SATCOM For Net-Centric Warfare October 2015

MilsatMagazine

Rocketing Off With ULA...
MEXSAT's Morelos-3 = Secure Comms
And
NROL-65 With 13 CubeSat Passengers

African Comms Critical Partnerships Required
Leveraging COTS For Communications
Advanced SATCOM Solutions For Mobile Apps
Moving Military + Government Space Assets
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Convergence + Disaggregation
Uncertainty Remains For U.S. Space Programs

cover image is courtesy of United Launch Alliance

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PUBLISHING OPERATIONS

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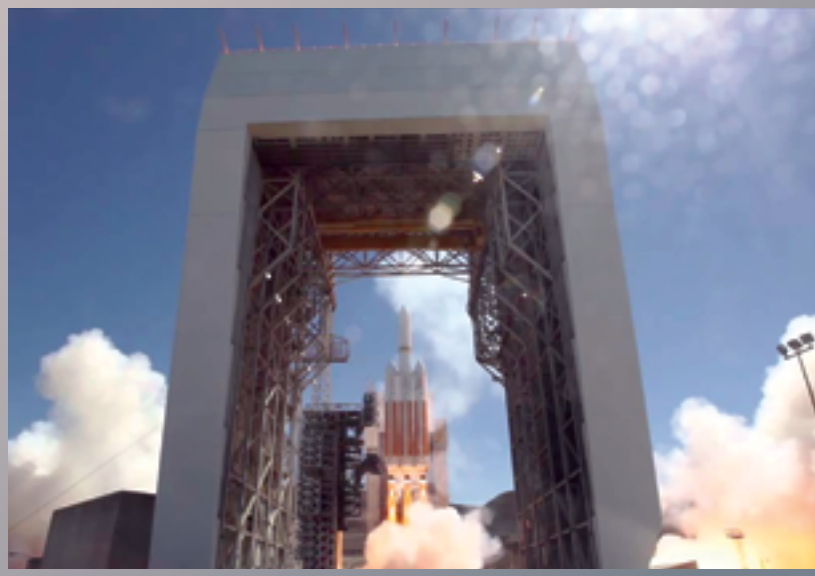
Hartley G. Lesser, Editorial Director
Pattie Waldt, Executive Editor
Jill Durfee, Sales Director, Editorial Assistant
Simon Payne, Development Director
Donald McGee, Production Manager
Dan Makinster, Technical Advisor

SENIOR CONTRIBUTORS

Tony Bardo, Hughes
Richard Dutchik, Dutchik Communications
Chris Forrester, Broadgate Publications
Karl Fuchs, iDirect Government Services
Bob Gough, Carrick Communications
Jos Heyman, TIROS Space Information
Giles Peeters, Track24 Defence
Koen Willems, Newtec

AUTHORS

Cristi Damian
Claudia Diamante
Vanessa Flores
Grady Fontana
Karl Fuchs
Staff Sgt. Francis Horton
Tech. Sgt. Todd Kabalan
Philip Kwong
Sr. Airman Cody Martin
Daniel Parry
Elliot H. Pulham
Nicole Robinson
Dr. Jared Squire



Left to right: The ULA Morelos-3 and NROL-55 launches.

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DISPATCHES

DISPATCHES

SES GS To Support FAA Uplink Requirements

Global satellite provider, SES Government Solutions (SES GS), will support the Federal Aviation Administration's (FAA) Wide Area Augmentation System (WAAS) on the ground as well as in space.

Raytheon Integrated Defense Systems has announced the company's selection of SES GS to build two GEO Uplink Subsystem stations to support the next generation of the WAAS network. The data transmitted by the uplink stations will improve the accuracy, integrity and availability of the GPS signals intended to enable aircraft to rely on GPS for all phases of flight, including precision approaches to airports within the coverage area.

SES GS was awarded the contract to include a WAAS hosted payload on its SES-15 satellite in April 2015. The uplink stations will be built on existing teleport facilities in Washington and California. All ground equipment installation will be completed prior to SES-15's anticipated launch in the first half of 2017.

FEATURES

DISPATCHES

LOST OPPORTUNITIES FOR THE SATELLITE INDUSTRY MUST BE HALTED

Satellite Industry Association (SIA) President Tom Stroup issued the following statement that urges Congress to reauthorize the Export-Import Bank of the United States:

"As lost opportunities for domestic commercial satellite manufacturers continue to mount, SIA urges Congressional leadership to reauthorize the Export-Import Bank of the United States (Ex-Im Bank). Without Ex-Im Bank, U.S. commercial satellite manufacturers are increasingly noncompetitive in a global marketplace where foreign buyers account for roughly 75 percent of all commercial satellite sales.

"Since the closing of Ex-Im Bank, the United States has had at least three pre-existing commercial satellite orders withdrawn, lost other awards, and been barred from other competitions entirely.

"This is just the tip of the iceberg. In the highly competitive commercial satellite manufacturing market, support from export credit agencies (ECAs) can be the difference between the winning proposal and a competitive one. And, in some cases, ECA support is a required component of the proposal.

"The longer the Ex-Im Bank remains closed, the greater the damage will be to U.S. satellite manufacturers and the hundreds of local businesses that supply them.

"American manufacturers have been the leaders in the global commercial satellite manufacturing market, winning 57 percent of orders placed in 2014. Congress risks allowing this competitive edge to slip by failing to ensure a level playing field for American-made satellites.

"Access to financing is a crucial element in winning satellite business – given that most commercial satellites cost hundreds of millions of dollars, raising the funds to order spacecraft is time-intensive, complicated, and can make or break a business plan.

"Foreign ECAs, recognizing the growing importance of the sector, have been aggressive in offering competing export credit deals for new satellite operators.

"Since 2010, Ex-Im has financed 16 satellite projects worth $4 billion, supporting tens of thousands of U.S. jobs. Satellites had been Ex-Im's fastest-growing category of financial activity, expanding from about $50 million annually in 2007-2009 to more than $1 billion annually in the last three years. This activity has generated a net profit for the Ex-Im bank, returning funds to U.S. taxpayers.

"Our industry can dominate the market if Congress ensures a level playing field with European satellite manufacturers, all of which have access to foreign ECA support. Congress must reauthorize Ex-Im as quickly as possible."

SIA is a U.S.-based trade association providing worldwide representation of the leading satellite operators, service providers, manufacturers, launch services providers, and ground equipment suppliers.

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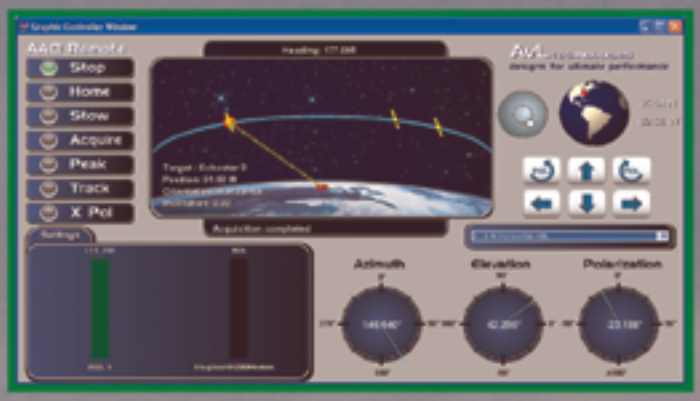

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DISPATCHES

NEW SSPB/BUC FOR MILITARY OPS

Advantech Wireless announces the release of their Second Generation Gallium Nitride (GaN) Technology based 50 Watt X-Band Solid State Power Block/Block Up Converter (SSPB/BUC) for Tactical Mobile Military Applications.

The Second Generation GaN based 50W X-band SSPBs from Advantech Wireless are weatherproof and constructed in a compact cooling enclosure for outdoor operation. These BUCs feature exceptional linearity and operating efficiency and are the smallest fully integrated units on the market today. With built-in design features and less than 3.5 kg, they are perfectly suited for harsh environments, SATCOM-On-The-Move (SOTM) and manpack terminal deployments. The design of the Second Generation 50W GaN X-band BUCs is based on Advantech

Wireless's industry proven reliable solid-state high power amplifiers. With protection against thermal runaway and out-of-lock conditions, the units are completed with power supply, phase-locked oscillator, mixer, filter and cooling mechanism providing the utmost in performance, convenience and efficiency.

"The Second Generation 50W X-band GaN product line continues on the development road map started by the 25W X-band GaN launched in 2012. With several hundred 25W units already successfully deployed in the field, the new 50W BUC will allow higher output power, and higher data rates for mission critical, bandwidth hungry operations in challenging mobile military environment.

"These units are designed for extreme low weigh SOTM, man packs, and flyaway applications, where weight and energy efficiency is the driving factor," said Cristi Damian, VP Business Development at Advantech Wireless.


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DISPATCHES

RFP FROM USAF FOR GPS III PUSH OFFS

The Air Force has published a final Request for Proposal (RFP) for Global Positioning System (GPS) III Launch Services, September 30.

Launch services include launch vehicle production, mission integration and launch operations for a GPS III mission scheduled to launch in 2018. Proposals are due back to the Air Force no later than November 16, in accordance with the solicitation instructions.

After evaluating proposals through a competitive, best-value source selection process, the Air Force will award a firm-fixed price contract that will provide the government with a total launch solution for the GPS III satellite.

The Air Force's acquisition strategy for this solicitation achieves a balance between mission success, meeting operational needs, lowering launch costs, and reintroducing competition for National Security Space missions.

This will be a standalone contract for one GPS III launch. GPS III is the next generation of GPS satellites that will introduce new capabilities to meet the higher demands of both military and civilian users.

GPS III is expected to provide improved anti-jamming capabilities as well as improved accuracy for precision navigation and timing. GPS III will incorporate the common L1C signal which is compatible with the European Space Agency's Galileo global navigation satellite system and compliment current services with the addition of new civil and military signals.

This is the first of nine competitive launch services planned in the FY 2016 President's Budget Request under the current Phase 1A procurement strategy, which covers awards with FY 2015-2017 funding. The next solicitation for launch services will be for a second GPS III mission.

The Phase 1A procurement strategy reintroduces competition for national security space launch services. Under the previous Phase 1 strategy, United Launch Alliance (ULA) was the only certified launch provider. In 2013, ULA was awarded a sole-source contract for launch services as part of an Air Force "block buy" of 36 rocket cores that resulted in significant savings for the government through FY 2017.

In May, Space Exploration Technologies (SpaceX) was certified for EELV launches resulting in two launch service providers that are qualified to design, produce, qualify, and deliver a launch capability and provide the mission assurance support required to deliver national security space satellites to orbit.

"Through this competitive solicitation for GPS III launch services, we hope to reintroduce competition in order to promote innovation and reduce cost to the taxpayer while maintaining our steadfast laser focus on mission assurance and assured access to space," said Lt. Gen. Samuel Greaves, Space and Missile Systems Center commander and Air Force Program Executive Officer for Space.

"With the recent certification of SpaceX, we now have multiple launch service providers that can service critical NSS missions. Reintroducing competition into EELV will ultimately save taxpayer dollars and increase assured access to space. " said Dr. Claire Leon, director of SMC's Launch Enterprise Directorate. "As part of this reintroduction of competition, we've been working with our industry partners to develop and finalize this RFP. Their feedback has been critical to developing the criteria for this source selection and how we are innovating government processes to better match commercial processes as directed by OSD's Better Buying Power 3.0. This is an exciting time in NSS launch acquisitions."

Artistic rendition of a GPS III satellite. Image courtesy of Lockheed Martin.

