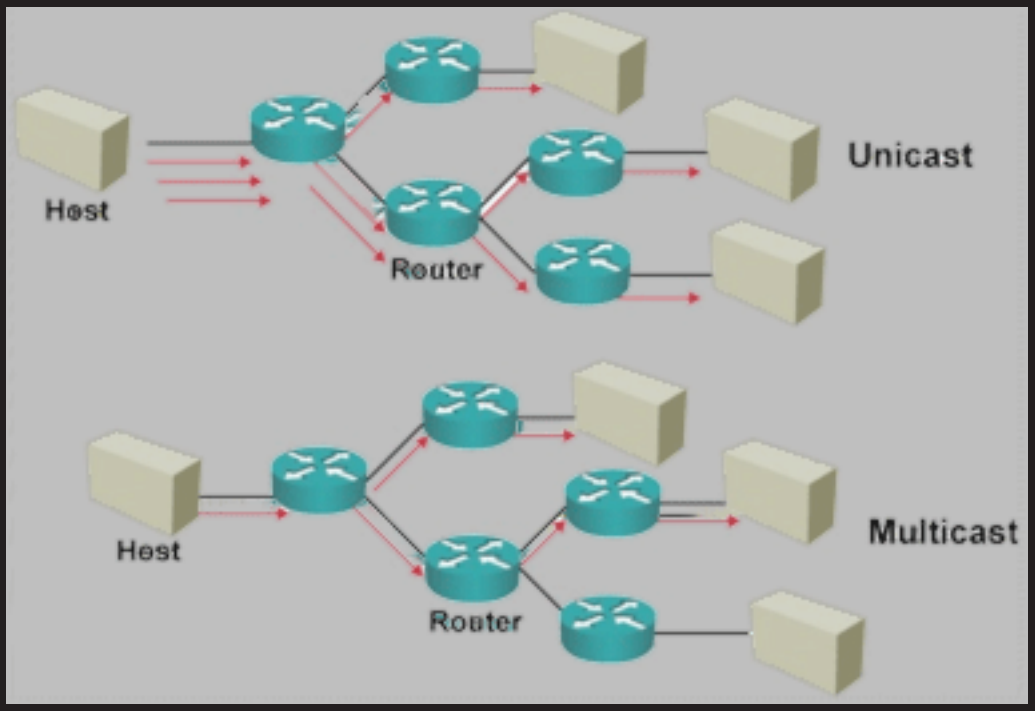
# SatBroadcasting™— Viable Solutions For E-Learning

**The challenge is that delivery of video content to the classroom, or to video distribution to customers, is usually done with platforms that are based on broadcasts over the air that do not allow for interactivity. The trade-offs of low cost satellite DTH systems such as these is a lack of bi-directional functionality that is required for modern, distance-learning interaction, newsgathering activities, and content distribution networks.**

The Internet has changed the e-Learning paradigm by introducing interactivity and multiple communication threads such as chat, video, audio, and desktop sharing into the educational realm. Likewise, video content delivery over existing Internet access networks has penetrated developed markets at an extremely fast pace.

These new applications require large amounts of bandwidth, which is quite costly in remote sites where no terrestrial infrastructure is readily available. Most Internet based applications like this are unicast; the application generates a single stream for each user, therefore, the number of streams increases with the number of users and the network can serve only as many users as bandwidth allows—this severely limits scalability.

e-learning




## A Solution Is @ Hand

IP multicast is an efficient mechanism for transmitting data from a single source to many receivers in a network. The destination address of a multicast packet is always a multicast group address. This address comes from the IANA block 224.0.0.0–239.255.255.255. A source transmits a multicast packet by using a multicast group address, while many receivers "listen" for traffic from that same group address.

Multicast is a scalable solution as it efficiently delivers content while conserving network resources. NewCom's shared satellite networks are specially designed to support Multicast traffic for these types of applications. The combination of iDirect Multicast features in the network and several IP streaming and e-Learning platforms that support multicast solves the scalability limitations of unicast in shared satellite networks.

The primary advantage of multicast over unicast is that it replicates the video stream closest to users at the last possible point in the network, as opposed to unicast, which replicates a single video stream for each user at the source. Multicast uses network servers, routers, and switches more efficiently without the time delays inherent to unicast systems. The primary advantage of NewCom's multicast over shared satellite networks is that it allows for fine granularity, and access restriction at the remote level, which facilitates conditional access mechanisms over a unified management infrastructure.