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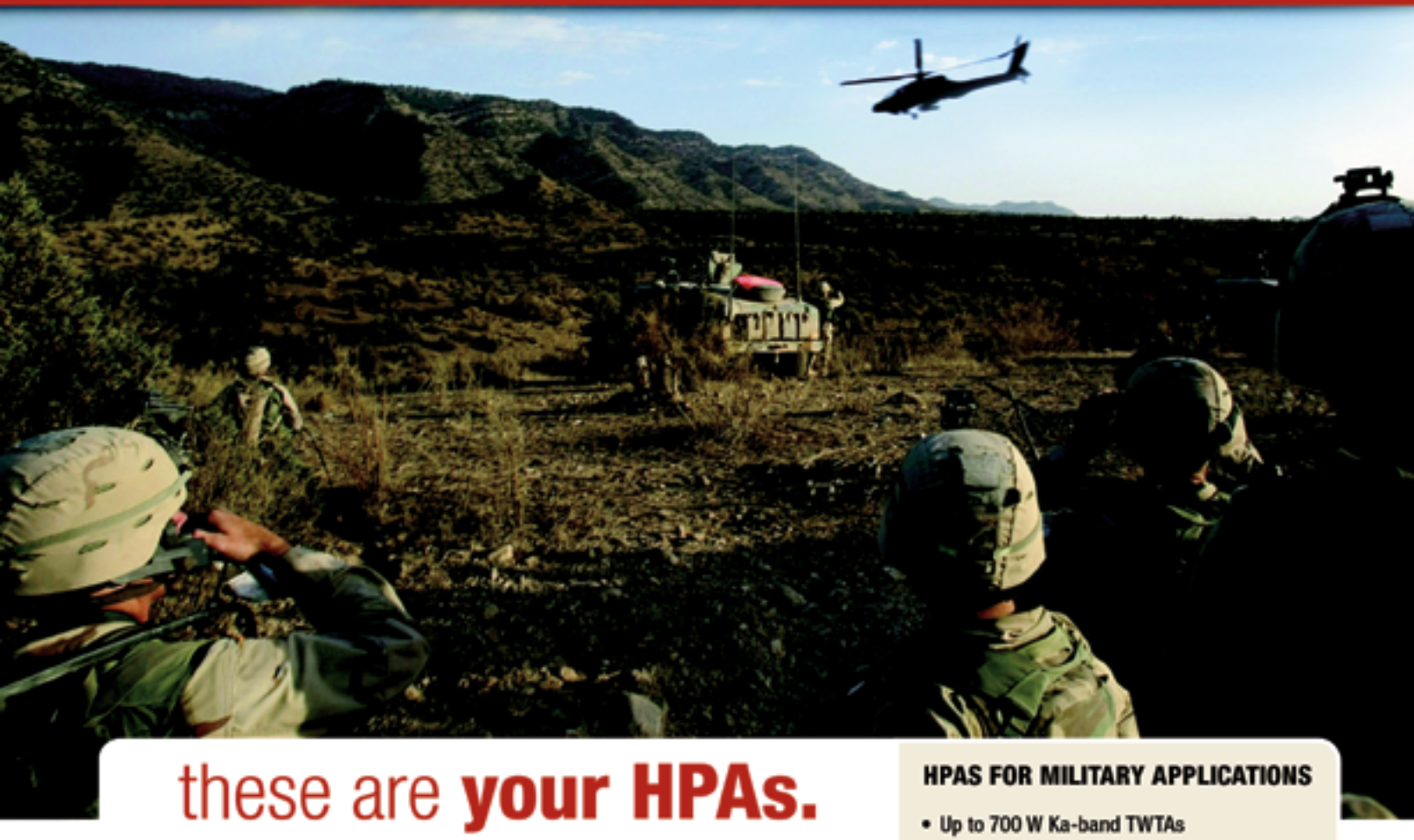

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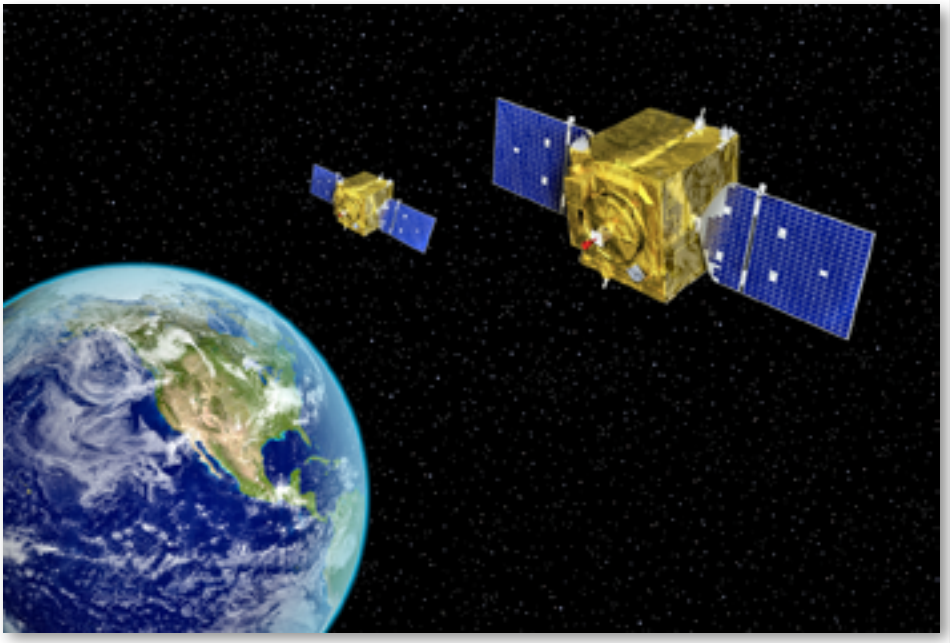
First Two GSSAP's Are Declared Operational By U.S.A.F.

U.S. AIR FORCE

General John E. Hyten, commander of Air Force Space Command (AFSPC), declared Initial Operational Capability (IOC) for the first two Geosynchronous Space Situational Awareness Program (GSSAP) spacecraft on September 29, 2015.

This significant achievement is reflective of the outstanding collaboration between numerous organizations, including AFSPC, U.S. Strategic Command (USSTRATCOM) and its Joint Functional Component Command for Space (JFCC Space), the Space and Missile Systems Center, 14th Air Force, the 50th Space Wing (50th SW) and Orbital ATK Corporation.

This is the latest in a series of efforts by the defense and intelligence communities to strengthen Space Situational Awareness (SSA), including establishing a new Joint Interagency Combined Space Operations Center, agreeing to continue working together to increase space collaboration and coordination, and taking other steps to increase resilience.



The declaration of IOC for GSSAP concludes successful testing of the system and brings on line an SSA capability that will improve our ability to rapidly detect, warn, characterize and attribute disturbances to space systems in the geosynchronous (GEO) environment.

The system reduces the likelihood of space collision, increases safety in this domain and will support USSTRATCOM's Unified Command Plan-assigned mission to plan and conduct SSA.

GSSAP's maneuverability and vantage point near GEO make it a valuable addition to existing U.S. operational assets. Other assets conducting SSA of GEO, which GSSAP complements, include the Space Based Space Surveillance system, which operates in LEO, and multiple ground-based sensors.

The Space and Missile Systems Center, located at Los Angeles Air Force Base, operated the satellites during nearly a year of developmental testing.

At the conclusion of testing, the Space and Missile Systems Center turned operational control of the satellites over to 14th Air Force, which was delegated to the 1st Space Operations Squadron, 50th Space Wing, for operational test and evaluation.

"We're extremely honored to declare IOC for the Geosynchronous Space Situational Awareness Program," said Lt. Col. Casey Beard, 1 SOPS Commander. "We look forward to integrating this new system and capability into our space-based space situational awareness architecture and enhancing space situational awareness."

GSSAP satellites are a space-based capability operating in the near-geosynchronous orbit regime, supporting U.S. Strategic Command space surveillance operations as a dedicated Space Surveillance Network (SSN) sensor.

GSSAP satellites are tasked to collect space situational awareness data that allows for more accurate tracking and characterization of man-made orbiting objects.

From a near-geosynchronous orbit, GSSAP will have a clear, unobstructed and distinct vantage point for viewing Resident Space Objects (RSOs) without the interruption of weather or the atmospheric distortion that can limit ground-based systems.

GSSAP satellites will operate near the geosynchronous belt and will have the capability to perform Rendezvous and Proximity Operations (RPO). RPO allows

The Automated Navigation and Guidance Experiment for Local Space satellite, an Air Force Research Laboratory experimental satellite, and two Air Force Space Command Geosynchronous Space Situational Awareness Program, or GSSAP, satellites launch July 28, 2014, from Cape Canaveral Air Force Station, Fla. The ANGELS program is managed by the AFRL's Space Vehicles Directorate, located at Kirtland Air Force Base, New Mexico. The 45th Space Wing provided launch support for the United Launch Alliance Delta IV vehicle, including weather forecasts, launch and range operations, security, safety, and public affairs.

Photo is courtesy of United Launch Alliance.

for the space vehicle to maneuver near a resident space object of interest, enabling characterization for anomaly resolution and enhanced surveillance, while maintaining flight safety.

Data from GSSAP will uniquely contribute to timely and accurate orbital predictions, enhancing our knowledge of the geosynchronous orbit environment, and further enabling space flight safety to include satellite collision avoidance.

GSSAP satellites will communicate information through the world-wide Air Force Satellite Control Network (AFSCN) ground stations, then to Schriever Air Force Base, Colorado, where 50th Space Wing satellite operators of the 1st Space Operations Squadron (1 SOPS) will oversee day-to-day operations.

Two GSSAP satellites were launched aboard a United Launch Alliance (ULA) Delta IV M+ (4,2) booster configuration from Cape Canaveral Air Force Station, Florida, on July 28, 2014.

Ongoing Support For Government Comms Demo'd By Inmarsat

Inmarsat has demonstrated the company's ongoing commitment to support government communications' needs worldwide by providing essential capability for both real-time crisis as well as emergency response preparedness and training in the recent Pacific Endeavor exercise.

The event was co-hosted by U.S. Pacific Command (USPACOM) and the Armed Forces of The Philippines (AFP) J6 and took place in Manila, Philippine. Military representatives from 21 Pacific nations also took part in SatCom Endeavor, a part of Exercise Pacific Capstone event, to jointly train and learn about the latest satellite communications capabilities.

This type of exercise is critical to the success and preparation for the next humanitarian aid disaster response (HA/DR) situation. As part of this training, Inmarsat executives provided an overview of the company's Broadband Global Area Network (BGAN) and Global Satellite Phone Service (GSPS). These services deliver a valuable 'First In' SATCOM capability, to first responders entering a disaster area based on its voice quality, small size, global coverage and ease of use.

Major Leo Caduyac, a Philippine Army Signal Command Soldier checks radio communications during Exercise Pacific Endeavor 2015. Sponsored by U.S. Pacific Command and hosted by the Armed Forces of the Philippines, Pacific Endeavor is a multinational workshop designed to enhance communication interoperability and expedite Humanitarian Assistance and Disaster Relief response in the Asia-Pacific. The workshop will be held until September 11, 2015, and will involve 21 allied and partner nations.

Underscoring its commitment to meeting and serving the mission-critical communications needs of the first responder community, Inmarsat also offers Global Xpress to deliver end-to-end, seamless, 'SATCOM as a Service' capability.

U.S. Marine Corps Major Erika Teichert, from the Naval Post Graduate School, instructs communicators from the Asia-Pacific region on the setup of a mobile satellite system in Makati City, Manila, Philippines, on September 10, 2015.

U.S. Pacific Command, photo by TSgt Todd Kabalan.

Supported by the only commercial worldwide Ka-band constellation built for mobility, it provides high-throughput communications solutions to government users that can take advantage of its ease-of-use, portability and reliability.

Inmarsat's portfolio of reliable, managed satellite communications services help overcome the hazards of both natural and man-made catastrophes. The company offers both voice and data access so responders can assess damage, rescue victims and call for support. They acquire instant phone, broadband and wideband services in critically-hit areas—regions where other communications options have failed—using equipment that is as easy to use as a standard cell phone, and often small and light enough to store in a backpack.

"Communications people are generally some of the first people on the ground," said Corporal Rochelle Rowe, a Royal New Zealand Air Force communications specialist, and a SatCom Endeavor participant. "If you can get communications up, even with a small 300k link, that's still something, and getting Internet access is really important to access the rest of the world, to call for help."

When a disaster strikes, many times the location's basic infrastructure is destroyed. The cell towers, the Internet providers and the backbone of communication infrastructure are gone. Setting up communication quickly after a disaster is vital to saving lives.

Hands on training with mobile broadband equipment give these partners a chance to practice and work out any issues.

"Having a system such as the BGAN is important because you can set it up in five minutes," said Cpl. Rowe."Even though it's a simple piece of equipment, it's quite good to get hands on so when you are in a HA/DR situation, and someone hands you a BGAN, you're not like, how do I use this thing?"

"The BGAN gives five or six people that first-in capability to tell their higher headquarters what the ground truth is, so that higher headquarters can plan and ensure that the right help is going to the right people, at the right time, and the right place," said Major Erika Teichert, a Marine Corps officer from the Naval Post Graduate School.

Strengthening relationships and interoperability is the main focus of exercise Pacific Endeavor 2015. SatCom Endeavor in particular, provided the partner nations the ability to build strong relationships in addition to strong networks. These relationships will be vital when the next HADR crisis comes.

Exercise Pacific Endeavor 2015 is comprised of multiple training modules aimed to keep participants ahead of cyber, satellite, and radio technological advances, in case of a disaster. Representatives from the Multinational Communications Interoperability Program (MCIP) are co-hosting the exercise with the Armed Forces of the Philippines (AFP) to help improve interoperability of communications technologies between partner-nations in the pacific region.

Story is courtesy of Inmarsat and Tech. Sgt. Todd Kabalan, Defense Media Activity – Hawaii News Bureau, U.S. Air Force.

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DISPATCHES

NRL's Dusty Plasma Rocket Launch

Launch of the Charged Aerosol Release Experiment (CARE II) from Andoya Space Center in Norway, September 16, at 19:06 GMT. Debris of polystyrene thermal cover of payloads rains particles on the launch pad. The rocket carried the radio beacon, chemical release, and instrument payloads to an apogee of 280 kilometers (km) for a dust release on the down leg at 266 km altitude.

Photo is courtesy of NASA/Wallops Flight Facility.

The U.S. Naval Research Laboratory (NRL), in collaboration with numerous universities and government laboratories studying the effects of dusty plasmas—charged dust particles that can occur naturally in the mesosphere—generated an artificial plasma cloud in the upper-atmosphere to validate the theory of 'dressed particle scattering' caused by this phenomenon.

Named the Charged Aerosol Release Experiment (CARE II), an instrumented rocket was launched September 16, at 19:06 GMT, from Andoya, Norway, using a NASA Black Brant XI sounding rocket.

After entering the ionosphere, 37 small rockets were fired simultaneously to inject 68 kilograms (kg) of dust comprised of aluminum oxide particulates, accompanied by 133 kg of molecules such as carbon dioxide, water vapor, and hydrogen.

The launch occurred just after sunset placing the dust particles in sunlight for easy viewing by cameras in darkness on the ground and with an airborne platform.

The large concentration of dust and exhaust material interacted with the ionosphere to produce a so-called 'dirty plasma' with high-speed pickup ions.

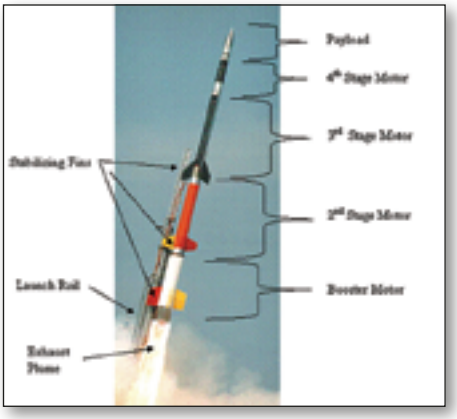
Visibly seen from the ground, the released dust produces an optical cloud, and, by attaching the electrons in the ionosphere, forms charged particulates. This plasma then generates waves that scatter radar signals used for remote sensing.

"The CARE launch was fully successful," says Dr. Paul A. Bernhardt, CARE principal investigator. "Ground-based radars tracked the effects on the ionosphere for twenty minutes, providing valuable data on how rocket motors affect ionospheric densities. The data will be used to validate simulations of natural disturbances in the upper atmosphere."

The NRL Plasma Physics Division's (PPD) Charged Particle Physics Branch and the University of Washington made measurements with plasma probes and electric field booms on a deployable instrument payload. Ionospheric disturbances were monitored with multi-frequency beacon transmissions from the rocket payload that were detected by a network of ground receivers from the Finnish Meteorological Institute (FMI), Sodankylä Geophysical Observatory (SGO), and NRL PPD.

Ground radars and optical instruments that recorded the dust release were provided by the European Incoherent Scatter Scientific Association (EISCAT); Institute of Applied Physics (Germany); Institute of Space Physics, (Sweden); and others.

The Black Brant XII rocket stands 65 feet tall and produces about 70,000 pounds of thrust at lift off. The fourth stage does not require fins since it is ignited outside the atmosphere. The 5 Hertz spin rate keeps the rocket stabilized, much like a gyroscope.



The Black Brant XII rocket stands 65 feet tall and produces about 70,000 pounds of thrust at lift off. The fourth stage does not require fins since it is ignited outside the atmosphere. The 5 Hertz spin rate keeps the rocket stabilized, much like a gyroscope.

Image courtesy of NASA.

The CARE theory effort was based in PPD and the Laboratory for Computational Physics and Fluid Dynamics (LCPFD) at NRL, as well as the Center for Space Science and Engineering Research at Virginia Tech. High frequency receivers were fielded by QinetiQ (UK) and by NRL PPD with stations in Oslo, Tromsö, and the University Center in Svalbard (UNIS).

A CARE data review is scheduled for December 2015 in San Francisco. During this review, Bernhardt says, the scientific results from the experiment will be compared with artificial and natural scatter processes to better understand the physics. Also, a follow-on CARE III experiment will be planned.

The Department of Defense (DoD) Space Test Program sponsored the launch and payload integration for the NRL CARE II mission. The rocket launch, and payload development was provided by the NASA Sounding Rocket Program.

The CARE experiments were designed to test the theory of dusty plasma scatter developed by scientists at the University of Tromsö in Norway and NRL PPD.

www.nrl.navy.mil/

Story by Daniel Parry, NRL Public Affairs Office

DISPATCHES

Droning On @ NIE

In this season's Network Integration Evaluation, or NIE, taking place on White Sands Missile Range, or WSMR, and Fort Bliss, Texas, coordinated units of remotely-operated and automated aircraft will be used to represent a possible threat on tomorrow's battlefields.

Members of the Targets Management Office with Program Executive Office for Simulation Training and Instrumentation, or PEO STRI, are using off-the-shelf quad and octocopters and flying them in groups. The endeavor is part of an Army Test and Evaluation Command, or ATEC, program to study possible use, effectiveness and countermeasures for the deployment of large numbers of synchronized drone aircraft.

"ATEC is our customer, they tasked us to come out and look at swarming, the variations and the payloads we can apply to this," said James Story, an engineer with the Targets Management Office, PEO STRI. "We saw this as a threat that wasn't being addressed and ATEC agreed."

While drones are seeing expanded use, with many different countries building, deploying, and selling large airplane-sized drones for military purposes, small-scale drones are still gaining a foothold, mostly due to the technical limitations involved. That technology is expected to improve, and the small-scale drone become more viable as a possible weapon, and it's that preparation for the future that is driving the swarming project.

"Right now there's hardly anyone doing swarms, most people are flying one, maybe two, but any time you can get more than one or two in the air at the same time, and control them by waypoint with one laptop, that's important," Story said. "You're controlling all five of them, and all five of them are a threat."

Normally used by hobbyists and photographers, the quadcopter style drones don't represent a huge threat in their current state. The tiny aircraft have a flight time of only a few minutes, and have a limited payload capacity. This makes them ill suited for the surveillance missions drone aircraft are most commonly associated with, which require an aircraft that can stay aloft for long periods of time, and carry heavy zoom and thermal camera systems.

The concern comes from the affordability of the off-the-shelf systems. Small military drones, custom designed for the military mission, and outfitted with the latest hardware can get quite expensive.

The Tarantula Hawk Micro Air Vehicle, a VTOL capable military drone about the size of a large bucket, comes with a price tag in the hundreds of thousands of dollars, with hundreds of thousands more needed to train an operator. An off-the-shelf quadcopter, like the 3-D Robotics Iris series used in the test, can be bought for around $1,000, and requires almost no training to operate.

For the NIE, the off-the-shelf drones will be configured to carry special payloads for specific mission functions. Cameras, bomb simulators, expanded battery packs and other systems will be tested on the aircraft to develop and analyze potential capabilities of the drones.
By conducting the flights at WSMR, the engineers can evaluate things like actual flight time and performance, as well as payload capabilities. Using data collected from the WSMR flights, the engineers hope they can increase the flight time of the drones, and make other improvements to make them more comparable to more expensive military drones.

"The payloads make the difference. When you add video, the camera, the heavier battery for more flight time ... so for the smaller bird here the flight time goes from about 15 minutes, to about seven minutes of flight time," Story said. "That's part of what we're doing here is seeing if we can increase the flight time."

From a military perspective, this low price tag of the off-the-shelf drones can translate to a level of disposability. A militarized version of one of these aircraft could be equipped with light weapons like small bombs they can drop, or be flown into a target and exploded like a cruise missile.

Even still, the threat of a single drone of this type is fairly small, as they lack hardened systems and armor, making them easy to shoot down using even a simple sportsman's shotgun. By coordinating dozens of drones or more into a single swarm, it's theorized the tiny aircraft could overwhelm a defender, presenting far more targets then can be easily destroyed and allowing at least some weaponized drones to reach their target.

"Even if you defeat one or two, if one of them slips past the guard that can pose a problem," said Michael Francis, integrated product team lead for the multirotor targets program.

In preparation for the NIE mission, PEO STRI came to WSMR in September to conduct initial flight tests at Condron Army Airfield. Using flight and navigation software also available off-the-shelf, the engineers and technicians were able to put up to 10 drones in the air at a time, conducting basic maneuvers and formations, and return to the launch point. While simple in appearance, the ability to put 10 drones in the air and execute a flight plan is a key step in the development and analysis of swarm tactics.

For the NIE, PEO STRI personnel will be deploying the drones as a kind of fire support unit.

Acting as a member of the opposing force, the drones will be used for short-range missions, flooding the airspace with drones to generate disruptive radar signatures, as well as being used as a kind of spotter, using simple video cameras to try and locate Soldiers and units.

"We're going to be flying proving the opposing force with swarm type assets, giving them radar saturation and getting eyes on using a video downlink," Francis said.

There's also plans to fit the drones with the ability to drop packets of flour, simulating the ability for the swarm to drop small bombs, allowing the drones to perform short-range strike missions.

Drone-test missions can be a big challenge to plan and execute. Fortunately WSMR has unrestricted military airspace, allowing the testing of remotely operated or autonomous aircraft at any altitude within the range's 3,200 square miles.

Certifying the systems through WSMR's flight safety office, establishing safe operations procedures was challenging, but the result is the ability to evaluate a new threat to the Soldier.

U.S. Army Engages In Network Exercise With Partner Nations

The Network Integration Evaluation, or NIE 16.1, was the largest such event ever conducted, since the exercises started in 2011, said Brig. Gen. Terry McKenrick, Commanding General, Brigade Modernization Command.

Normally, there are between 3,500 and 3,800 participants—NIE 16.1 has more than 9,000 U.S. and coalition soldiers, supported by more than 3,000 civilians participating primarily at Fort Bliss, but also other locations around the U.S. and the world.

Among the many Army units participating this time are I Corps Headquarters; 1st Armored Division Headquarter, along with several 1st Armored Division brigades; a brigade headquarters from the United Kingdom, along with a company of Strykers being used by the United Kingdom's Scots Guards; 82nd Airborne Division, which will conduct a joint forcible entry; and, 101st Airborne Division, which will conduct an airborne assault.

The U.K. and Italy join U.S. units on the ground with 12 other nations, as well as other U.S. military units, some of which will participate virtually, using a variety of simulations.

Some 300 platforms, including just about all the vehicles in the Army's inventory, as well as experimental vehicles, loaded with a of radios, satellite communications gear and mission command applications, are being evaluated, along with radios carried by dismounted Soldiers, McKenrick said.

NIE 16.1 is assessing manned and unmanned teaming—the ability to increase situational understanding, lethality, and sustainment of maneuver forces while reducing manpower and risk, he said. In all, three unmanned ground systems are being evaluated, as well as several networked unmanned air systems.

Network provides the ability for Soldiers in command posts, mounted and dismounted to download situational awareness data from the unmanned air systems.

While NIE 16.1 is about experimentation, an equally valuable focus will be on readiness, McKenrick said. The realistic training will be equivalent to a combat training center rotation, with a hybrid threat featuring combined-arms maneuver and wide-area security against an opposing force. Weapons of mass destruction scenarios will also be incorporated.

McKenrick said the Army is now going through an "assessment process" of accrediting White Sands-Bliss-Holloman as a "joint-multinational training capability. That will help us bring in more joint and multinational partners in future exercises."