## Specific Applications

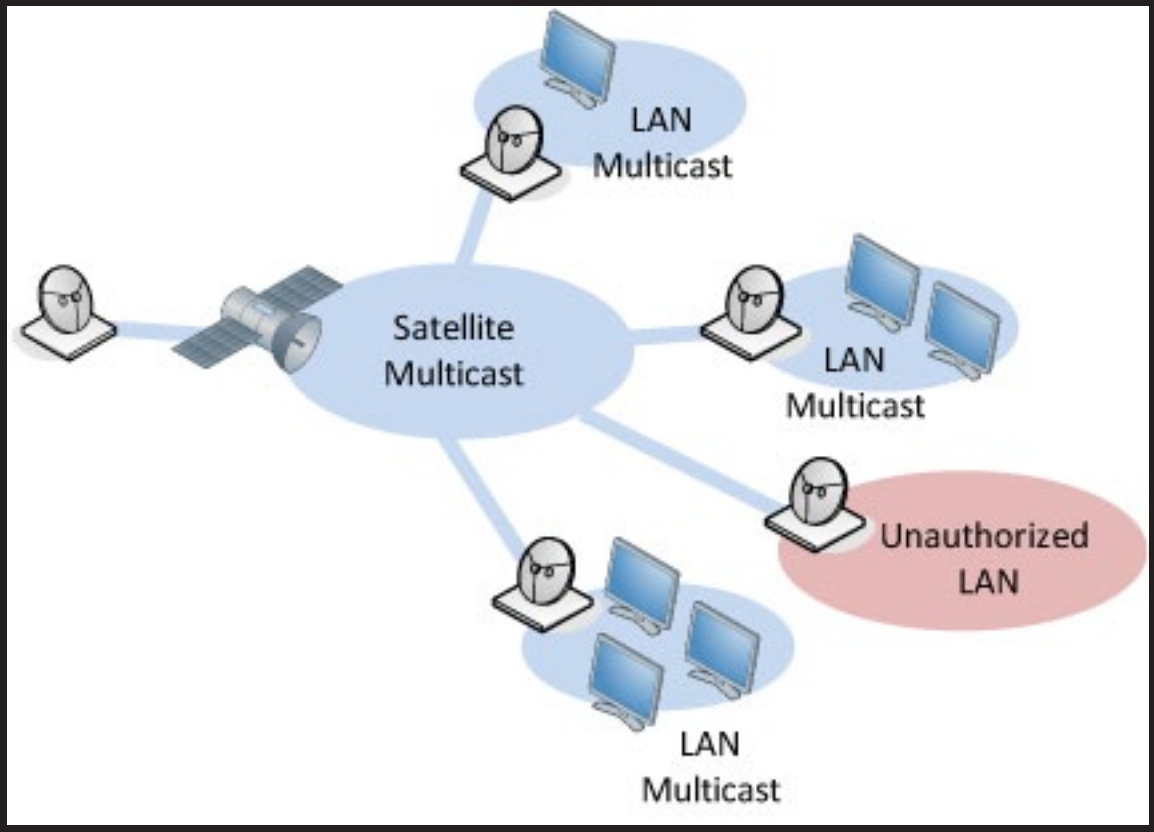
*— E-Learning networks*
*— IPTV CDN*
*— Radio Broadcast Services*
*— Emergency Broadcast Services*
*— Live and pre-recorded occasional video multicast over iDirect Networks*

## Multicast Marvels

Typical e-Learning platforms require a minimum of 256Kbps per video stream received or sent per participant. In a multicast environment, the video stream is received by all participants and counted only once within the multicast domain, regardless of the number of participants.

Inexpensive IP video and audio streaming applications can multicast their media streams to multiple end points, using very little bandwidth compared to individual streams delivered to each remote end.