Now and in the future, the Army will operate as part of a joint and coalition force, he said. It's spelled out in the Army's keystone doctrine known as the "Army Operating Concept: Win in a Complex World." To do that effectively requires compatibility across network architectures that each of the armies use, he said. That's why this exercise and getting it right is so important to the U.S. and its partner nations.

Besides Fort Bliss, the exercise will also spill over to adjacent Holloman Air Force Base and White Sands Missile Range, both in New Mexico. To give sense of scale, White Sands is 3,200 square miles, Fort Bliss 1,700, while the entire state of Rhode Island is a mere 1,214.

NIE 16.1 will be different from any other previous NIE, McKenrick said. NIE 16.1 will be the "final proof of concept" for a new annual exercise, which will start at the beginning of fiscal year 2017. That new exercise will be called the Army Warfighting Assessment, or AWA, with the first being AWA 17, which will be conducted in October 2016.

NIE 16.1 and AWA will not focus on the traditional NIE programmatic testing required for systems to become or not become programs of record, or go back into development, he said. AWA-17 will focus on 38 concepts and capabilities that U.S. Army Training and Doctrine Command, or TRADOC, identified, he said.

Strict testing requirements, in other words, will be lifted to give industry and the Army's own lab engineers the freedom to explore new capabilities with Soldier feedback in realistic settings.

NIE 16.1 and AWA will focus on experimentation involving integration of U.S. and coalition networks to see what works, what doesn't, why it doesn't, and what solutions might be possible.

Another difference between NIE 16.1/AWA and past NIEs, is that there will be a lot more stakeholders present on the ground, said McKenrick. They include the requirements and acquisition communities, TRADOC and industry partners, as well as eight of the Army's centers of excellence, with heavy participation from the Mission Command, Maneuvers, Fires and Cyber CoEs. It will be a "truly collaborative environment, a team-of-teams effort."

Development Centers will be eliciting Soldier feedback on some 73 systems, reviewed by Plans and Operations, Army G-3/5/7, that will be evaluated, he said. Also, TRADOC will be looking to see how new technology could drive doctrine and how doctrine could influence new technology.

New technology could be software, hardware, app-like devices, security solutions, wireless capability to replace hardwiring, energy-saving devices and so on— items needed to enable the Army to be more expeditionary, a key cornerstone of Force 2025 concept.

While this year's NIE has heavy NATO participation, next year's will focus more on partner nations within the U.S. Pacific Command's area of responsibility, McKenrick added. Sea-basing, along with Marine Air-Ground Task Force experiments, will be included as well. Units are still being identified that will participate. Australia has already "signed up."

Story by Vanessa Flores, ASA(ALT) System of Systems Integration Director Public Affairs SOSI

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Extended Combat Training Required Open Lines Of Communication For 648th RSG

Soldiers with the 648th Regional Support Group set up and train with a Very Small Aperture Terminal Satellite during a war exercise at Fort McCoy, Wisconsin.

Photo by Staff Sgt. Francis Horton.

Soldiers with the 648th Regional Support Group (RSG) participated in a war simulation recently for their Extended Combat Training.

During ECT, the soldiers mixed real world scetnarios and war games; managing the needs of the Forward Operating Bases they oversaw and reacting to daily simulated attacks.

"Our job...was to provide for the defense and collaboration between multiple FOBs," said Lt. Col. Greg Atwood, S3 Officer, 648th RSG.

These duties include making sure the FOBs have the necessities to support their Soldiers, such as food, laundry and bath facilities, water and other necessities, Atwood said.

Meanwhile, the 648th reacted to simulated mortars, improvised explosive devices and small arms fire.

Of course, no training mission is complete without its challenges.

"Probably the biggest challenge of all was having less than half of our staff," said Lt. Col. Jan McCall, Deputy Commander, 648th RSG.

The 648th has around 99 soldiers assigned, but only 44 went to ECT, meaning many had to work long hours and take on extra duties.

"I learned something new that's outside of my job. Sometimes it's good to know more than just your job," said Pfc. Darqeisheona Howard, administrative specialist, 648th RSG.

"At first I was kind of iffy about it," Howard said. She was hoping to work more within her military occupational specialty.

Due to personnel shortages however, Howard found herself in a job position she wasn't trained for. Rather than handling administrative duties, she was trained on the spot as a radio telephone operator, keeping lines of communication open between the FOBs, she said.

There was also an issue with the Personnel Status Report which tracks how many soldiers are supposed to be in the training area, McCall said.

"We took over for another Regional Support Group. There were a little over 1200 unaccounted soldiers," McCall said.

She and her staff worked long hours contacting the leaders of their subordinate FOBs to account for every soldier assigned to the exercise.

ECT also gives soldiers a chance to expand their knowledge and build better leadership skills.

"This training has made me grow as a leader and has shown me what the flow of information is like in a theater environment." said Sgt. 1st Class Floyd Glasco, Engineer Operations noncommissioned officer.

One of the most important parts of any exercise is the morale and well-being of the soldiers.

"I also keep up my soldiers' morale," Glasco said with a smile. "If I don't make Spc. Dunn laugh just once a day, then I am not doing my job."

Story by Staff Sgt. Francis Horton, 363rd Public Affairs Detachment, U.S. Army

DISPATCHES

High Throughput SATCOM That Leverages Existing Ku-Band Hardware

Mobil Satellite Technologies announces the company has launched a new, high-bandwidth, 10 Mbps download x 4 Mbps Ku-band service for use anywhere in the North America.

This iDirect compatible service offers a great solution for users requiring high-throughput satellite performance while leveraging existing Ku-band hardware.

Ku-band service operates with longer wavelengths, giving Ku-Band a superior ability to perform through inclement environmental conditions.

The Mobil Satellite Technologies satellite network has been configured to support this new service with 1.2 meter antennas with only an 8 Watt BUC, which are now available in a small, fan-less form factor that no longer require auxiliary power supplies that allows a simple replacement of the existing BUCs on almost any mobile or fixed 1.2 meter VSAT antenna.

Kirk Williams, Direcor of Sales at Mobil Satellite Technologies, commented: "This new service gives users the ability to upgrade to an extremely robust satellite broadband service while continuing to use their existing Ku-Band equipment. Before this new service, users would have had to buy all new Ka-band satellite hardware to have access to service plans offering these kinds of data speeds."

"Programs and applications that require large amounts of bandwidth are becoming more and more common, so satellite network operators need to keep up. With this new 10 MB service on our proven iDirect network, we can deliver the enterprise-grade, high-throughput satellite service plans that users are asking about." said Bud Burton, President of Mobil Satellite Technologies. "This is just another step in our mission to deliver the best possible service and the very latest features to our customers."

DARPA Seeking Gremlins Assistance

For decades, U.S. military air operations have relied on increasingly capable multi-function manned aircraft to execute critical combat and non-combat missions.

Adversaries' abilities to detect and engage those aircraft from longer ranges have improved over time as well, however, driving up the costs for vehicle design, operation and replacement.

An ability to send large numbers of small unmanned air systems (UAS) with coordinated, distributed capabilities could provide U.S. forces with improved operational flexibility at much lower cost than is possible with today's expensive, all-in-one platforms—especially if those unmanned systems could be retrieved for reuse while airborne. So far, however, the technology to project volleys of low-cost, reusable systems over great distances and retrieve them in mid-air has remained out of reach.

To help make that technology a reality, DARPA has launched the Gremlins program. Named for the imaginary, mischievous imps that became the good luck charms of many British pilots during World War II, the program seeks to show the feasibility of conducting safe, reliable operations involving multiple air-launched, air-recoverable unmanned systems.

The program also aims to prove that such systems, or "gremlins," could provide significant cost advantages over expendable systems, spreading out payload and airframe costs over multiple uses instead of just one.

"Our goal is to conduct a compelling proof-of-concept flight demonstration that could employ intelligence, surveillance and reconnaissance (ISR) and other modular, non-kinetic payloads in a robust, responsive and affordable manner," said Dan Patt, DARPA program manager.

The Gremlins program seeks to expand upon DARPA's Request for Information (RFI) last year, which invited novel concepts for distributed airborne capabilities.

It also aims to leverage DARPA's prior success in developing automated aerial refueling capabilities, as well the Agency's current efforts to create advanced UAS capture systems for ships.

The program envisions launching groups of gremlins from large aircraft such as bombers or transport aircraft, as well as from fighters and other small, fixed-wing platforms while those planes are out of range of adversary defenses. When the gremlins complete their mission, a C-130 transport aircraft would retrieve them in the air and carry them home, where ground crews would prepare them for their next use within 24 hours.

DARPA plans to focus primarily on the technical challenges associated with safe, reliable aerial launch and recovery of multiple unmanned air vehicles. Additionally, the program will address new operational capabilities and air operations architectures as well as the potential cost advantages.

With an expected lifetime of about 20 uses, Gremlins could fill an advantageous design-and-use space between existing models of missiles and conventional aircraft, Patt said. "We wouldn't be discarding the entire airframe, engine, avionics and payload with every mission, as is done with missiles, but we also wouldn't have to carry the maintainability and operational cost burdens of today's reusable systems, which are meant to stay in service for decades," he said.

Moreover, gremlin systems could be relatively cost-efficient if, as expected, they leverage existing technology and require only modest modifications to current aircraft.

The DARPA Special Notice that describes the specific capabilities sought is available at ***http://go.usa.gov/36ARH***.

The Gremlins program plans to explore numerous technical areas, including:

- ***Launch and recovery techniques, equipment + aircraft integration concepts***
- ***Low-cost, limited-life airframe designs***
- ***High-fidelity analysis, precision digital flight control, relative navigation and station keeping***

Proposers are encouraged to explore these areas as well as other technologies that could help the program achieve its goals.

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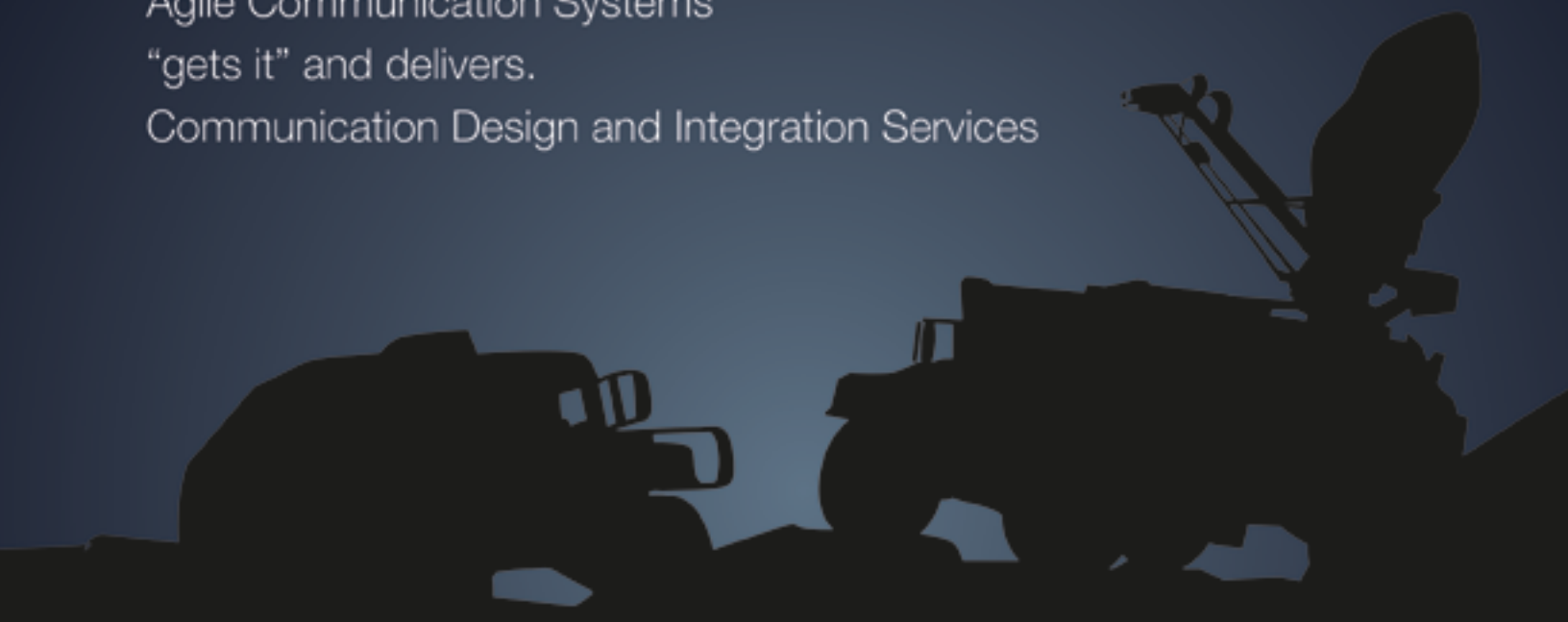

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Predicting The Weather Patterns For The Air National Guard

Staff Sgt. Jennifer Burgos, weather forecast apprentice, explains the effects of Tropical Depression Bill June 18, 2015, during a presentation provided at Ebbing Air National Guard Base, Fort Smith, Arkansas. Weather forecasters analyze weather conditions, prepare forecasts, issue weather warnings and brief weather information to pilots.

U.S. Air National Guard photo by Senior Airman Cody Martin.

Pilots in the Air National Guard must be aware of a number of different factors when they fly.

However one of the biggest variables to consider is the weather. To combat the unpredictable, the ANG has weather forecasters to keep pilots informed of conditions in real-time helping to play a vital role in ensuring flight plans are as safe as possible.

As part of the mission conversion here, weather forecasters are preparing to switch gears for a new type of pilot and plane—the remotely piloted aircraft.

Weather specialists in the ANG are responsible for predicting weather patterns and preparing forecasts to brief pilots and commanders on weather conditions, which can often make the difference between performing a mission or standing down.

Before the conversion to an RPA and intelligence, surveillance and reconnaissance mission, 188th Wing weather forecasters predicted weather patterns for A-10C Thunderbolt II "Warthog" pilots.

"The good thing with the RPA is you get live feed," said Tech. Sgt. Joseph Williams, weather forecast specialist. "You can use that to your advantage and see storms rolling in, or see what level the clouds are at and adjust your forecast for that."

A unique advantage that the RPA provides is with its live feed. The live feed can be viewed on multiple monitors during flight, providing a distinct accessibility. Pilots of the A-10 can contact forecasters via radio, but it does not provide the efficiency of live feed that can be analyzed during an RPA pilot's flight.

"One of the advantages [sensors] provide is that it gives us more eyes in the sky," said Staff Sgt. Jennifer Burgos, weather forecast apprentice.

Weather specialists have to be cautious of the affect weather can have on RPAs. Sand and dust storms, clouds above freezing level and other types of weather can impact the visual sensors. Overseas, weather forecasters pool satellite data to deter negative impacts to the mission due to weather.

"Satellite may be one of our only tools overseas, but it's an amazing tool to have," Williams expressed. "You can see what's going on in the atmosphere through all of our satellites, which helps exponentially when it comes to mission planning and sharing information."

Face-to-face communication is a huge advantage to the ISR field that the 188th Wing will be providing, and weather specialists will benefit just as much from this opportunity.

Members of the 188th ISR Group will be housed in one building to enhance efficiency and accelerate the speed of information to the RPA pilots.

Weather forecasters at the 188th get the unique chance to obtain information on the weather the pilot is flying in and either walk over or speak through the radio to get that critical information to them.

"It is a lot easier to get pilots' information because everybody knows that weather changes rapidly in any location, here or overseas," Williams stated. "If you have a pilot who's flying a mission thousands of miles away and you can walk over or get on your radio and talk to the pilot about what you just saw, it is a huge benefit and can save assets."

The mission of weather specialists within the 188th and the Air National Guard is essential to pilots and their aircraft in completing key mission objectives. Their success shows that the ANG is an inseparable part of the total force and a proven choice for the warfight.

Ebbing Air National Guard Base, Fort Smith, Arkansas—Story by Senior Airman Cody Martin, 188th Wing, U.S.A.F.

MUOS SATCOM Testing In Antarctica By the Air Force Research Laboratory

Members of an Air Force, Navy and Lockheed Martin team test a satellite communications system in Antarctica. Photo courtesy of AFRL.

Instant and easy connectivity for mobile devices is often taken for granted, but modern cellular networks are tied to cell towers. How do you make a call when cell towers are not available?

To answer this question, teams from the Air Force Research Laboratory's Information Directorate, the United States Navy and Lockheed Martin came together to design, build and test the Mobile User Objective System (MUOS), a satellite communications system designed to be a large cell tower in the sky which would improve and provide more communications capability for U.S. forces on the ground.

The basic design works like a typical cellphone system, except that the tower is not on the ground but instead is on a geosynchronous satellite 22,000 miles above the Earth. There are four satellites to give global coverage. The original design of the 3G signal was modified so that it could connect to the satellite. The satellite beams the call signal down to a control station on the ground to connect to the network and complete the call.

User's need a MUOS "phone" to use the system. At this time, the "phone" looks like a typical tactical radio, but new MOUS radios will get smaller as the system matures.

One of the tests for the system took place in Antarctica. Members of the team were able to catch a ride with the 62nd Airlift Wing which was responsible for Operation Deep Freeze, the annual resupply mission of the National Science Foundation (NSF), McMurdo and Amundsen-Scott Stations in Antarctica. Within 20 minutes of arriving in Antarctica the team was able to send out the first ever voice and data communications from the Continent.

During the trip they were able to gather data that would be used to improve MUOS as it matures to full operation capability.

Michael Gudaitis, AFRL team lead said that tests demonstrated 3G- cellular quality voice, text, and data calls in a place where no cellphones exist. "Think about how you feel when you don't have cellphone coverage, especially when you need it most," said Gudaitis. "In Antarctica, with the MUOS system, we were able to demonstrate calls from places where no other radio or cellphone would work."

DISPATCHES

Military Sealift Command + Ulchi Freedom Guardian 2015

On the southern coast of the Korean peninsula, four Sailors with Expeditionary Port Unit 114 from San Diego were tracking ships entering this area, the second largest port in the Republic of Korea (ROK).

These Sailors were staged in a small, modified shipping container that was equipped with various types of critical communication equipment. The container, called a Mobile Sealift Operations Center (MSOC), was a prepositioned asset from Busan and reserved for quick deployment during contingencies or exercises such as this one, Ulchi Freedom Guardian (UFG) 2015.

Set near the edge of the pier, next to the starboard side of the USNS Washington Chambers (T-AKE 11), a dry cargo and ammunition vessel that was here undergoing a scheduled voyage repair, one of the MSOC's role during a contingency or operation is to direct and assist supporting ships.

"During an operation, this post could be overwhelmed with ships coming in with its cargo and some of the local ports are not equipped to handle our ships," said Navy Lt. Cmdr. Phillip R. Casalegno, a reserve-component Sailor and executive officer of EPU 114, which is part of Military Sealift Command (MSC) Pacific. "Essentially, we become the military liaison for the local port authority."

Port operation here is just one aspect of MSC Far East's participation in UFG. More than 30 MSC personnel located in Korea, Singapore and Japan participated Aug. 17-28 in UFG 2015, a major computer-simulated exercise involving more than 30,000 U.S. service members.

The exercise, one of two annually scheduled between the U.S. and ROK forces, tested the ability to respond to a contingency on the Korean peninsula. Australia, Canada, Columbia, Denmark, France, and the United Kingdom also participated this year.

Despite the small exercise footprint of MSC Far East, the scope of the UFG training was both diverse and complex, managing hundreds of simulated U.S. government and

Petty Officer 1st Class Joseph M. Anderson, a hospital corpsman with Expeditionary Port Unit (EPU) 115, holds a satellite dish steady while Petty Officer 1st Class Michael S. Napoleon, a boatswain's mate with EPU 115, disassembles the dish on the Mobile Sealift Operations Center (MSOC) here during Exercise Ulchi Freedom Guardian (UFG) 2015.

U.S. Navy photo by Grady T. Fontana.

commercially contracted dry cargo ships and fuel tankers to and from the Korean area of operations. Scenarios included adverse weather, unscheduled maintenance, fueling of vessels, bunkering and working with host nation port authorities.

The EPU had 17 billets to operate the MSOC and assist with port operations, but for this exercise they only deployed four here and a second EPU at Yokohama, Japan.

"Our unit had already addressed several other requirements this year, including training a large group for [Exercise] Key Resolve at Chinhea [ROK] in March, so I was mainly taking the new personnel," said Casalegno. "That made the training even more valuable since two of the three had never seen the inside of an MSOC. They were trained and ready for operations by the end of the exercise."

In Pier 8 at Busan, eight Navy personnel from MSC Far East Reserve Unit 102 augmented permanent MSC Office Korea staff. They manned a 24/7 crisis action team, and the Combined Seaport Command Center, a centralized command and control center that can manage cargo ships at ports throughout South Korea. Here, MSCFE Sailors worked closely with the Army's Surface Deployment and Distribution Command (SDDC), and ROK army and navy personnel.

While the bulk of the exercise activities took place in South Korea, MSC Far East headquarters in Singapore played a key role. Nine reserve-component Sailors from St. Louis-based MSC Far East Reserve Unit 101 and Sealift Support Unit 102 augmented permanent command staff in manning an around-the-clock command and control center, working with counterparts from the staff of Commander, Task Force 73. During UFG, they monitored and directed all simulated MSC shipping traffic throughout the western Pacific.

"We supported any sealift and combat logistics requirements for the exercise," said U.S. Navy Cmdr. Christopher Cassano, a reserve-component Sailor and operations officer for MSC Far East RU 101. "We also supported any request-for-information of MSC assets and any other exercise roles such as one for a noncombatant evacuation operation."

In Yokohama, six reserve-component Sailors from MSC Far East RU 101 and four from Syracuse, New York-based EPU 104 joined counterparts from SDDC in manning the Japan Seaport Coordination Center (JSCC). During exercises and contingency operations, the JSCC serves as the single point of contact for sealift activities and cargo destined for Japan.

The Sailors from EPU 104, a highly mobile unit that can deploy quickly and establish port operations even under the most adverse conditions, also visited the Japanese ports at the Yokohama North Dock; Hakozaki Fuel Terminal at Fleet Activities, Yokosuka; and Kure/Hiro Ammo Pier, near Hiroshima to assess the capabilities of those ports and to conduct Port Risk Assessment Surveys.

"Our time here in Japan provided excellent training opportunities for the members of both units," said U. S. Navy Lt. Cmdr. Paul Unverzagt, a reserve-component Sailor and executive officer of EPU 104.

Story by Grady Fontana, Military Sealift Command, Far East

DISPATCHES

Patented NASA Technologies To Be Offered To Entrepreneurs

NASA is unveiling a new opportunity for start-up companies to license patented NASA technology with no up-front payment—the Startup NASA initiative addresses two common problems start-ups face: raising capital and securing intellectual property rights.

Aimed at encouraging the growth of high-tech businesses and advancing American innovation, NASA's Technology Transfer Program within the Office of the Chief Technologist designed this initiative to allow start-up companies to choose from a diverse portfolio of more than 1,200 patented NASA technologies that range from materials and coatings to sensors, aeronautics technologies, instrumentation and more.

Finding the technologies available for license is but a click away—NASA has created a streamlined, online patent portfolio that covers 15 categories and packed with patents protected by the U.S. government. Once a desired technology is identified, an online application can be filled out and submitted through the website.

Although the license itself is free, the start-up companies must adhere to the following guidelines: This offer is open only to companies formed with the express intent of commercializing the licensed NASA technology.

- *"No up-front payment" means NASA waives the initial licensing fees, and there are no minimum fees for the first three years.*
- *Once the company starts selling a product, NASA will collect a standard net royalty fee. This money goes first to the inventor and then to maintaining the agency's technology transfer activities and technology advancement.*
- *This announcement applies only to non-exclusive licenses, which means other companies may apply for similar rights to use the technology for commercial purposes. However, NASA will consider further exclusivity if the start-up wishes to negotiate.*
- *Companies entering into these licenses are bound by all requirements in federal licensing statutes and NASA policies, including development of a commercialization plan and reporting on efforts to achieve practical application.*

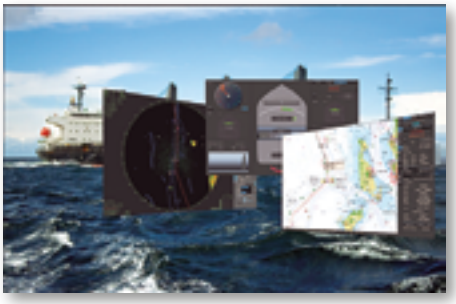
DISPATCHES

Something Fishy In Indonesia? Transas ECDIS To Monitor Marine Resources

Transas' ECDIS has been selected for installation on board 20 Surveillance vessels under operation of the Directorate General of Marine Resources and Fisheries Surveillance, Ministry of Marine Affairs and Fisheries (PSDKP – KKP), Republic of Indonesia.