For additional information, head over to Newcom's website ***http://newcominternational.com/***



# NSR Analysis: SCADA/M2M Under Threat From Cellular

*by Jose Del Rosario, Senior Analyst, NSR, Manila*

**In December of 2012, SkyBitz announced the Falcon Series GXT100, a new global positioning satellite (GPS) asset tracking solution for 3G/4G cellular networks with seamless North American coverage. With this launch, SkyBitz indicated that it is able to provide additional cost-effective solutions for complete asset visibility to its customers.**

The announcement is noteworthy for two reasons:

- *First, SkyBitz participates in the largest market vertical in the SCADA/M2M market (the North American Transportation/Cargo sector), and it is also one of the key players in this vertical.*
- *Second, it has exclusively used satellite solutions in targeting its customers prior to the December 2012 announcement.*

The inclusion of cellular 3G in its portfolio is certainly a strategic move where two (among many) advantages are garnered by SkyBitz:

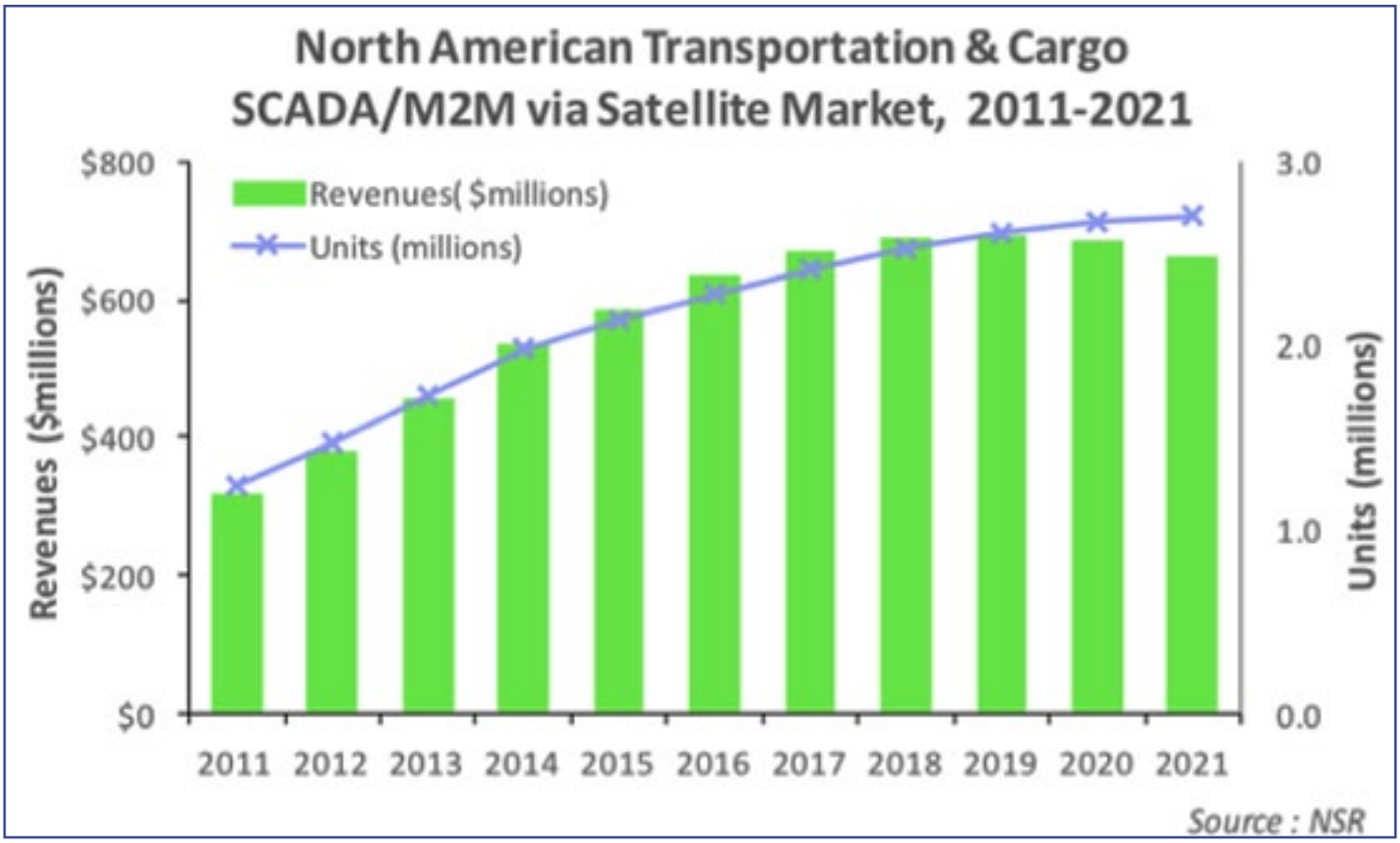
- *Higher bandwidth solutions and offerings using 3G/4G cellular can be achieved.*
- *Lower costs to support higher bandwidth services will likewise be achieved.*

The question raised not only for SkyBitz but for all players serving the North American market is clear: Will satellite SCADA/M2M solutions be replaced or lose substantial market share to cellular 3G/4G?