During the contract signing ceremony, the Director General of Marine Resources and Fisheries Surveillance Mr. Asep Burhanudin stated, "Fitting the surveillance vessels with ECDIS will help us to better monitor the Indonesian waters and support prevention of illegal fishing which is one of key issues for the Ministry of Marine Affairs and Fisheries."

The systems will be supplied and installed in cooperation with the Transas long-term local partner PT MultiIntegra.



"Transas ECDIS will be integrated with main sensors such as GPS, Gyro, Speed Log, Wind Sensor and also AIS Transponder that can be operated in silence mode," said Director of Surveillance Vessel, Directorate General of Marine Resources and Fisheries Surveillance Ir. Budi Halomoan, M.Sci.

Aloys Sutarto, CEO of the PT MultiIntegra added, "PT MultiIntegra and Transas have been working together in the Indonesian market for many years. And the new contract is a sign of our frutiful cooperation in delivering high-class solutions to the shipping industry."

Transas ECDIS has been supplied to numerous customers in Indonesia, including DISHIDROS- the Indonesian Navy, PELNI, PERTAMINA, BASARNAS, private shipping companies such as Gemilang Bina Lintas Tirta (GBLT), Samudera Indonesia, and many more, with local support and after sales service provided by the PT MultiIntegra.

Supporting ULA's Morelos-3 Launch Is The U.S.A.F.'s 45th Space Wing

The U.S. Air Force's 45th Space Wing supported the United Launch Alliance's 100th launch, an Atlas V 421 flying the Morelos-3 communications satellite for Mexico's Secretariat of Communications and Transportation on October 2 from Launch Complex 41 at Cape Canaveral AFS.

Lockheed Martin's Commercial Launch Services provided the Atlas V rocket that carried the Morelos-3 to its destination in space.

ULA launches the Morelos-3 satellite aboard an Atlas V launch vehicle. Photo is courtesy of ULA.

The satellite is a part of the Mexsat constellation of satellites that delivers advanced telecommunications throughout Mexico, providing secure communications for Mexico's national security needs in addition to providing communications to rural zones, as a complement to other existing networks.

Eastern Range instrumentation provides radar tracking, telemetry, communications, command/control sites, camera and optical sites, and other support capabilities such as meteorology.

Instrumentation is necessary to safely and successfully conduct civil, commercial, and national security spacelift operations and ballistic missile tests and evaluation.

Eastern Range assets are based on dependable designs and technology and are arrayed in a highly efficient architecture designed to ensure safety of the launch environment and the public at large.

"Our capabilities in space have always been, and will continue to be, leveraged through partnerships with industry," said Brig. Gen. Wayne Monteith, 45th Space Wing commander. "I am very proud of our team and their support of ULA's historic record number of launches since 2006. We are the Nation's premier gateway to space and we stand ready to support."

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MORELOS-3 LAUNCH ES MUY BUENO—SECURE COMMS WILL RESULT FOR MEXICO'S NAT'L SECURITY NEEDS

The launch of the Morelos-3 satellite for Mexico. Photo is courtesy of United Launch Alliance.

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On October 2, Lockheed Martin Commercial Launch Services and United Launch Alliance (ULSA) launched an Atlas V rocket that carried the Morelos-3 satellite to orbit for Mexico's Ministry of Communications and Transportation (Secretaría de Comunicaciones y Transportes de México).

The completed Morelos-3 satellite. Photo courtesy of Boeing.

Photo of Morelos-3 in nosecone is courtesy of United Launch Services.

The mission, procured for Mexico by Lockheed Martin Commercial Launch Services, launched at 6:28 a.m. EDT from Space Launch Complex-41 and was the 100th successful mission for United Launch Alliance.

"Congratulations to Lockheed Martin Commercial Launch Services and Mexico's Ministry of Communications and Transportation on today's successful delivery of the Morelos-3 satellite into orbit, providing advanced telecommunications throughout Mexico." said Jim Sponnick, ULA vice president, Atlas and Delta Programs. "Today was an especially proud day for our team as we launched our 100th, successful, one-at-a-time mission since the formation of ULA in 2006. Congratulations to the entire team, including our many mission partners on this unprecedented achievement."

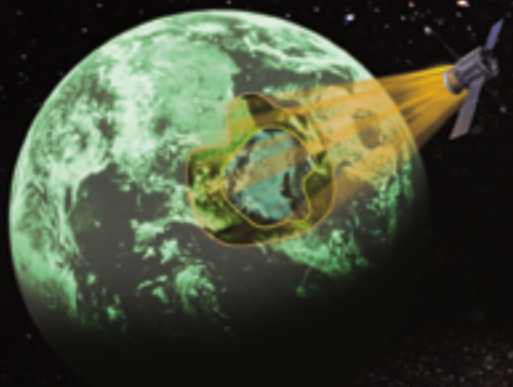
The Morelos-3 launch was accelerated to an earlier position on the Atlas launch manifest, thanks to an agreement with the United States Air Force. The agreement allowed the MEXSAT customer to launch atop an Atlas V rocket using a launch slot that was previously manifested for a Global Positioning System satellite.

This change demonstrates ULA's ability to meet the needs of commercial customers and the U.S. Air Force's willingness to accommodate the real-time and crucial needs of other satellite programs.

This mission was launched aboard an Atlas V 421 configuration vehicle, which includes a 4 meter diameter payload fairing and two Aerojet Rocketdyne solid rocket motors attached to the Atlas booster.

The Atlas booster for this mission was powered by the RD AMROSS RD-180 engine and the Centaur upper stage was powered by the Aerojet Rocketdyne RL10C-1 engine. This was the 57th Atlas V launch since the vehicle's inaugural mission in 2002 and the fifth in the 421 configuration.

Boeing is responsible for the design, development and delivery of this integrated system, which is comprised of a fixed service satellite and two Boeing geomobile satellites, two ground stations in Mexico for network and satellite control, and prototype user terminals. The first Boeing-built satellite for the MEXSAT system launched in May 2015, but was lost due to a launch vehicle failure.



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Colonel Atogeba Alobawone, Director, Directorate of Defence Communication and Information Systems, **Ghana Armed Forces**

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A 8.30-12.00 **Global Government Payload Exploration**
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C 12.30-17.00 **Perspectives On Ground Systems**
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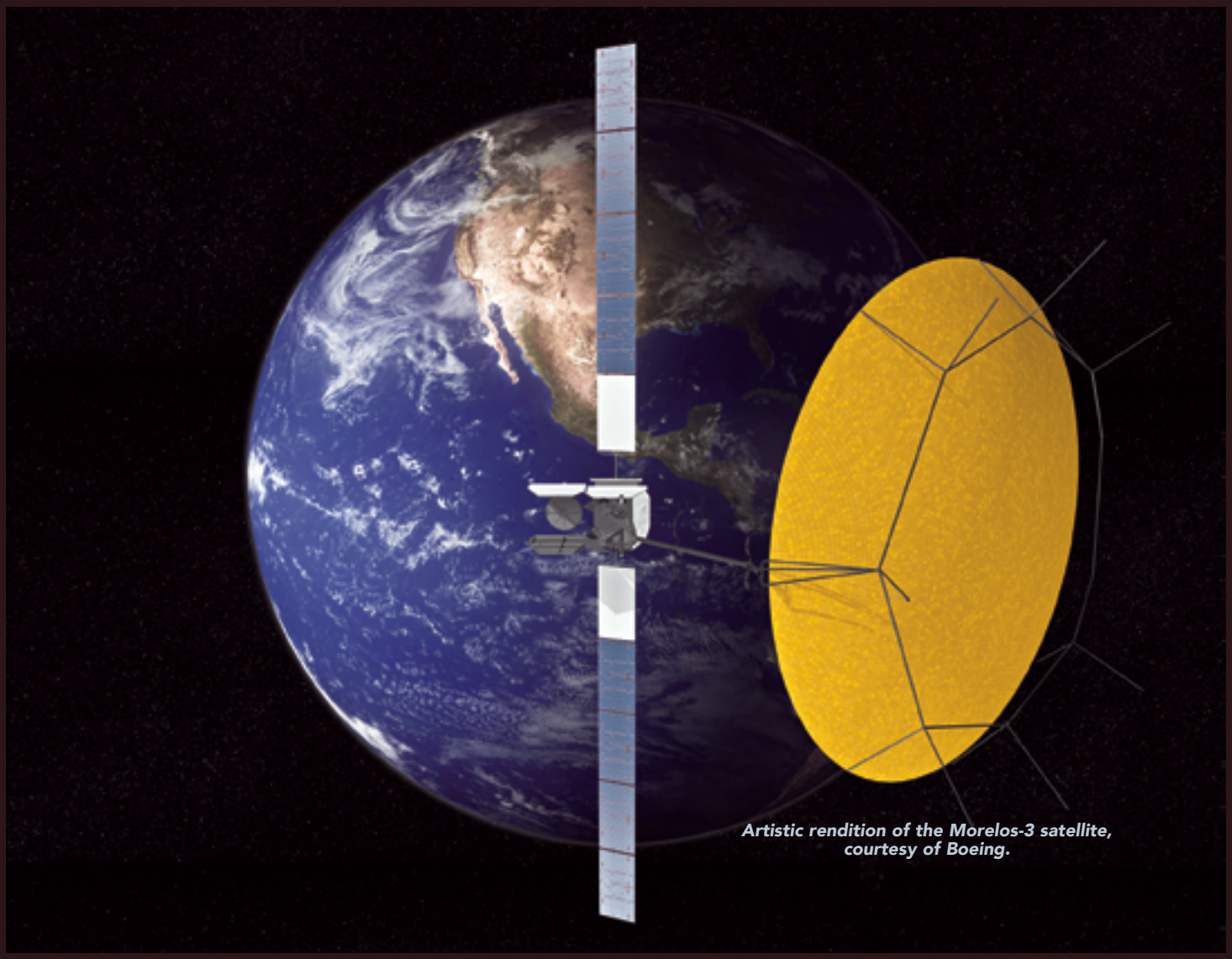

Artistic rendition of the Morelos-3 satellite, courtesy of Boeing.

"This latest milestone represents Boeing's fourth generation of satellites for Mexico and underscores how our satellites' capabilities improve daily and emergency communications," said Mark Spiwak, president, Boeing Satellite Systems International.

Morelos-3 is part of the MEXSAT constellation of satellites, which provide secure communications for Mexico's national security needs and communications to rural zones to complement other, existing networks.

The MEXSAT program is an end-to-end satellite communications system that provides 3G+ communications services to mobile terminals across multiple platforms. These services include education and health programs, voice, data, video and the Internet. After being on orbit for 10 months and following antennas extensions as well as completing required trial runs, the satellite will start normal operations.

With more than a century of combined heritage, United Launch Alliance is the nation's most experienced and reliable launch service provider. ULA has successfully delivered 100 satellites to orbit that provide critical capabilities for troops in the field, aid meteorologists in tracking severe weather, enable personal device-based GPS navigation and unlock the mysteries of our solar system.

The Morelos-3 was delivered to a geo-synchronous transfer orbit and is the second of two communications satellites that comprise the MEXSAT communications satellite system. Mexsat is a constellation of satellites owned by Mexico's Secretaría de Comunicaciones y Transportes (Ministry of Communications and Transportation) and operated by Telecomunicaciones de México (Telecommunications of Mexico) that delivers advanced telecommunications throughout Mexico.

Morelos-3 is a 702HP geomobile satellite built by The Boeing Company. The 702HP satellite will supply 14 kilowatts of power through five panel solar array wings that use high-efficiency, ultra triple-junction, gallium arsenide solar cells. The satellite will also carry a 22 meter L-band reflector that enables connectivity to handheld terminals, complemented by a 2 meter Ku-band antenna. The life expectancy for Morelos-3 is 15 years.

Lockheed Martin Commercial Launch Services, is a wholly owned subsidiary of the Lockheed Martin Corporation and markets the Atlas V to commercial satellite customers worldwide. The company also offers Athena launch services for small satellites and multi-payload RideShare missions. The company is responsible for contracts, marketing, sales and mission management for commercial and international government Atlas V missions and all Athena missions.

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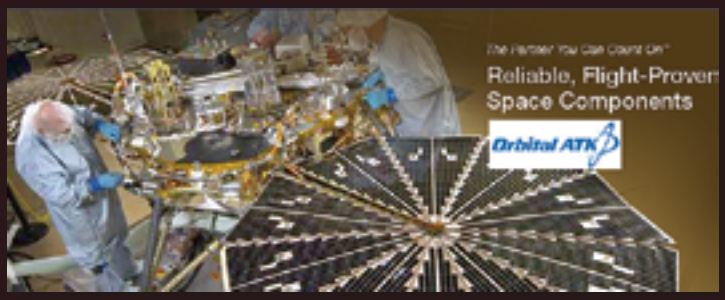

Orbital ATK, Inc. provided critical launch vehicle and satellite payload hardware for the Lockheed Martin Commercial Launch Services launch of Mexico's Morelos-3 satellite aboard an Atlas V.

Morelos-3 is the second satellite within the MEXSAT communications satellite system. MEXSAT is a constellation of satellites owned by Secretaría de Comunicaciones y Transportes, a government agency of Mexico, and operated by Telecomunicaciones de México, which delivers advanced mobile and fixed satellite telecommunications throughout Mexico.

Orbital ATK's contributions to the Atlas V and Morelos-3 satellite include cutting-edge technologies from across the company. Contributions include a large composite faring, retro motors and propellant tanks for the rocket, and thermal and structural components on the satellite.

For the Atlas V rocket, Orbital ATK produced the 10-foot diameter composite heat shield, which provides higher performance with lower weight, and essential protection for the first stage of the launch vehicle from engine exhaust temperatures in excess of 4,000 degrees Fahrenheit. The assembly was fabricated using advanced fiber placement manufacturing techniques at Orbital ATK's Iuka, Mississippi facility. This is the 57th Atlas V launch using Orbital ATK-built composite structures.

This launch also marked the 22nd successful flight of Orbital ATK produced retro motors. Eight of these solid motors supported separation of the spent first stage. The Atlas V retrorocket is built at Orbital ATK's Missile Defense and Controls facility in Elkton, Maryland.

For the Morelos-3 satellite, Orbital ATK provided the structures for the booms and the 22-meter payload antenna that make up the precision stable backing structure for the Harris deployable antenna. Orbital ATK's Space Components Division facility in Magna, Utah, manufactured these components for the spacecraft.

The division also supplied propellant tanks for the Atlas V rocket. Orbital ATK has provided similar structural components for the spacecraft industry for more than 35 years from sites in California and Utah. The Orbital ATK Beltsville, Maryland, facility manufactured the Loop Heat Pipes and payload heat pipes which are an integral part of the satellite's thermal control system. Orbital ATK has delivered more than 50,000 heat pipes to the space industry with perfect, on-orbit mission success.

"With every launch I am reminded that the products we build are extremely important to our customers," said Scott Lehr, President of Orbital ATK's Flight Systems Group. "We are pleased to be a part of this important mission to help increase the telecommunications capability of the Government of Mexico."

FULL LAUNCH SUPPORT FROM THE U.S.A.F.'S 45TH SPACE WING

The U.S. Air Force's 45th Space Wing supported the United Launch Alliance's 100th launch of an Atlas V 421 flying the Morelos-3 communications satellite for Mexico's Secretariat of Communications and Transportation on October 2 from Launch Complex 41 at Cape Canaveral at 6:28 a.m. EDT.

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NRO HEADS TO ORBIT WITH LAUNCH OF NROL-55 BY ULA WITH 13 CUBESAT PASSENGERS

A United Launch Alliance (ULA) Atlas V rocket carrying a classified payload for the National Reconnaissance Office (NRO) and 13 CubeSats lifted off from Space Launch Complex-3 October 8 at 5:49 a.m. PDT.

Designated **NROL-55**, the mission is in support of national defense. This is ULA's 10th launch in 2015 and the 101st successful launch since the company was formed in December 2006.

The Atlas V rocket also delivered 13 Government Rideshare Advanced Concepts Experiment (GRACE) CubeSats to orbit. The nine NRO-sponsored CubeSats and four NASA-sponsored CubeSats were mounted to the Aft-Bulkhead Carrier, which is located on the back end of the Centaur upper stage.

The 13 CubeSats were developed by..

- *Aerospace Corporation*
- *U.S. Army's Space and Missile Defense Center*
- *Tyvak*
- *SRI International*
- *University of Alaska-Fairbanks*
- *Salish Kootenai College*
- *AMSAT*
- *Jet Propulsion Laboratory.*

Weighing 1-5 kilograms, these smallsats were developed, launched and controlled at a fraction of the cost of a typical, operating satellite.

The NRO payload and GRACE CubeSats were launched aboard an Atlas V Evolved Expendable Launch Vehicle (EELV) 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, powered by an Aerojet Rocketdyne RL10C-1 engine.

The NRO satellite is believed to be a KH-11 (Kennan) reconnaissance satellite. This platform conducts electro-optical reconnaissance of Earth from a Sun-Synchronous, near polar, LEO.

ULA's next launch is the Atlas V Global Positioning System (GPS) IIF-11 satellite for the U.S. Air Force, scheduled for October 30 from Space Launch Complex-41 from Cape Canaveral Air Force Station, Florida.

The EELV program was established by the U.S. Air Force to provide assured access to space for Department of Defense and other government payloads. The commercially developed EELV program supports the full range of government mission requirements, while delivering on schedule and providing significant cost savings over the heritage launch systems. The next NRO launch is on schedule for early 2016, also from Vandenberg.

A United Launch Alliance Atlas V rocket carrying a National Reconnaissance Office payload launches from Vandenberg AFB on October 8, 2015. The rocket launched at 5:49 a.m. PDT from Space Launch Complex-3 by Team Vandenberg.

U.S. Air Force courtesy photo is by Senior Airman Kyla Gifford.

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Orbital ATK, Inc. supported this ULA Atlas V successful launch from Vandenberg Air Force Base in California. Using advanced fiber placement manufacturing and automated inspection techniques, Orbital ATK produced the 10-foot diameter composite heat shield on the ULA Atlas V rocket, which provides essential protection for the first stage of the launch vehicle from engine exhaust temperatures in excess of 4,000 degrees Fahrenheit. The large composite structure was fabricated at Orbital ATK's Iuka, Mississippi, facility. This is the 58th Atlas V launch using Orbital ATK-built composite structures.

This flight marked the 23nd successful flight of the Orbital ATK retro motors. Eight of these solid motors provided thrust for separation of the spent first stage. The ULA Atlas V retrorocket is built at Orbital ATK's Elkton, Maryland, facility.

"Congratulations on today's successful launch of NROL-55! ULA is honored to have collaborated with the NRO Office of Space Launch and the Air Force on the integration and launch of the NROL-55 spacecraft to orbit with our Atlas V vehicle," said Jim Sponnick, ULA vice president, Atlas and Delta Programs. "Launches like this only happen with exceptional teamwork by an extremely talented team and a one-launch-at-a-time focus on mission success. The GRACE CubeSats will perform missions demonstrating tracking technologies, software-defined radio communications and will also conduct other measurements and experiments. We are happy that ULA could play a part in bringing these nano-satellites to orbit along with the NRO payload through a cost-effective rideshare."

Colonel Clint Hunt, USAF, Director, NRO Office of Space Launch, said, "I commend everyone who made this launch successful. This launch adds another powerful mechanism to the nation's security toolkit. It also demonstrates the efficiencies of CubeSat rideshare on an NRO mission. This mission is a great example of how NRO, NASA, the Air Force, and our academic colleagues collaborate to amplify innovative technology to support the nation."

"Orbital ATK-produced structures and components on the ULA Atlas V launch vehicle contributed to another successful launch today," said Scott Lehr, President of Orbital ATK's Flight Systems Group. "Our products play a vital role in delivering on mission commitments critical to national security."

Kimberly Locke of **Aerospace Corporation** detailed the specifics of the company's payload aboard the NROL-55 mission.

Geoffrey Maul, left, and Jacqueline Tardif work on one of the AeroCube-7 triplets.

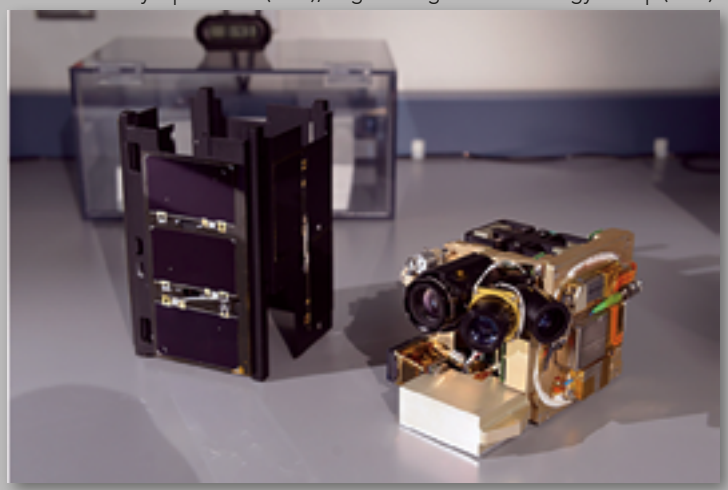
Photo is courtesy of Aerospace Corporation — Eric Hamburg

Riding on the coattails of its older siblings, AeroCubes 1 through 6, the first in the AeroCube-7 (AC-7) trilogy is aboard the Atlas V launch vehicle, which successfully launched from Vandenberg Air Force Base, California, on October 8—the remaining two CubeSats in this series are scheduled for launch in the spring of 2016.

The AeroCube-7 trilogy, supported by the Space Technology Mission Directorate (STMD) at NASA headquarters in Washington, D.C., is designed to demonstrate two different capabilities—high-speed optical transmission of data, and small spacecraft proximity operations. NASA calls the overall mission the Optical Communications and Sensor Demonstration (OCSD) mission.

The first AC-7 flight is a pathfinder that will demonstrate most of the subsystems required for both OCSD missions and will be used to evaluate the performance of the attitude-control system. The pathfinder is also expected to demonstrate optical downlinking at speeds up to 100 megabits per second to a ground-based, 30-cm telescope, using an advanced attitude-control system and a moderate-power, tightly-focused laser beam.

"Much of the pathfinder's mission is to see how fast we can communicate to Earth from a CubeSat in low-Earth orbit," said Dr. Richard Welle, Microsatellite Systems Department, Space Materials Laboratory, Technology and Laboratory Operations (TLO), Engineering and Technology Group (ETG).



One of the AeroCube-7 triplets: The body is on the left, and the internal components are on the right.

Photo is courtesy of Aerospace Corporation—Eric Hamburg.

The second phase of the mission will address the need for low-cost sensors that small spacecraft can use to help them maneuver and operate safely while in close proximity to other spacecraft or objects in space. This will enable multiple small spacecraft to operate cooperatively during science or exploration missions, to approach another spacecraft or object for in-space observation or servicing, or to connect small spacecraft together to form larger systems or networks in space.

According to NASA, the Block II AC-7 satellites will be modified and upgraded as necessary to incorporate any lessons learned from the pathfinder mission and the laser communication system will be tuned to higher data rates provided they can be supported by the attitude-control system. Additionally, the Block-II satellites, flying together, will perform the proximity operations demonstration.

The mission is funded through NASA's Small Spacecraft Technology Program (SSTP) within STMD. SSTP was created, according to NASA, specifically to develop and demonstrate new technologies and capabilities for small spacecraft.

These smallsats, commonly referred to as CubeSats, are power challenged due to their small size. They can collect and store a relatively small amount of energy, an essential ingredient for performing many operations in space. This power challenge makes it difficult to meet the large power requirements that are typical of high-bandwidth data transmission systems.

Laser communication offers the potential for high-bandwidth communications at power levels well below comparable radio-frequency systems.

"These AeroCubes represent a continuing commitment to determining what can and cannot be done in such a small package," said Welle.

A CubeSat is a 10-centimeter (about 4 inches) on a side, cube-shaped satellite that conforms to the CubeSat Standard developed by the California Polytechnic State University (CalPoly) at San Luis Obispo. These small satellites are most often ejected into space from a Poly-Picosatellite Orbital Deployer (P-POD). The P-POD is the most widely used interface between CubeSats and launch vehicles, and its design is responsible for the iconic cubic shape.