In NSR's view, cellular offerings will impact the satellite SCADA/M2M proposition over time, particularly in the Transportation/Cargo sector as outlined in the graph on this page, where revenue growth is expected to be flat and then turn negative towards the end of the forecast period despite the increase in in-service units.

The impact will be gradual, however, and not highly disruptive, giving time for the industry to make the necessary adjustments in dealing with the cellular threat. Here's why:

- *Orbcomm offered a dual mode solution using satellite and cellular technologies to serve its large customer base, which included the trucking industry. Although cellular traffic is being run by Orbcomm's customers, NSR understands that most of Orbcomm's traffic is still on satellite mode.*



- *The long haul trucking industry in North America—Canada and the U.S.—is still susceptible to blind spots in cellular coverage within the region, necessitating the continued use of satellite platforms to plug these coverage holes.*
- *The long haul trucking market extends through the Americas due to trade agreements like NAFTA such that blind spots become even more prevalent.*
- *Satellite solutions offer simpler billing and coverage advantages compared to cellular networks where roaming agreements, signal handoffs and other technical, regulatory and business aspects have to be taken into account.*
- *Finally and perhaps most importantly, satellite solution costs are coming down and are also beginning to support higher bandwidth offerings such as BGAN M2M, which offer similar services as cellular 3G.*

Moreover, on the horizon are next-generation satellite solutions that include Iridium NEXT and various players in the HTS camp that will offer higher-level bandwidth services for a fraction of today's costs.

## The Bottom Line

The SkyBitz move to offer cellular 3G/4G should certainly be lauded. In its latest ***SCADA/M2M via Satellite, 3rd Edition*** report, NSR noted that terrestrial integration in order to avert terrestrial competition may be key to continued growth. NSR recommended that the satellite SCADA/M2M industry should incorporate terrestrial wireless solutions to their portfolio in order to gain market competitiveness. However, this does not mean that satellite offerings will be quickly eroded by cellular offerings. Both technologies can, and should, co-exist with each complementing the other in a standalone, hybrid or dual-mode offering.

It should be noted that cellular SCADA/M2M has been around for more than a decade and despite its presence, the satellite-based SCADA/M2M market has continued to grow in all verticals, including Transportation and Cargo. Competition has been posed by cellular technologies, but the customer base of satellite SCADA/M2M has by nature deployed satellite and terrestrial wireless solutions as complementary platforms.

Over time, however, as cellular coverage continues to improve, and other business aspects begin to be resolved, SCADA/M2M customers will likely begin to increasingly deploy cellular solutions and thus erode the satellite value proposition.


***About the author***

Mr. Del Rosario is a senior member of the consulting team where he focuses his research on quantitative modeling, data verification, and market forecasting for the commercial and government satellite communications sectors. He conducts ongoing research with specialization in policy analysis, economic indicators, regulatory initiatives and end user demand trends. In addition to authoring numerous syndicated reports in his areas of focus, Mr. Del Rosario has been involved in a wide range of strategic consulting projects, from high throughput satellites (HTS), hosted payloads, wireless backhaul, SCADA/M2M/LDR and multi-mission satellite programs.

# *Sadtler On Careers: Shifting The Recruiting Paradigm*

*by Bert Sadtler, Contributing Editor*

**Companies today must re-assess their talent needs in order to remain competitive and drive growth. The satellite communications industry faces challenges and remains ripe with new opportunities. The right talent can make a huge impact. Employers need to get it right and make a "great hire."**

**To assist with career searches, we asked Bert Sadtler of Boxwood Executive Search to discuss various aspects regarding the processes of recruitment and hiring as well as how Companies can retain crucially-needed talent. Boxwood is located in the Washington DC region and has success in senior level recruitment in satellite communications, government contracting, and within the intelligence community. Boxwood also provides a consulting solution for the analysis and improvement of the employer's current recruitment process. If you would care to submit a recruitment, hiring, or retention question for Bert to answer, please email your question to BertSadtler@BoxwoodSearch.com.**

Nothing stands still, certainly not in business where the paradigm is in a constant shift. Human Resource Departments have held the roles of benefits management and recruiting. Few companies have changed the HR responsibilities as the business paradigm shifts.

Granted, technology has made its impact. However, technology is nothing more than a tool. Business keeps changing. Critical talent is needed for companies to grow and enjoy success. Shouldn't we be asking "*Do we need to adjust our process in order to target and attract the best talent?*"

Forward thinking is needed to attract top talent. Today, benefits management and recruiting require two completely different skill sets. Consider the following:

- *The traditional recruitment process has been implemented and managed by Human Resource Departments.*
- *The classic approach is to bundle the following responsibilities and assign them to HR:*
  - » Employee relations
  - » 401K Plans
  - » Medical Benefits
  - » Compliance with employment regulations
  - » Recruitment and hiring of talent

Today's employment benefit plans have become complex and expensive. The HR professional who is a benefits expert has a full workload keeping their employer current and efficient. They must focus their priorities internally and could be regarded as spending their time playing "defense."

As the "defensive mindset" requires having a deep understanding of the employer's internal issues, "the defensive player" is generally someone who is most comfortable spending their time in the office.

At the same time, the acquisition of talent has become much more complex than simply posting a "help wanted" flyer.

- *In today's environment of fear and uncertainty, the pressure is on for employers to repeatedly get it right and make a great hire*
- *Best Practices Recruiting has become less about the "hiring wedding" and more about the longer-term "hiring marriage" where a successful hire is measured six months after the "wedding" to confirm the new talent is a valuable asset*
- *Recruiting for great talent is a pro-active event, requiring business discussions with business units in order to solve business problems*
- *Recruiting for great talent can be regarded as playing "offense"*
- *The "Offense's playing field" exists in the office as well as outside the office and requires an outwardly focused approach*

With the paradigm shift toward a deeper and diverging focus, does your company's HR team frequently spend time attending and participating in business functions and events? Is your HR team involved in understanding and solving business problems? Is this a realistic expectation? How can the "Defensively focused" HR Department effectively implement "Offense focused" recruiting?

Therefore, under the shift in the recruiting paradigm, how can the HR Department be expected to fully implement the responsibility of playing defense and offense at the same time? The paradigm is shifting HR and Recruiting to be more opposing then complimenting. It would be like playing center on an NBA basketball team in the morning and then riding a racehorse in the afternoon.

New adopters and nimble thinking employers are developing models which provide HR with the tools and focus to continue to deliver an excellent benefits program while standing up a new role focused on critical acquisition of great talent and aligning recruitment as an integrated business unit member.

Best practices recruiting is evolving out of HR and into its own separate discipline where it solves business problems by attracting and acquiring the right talent in direct partnership with the business units. Metrics to measure recruitment success and successful recruitment performance rewards will closely mirror the metrics and rewards of the company's business performance models.

When it comes to hiring the right talent, the stakes are high. You can be an NBA center. You can be a Triple Crown jockey. Trying to be both means you are likely to not do either very well.

***About Boxwood Search***

There is a battle for senior level talent. A great hire can make a long term positive impact and a failed hire can prove to be very expensive. How does a company recruit and hire the right talent? It is more than just networking within the community of friends and business associates. It requires focusing on results through a process oriented approach. We are committed to reaching a successful outcome. Our recruitment method has repeatedly proven to deliver very qualified senior talent.

We exclusively represent employers in the marketplace as a dedicated resource and discrete trusted advisor. Through original research and industry contacts, we will target qualified candidates and motivate them to consider the opportunity.

We will screen candidates against key criteria, analyze technical fit along with cultural fit, interview, contact references and present our recommendations. Upon making the offer, we are the employer's advocate and an active participant in communicating with the candidate until offer acceptance has been secured. Results are guaranteed.

# *What Is A GPS Simulator?*

**As GPS receivers are built into more mission-critical devices for difficult application environments, and designed with the emerging capabilities of a multitude of GNSS constellations and augmentation systems, developers and manufacturers need better ways to guarantee performance. That's where a GPS simulator comes in.**

**While the test engineer has a variety of choices for testing GPS-based positions, navigation and timing functions of their integrated GPS receivers, simulation offers the most flexibility, compared to testing with over-the-air signals ("live sky"), or record and replay solutions. Having complete control over the generation of GPS signals is the only way to have confidence in your hardware and software's ability to perform—under any condition.**

To understand a GPS simulator, it is helpful to understand some of the details of GPS transmissions. The GPS constellation consists of at least 24 satellites, orbiting every 12 hours, broadcasting navigation data on different frequencies. GPS is just one of several global navigation satellite systems (GNSS) in operation, or soon to be in operation. Most navigation applications today use the GPS L1 frequency at the radio frequency 1575.42 MHz. Onto this carrier frequency, satellites transmit identification information and a navigation message that contains synchronized time, the satellite's orbital data (ephemeris) and data on the expected positions of all the satellites in the constellation (almanac). It is from this data that receivers can accurately calculate their distance from several satellite signals at the same time to achieve its navigation solution through trilateration.

GPS simulators are radio frequency generating instruments that are capable of transmitting the same exact data as GPS satellites. However the value of a GPS simulator is in the ability to change a wide variety of parameters right from the test bench:

- Data from the satellite:
  - » *Date/Time via the clock parameters*
  - » *Satellite ID (PRN code)*
  - » *Ephemeris and almanac*
- Conditions as seen by the receiver:
  - » *Number of satellite signals*
  - » *Power level*
  - » *Atmospheric and antenna errors through models*
  - » *Multi-path conditions*
- Position of the receiver
  - » *Start position (latitude, longitude and elevation)*
  - » *Trajectory (motion path)*

It is the combination of all these parameters that make up a "scenario" for a GPS simulator. All Spectracom GPS simulators can generate simple single-satellite signals to verify receiver signal acquisition and validate assembly. Some Spectracom GPS simulator models can simultaneously generate signals from many satellites, GPS and GLONASS, L1 and L2 frequencies, and satellite-based augmentation systems (SBAS); WAAS (North America), EGNOS (Europe), MSAS (Japan), and GAGAN (India). These GPS simulators even adjust signal transit time and relativistic effects to simulate receiver motions to ensure the system is capable of performing under any trajectory.

## *Why Simulate GPS RF Signals?*

### *#1*
### *Test GPS RF signals anytime, anywhere from the convenience of your bench*

*You can test GPS receivers by creating and maintaining the infrastructure to pipe "live-sky" GPS signals from a roof-top antenna to your test bench, or you can test your product in the parking lot of your facility. Sometimes easy (small devices). Sometime hard (rolling aircraft out of the hanger). Always inefficient. Alternatively, save time and money with GPS signal simulation. Test your device virtually any place and time.*

### *#2*
### *Test any environmental condition*

*Testing with GPS signals from the live-sky limits the test to existing environmental conditions. Only what exists on that date, time and place. Only those satellites. Testing with a record-replay box is limited to the recorded environment in the same way. Simulation allows the control of any parameter—creating and saving scenarios so testing is repeatable across every scenario set that you want to maintain. Only then do you have confidence that your product will perform in the conditions you design to.*

### *#3*
### *Test receiver movements without taking a step*

*Sure field trips are fun, but tell that to the tester verifying GPS receive performance at highway speeds. Worse yet, at aircraft speeds! GPS simulation allows you to quickly test any motion pattern from portable consumer electronics to UAVs and missiles. Save the cost of rocket fuel. Simulate.*

### *#4*
### *Understand problematic error sources*

*Live-sky signals will include whatever impairments to the signals that exist at that particular time and place, however fleeting such as those from atmospheric conditions, signal obscuration, or multipath/fading. And worse, those impairments are unknown to the tester. Understand exactly how your device performs under a variety of error sources. Simulation eliminates fear of the unknown.*

# In The Next Issue Of SatMagazine...

## Inmarsat Pricing Rises Again On March 1st...

### *Bulk Carriers and Low Volume Users to be hard hit*

**Gottlieb International Group reports that Inmarsat's Fleet Broadband and E & E prices are going up again.**

On March 1st, vessels using less than 200MB per month of Fleet Broadband, typically Bulk Carriers, will see an 18 percent price hike.

The trickle down effect is that this forces clients, who will then be paying an amount close to the 200MB Entry Plan price, to choose to upgrade.

This results in a dramatic 50 percent price rise and an additional annual cost per vessel of around $3,900 per year—in addition to the increase already imposed last May.

In the March edition of *SatMagazine*, **Gottlieb International Group**'s Managing Director, *Alan Gottlieb*, will examine the strategy behind Inmarsat's unexpected and unwelcome price hikes, its effect on Inmarsat's customer base, and on Inmarsat's future.

***Don't miss this important and crucial article!***