The common thread or tether, pardon the space pun, is that of technology testing and development. "These small satellites give us and others in the satellite business the opportunity to test power, attitude control, and communications features," said Welle.

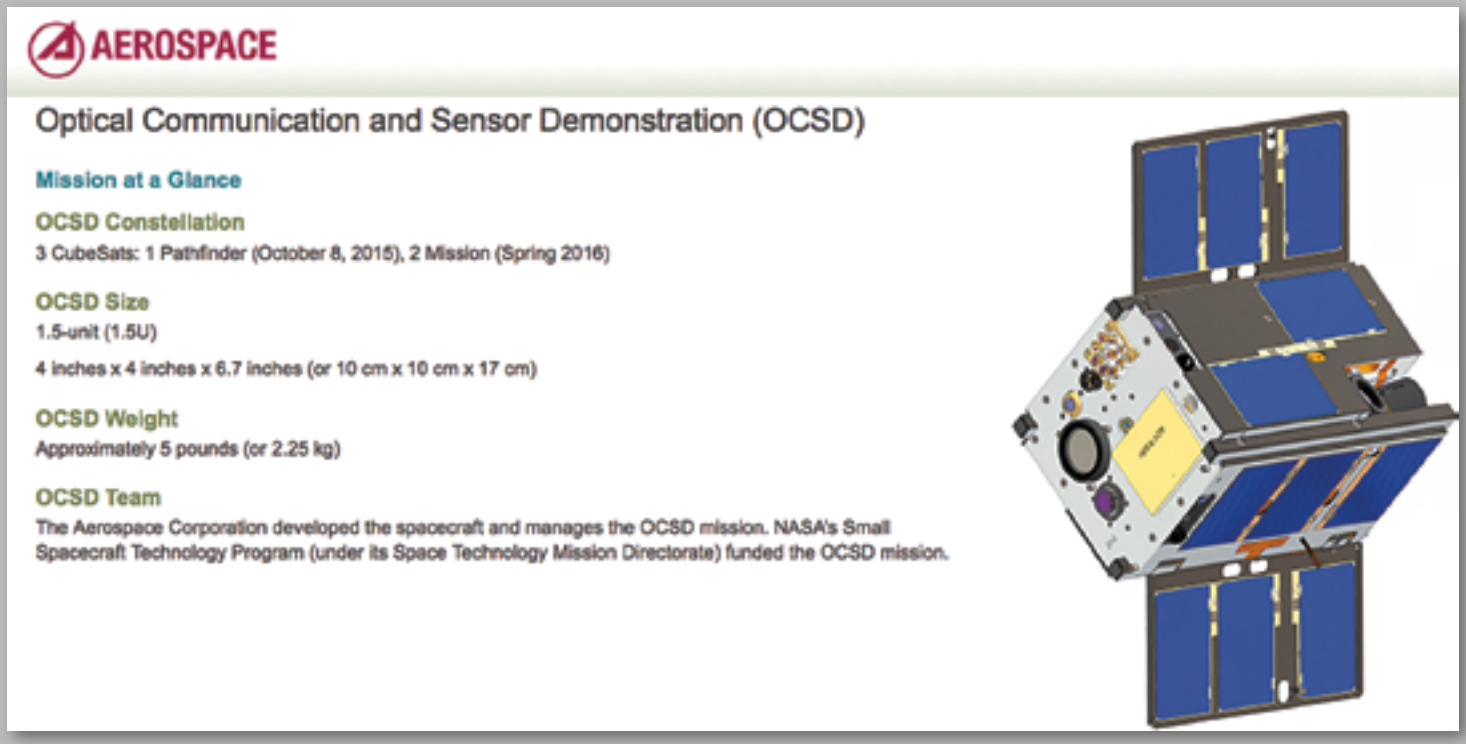
The small size and comparative simplicity of CubeSats encourages rapid development and testing, with a development cycle measured in months instead of the years typical of larger satellites. The entire satellite mechanical design can be incorporated in a single SOLIDWORKS model, which simplifies the design process while making it easier for the design team to identify any potential issues.

Geoffrey Maul, CAD design specialist in the Microsatellite Systems Department, has been the principal designer of several AeroCubes, and brought this experience to the AC-7 design.

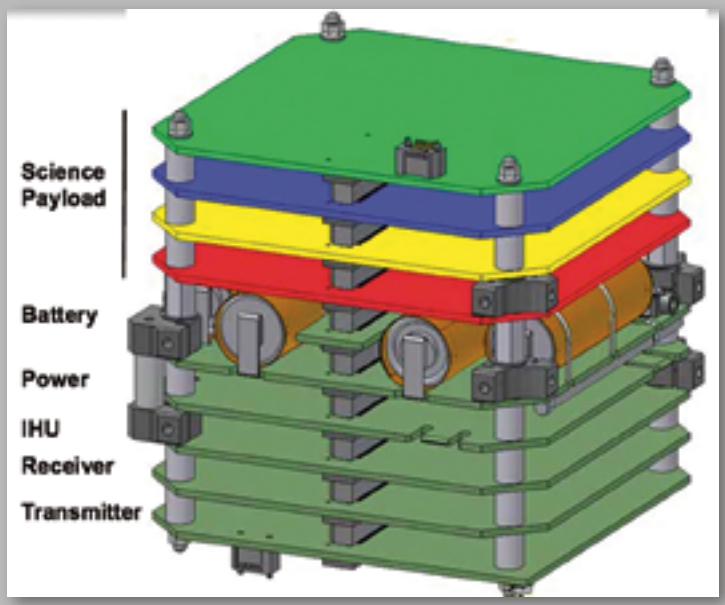
"Flexibility is probably the biggest challenge when designing a CubeSat," said Maul. "When we start a CubeSat design, we have to pick a starting point and, sometimes, that means making certain assumptions that prove to be wrong. My job is to make sure the physical design can adapt to whatever changes are required when those assumptions change."

The challenge of flexibility is also a feature that allows CubeSat technology to evolve as fast as it has, ultimately leading to the very-high capacity communication system that will fly on AC-7, Welle added.

One of the passengers was the Fox1A CubeSat from **The Radio Amateur Satellite Corporation (AMSAT)**. *Barry Baines* offers the following information regarding this CubeSat in the organization's *APOGEE VIEW* publication.



Fox-1A is part of the ELaNa-XII group of satellites. There is a significant sense of pride in completing a spacecraft that will be used by amateurs, students, and scientists who will benefit from amateur radio capabilities on board the CubeSat, educational opportunities that our spacecraft can provide to the classroom, and the scientific data that will be available from payloads on board provided by university students and faculty.



Fox-1 Stack: 400 mW TX downlink on 2M, 70 cm RX, IHU with 32-bit processor, 128K program memory, 16K RAM, 128K MRAM to store telemetry and experiment data.

Diagram courtesy of AMSAT.

The Fox-1 mission is an education mission that will host a two-way FM communications transponder and an experiment payload allowing students to relay messages from Earth to space and back to other students somewhere on the planet requiring only a simple walkie-talkie style radio, combined with a small, hand-held antenna.

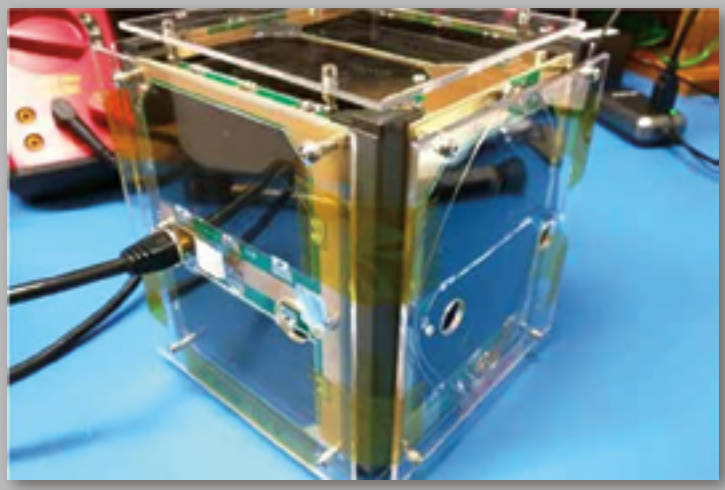
The P-POD containing Fox-1A and co-passengers are mated with the Centaur upper stage of the Atlas V in preparation for the Ocrober 8 launch from Vandenberg Air Force Base.

Fox-1 satellites include two telemetry formats:

- *Slow Speed, also called Data Under Voice (DUV) is 200 bps FSK data sent at the same time as the transponder audio. Whenever the transmitter is on, data is being sent. This happens during beacons and during live QSOs.*
- *High Speed is 9600 bps FSK sent instead of the transponder. This is used for data intensive experiments such as the Virginia Tech Camera and the University of Iowa HERCI experiment. This is only active when commanded from the ground. Users can recognize High Speed because it sounds like an old school computer modem.*

FoxTelem, an application from AMSAT, will receive and store both formats, assuming you can feed it audio that does not have the frequencies below 200 Hz filtered. For High Speed, the audio must also extend to include the full 9600bps bandwidth of the FM signal. For both modes this is best achieved from a Software Defined Radio or from the 9600 bps packet port of some radios.

The Fox Telemetry Decoder is being released to demodulate, store and analyze telemetry data from AMSAT's Fox series of CubeSats. The organization hopes users will also upload received telemetry data to the AMSAT server so thatinformation can be used by other Amateur Scientists and AMSAT research partners, whose experiments fly with the Fox satellites



Fox-1A sporting her final set of solar panel covers ready for the P-POD.

Photo is courtesy of AMSAT.

Photo credit: AMSAT

AMSAT also provided these Fox-1 Operating Hints...

- *Use a small beam like the Arrow Antennas Yagi or Elk log periodic, clear of obstructions.*
- *Select the 67. 0 Hz PL/CTCSS for transmit AMSAT recommends to use no more than 5 watts with a modest gain antenna*
- *Open your Squelch all the way*
- *Use a combo headphone/boom mike to reduce feedback/echo (and give you a free hand)*
- *Use a printout or your laptop, smartphone or tablet to track the satellite path over your QTH*
- *Apps include Satellite Explorer Pro (iOS) and AmsatDroidFREE (Android)*
- *Have an audio recorder to log the QSO (it is difficult to talk, point the antenna, do PTT operation, remember the callsign, and think - all at the same time)*
- *Set your transmit and receive frequencies in memories to make tuning easier Twist the antenna as the pass progresses to improve signal strength*

For Aerospace's latest information on the OCSD mission, please visit ***http://ocsd.aerospace.org***.

The AMSAT infosite is located at:
http://www.amsat.org/

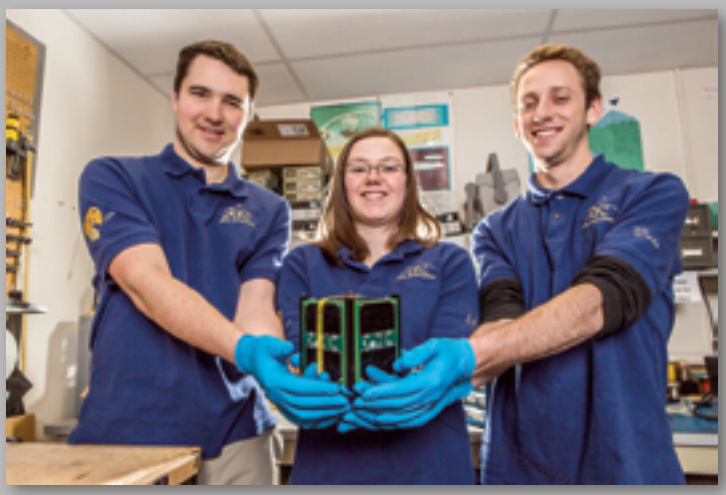
Sue Mitchell, writing for the **University of Alaska—Fairbanks**, offers information regarding the university's CubeSat inclusion in the NROL-55 mission.

A small research satellite designed and built by University of Alaska Fairbanks students was among 13 launched on October 8 from Vandenberg Air Force Base in California.

The tiny satellite, known as a CubeSat, flew on the NASA National Reconnaissance Office's Government Rideshare Advanced Concepts Experiment, or GRACE.

The **Alaska Research CubeSat**, called **ARC-1**, was the culmination of a UAF Alaska Space Grant Program project five years in the making and the result of work by a whole team of students, as well as collaborations between the College of Engineering and Mines and the Geophysical Institute.

UAF engineering students Patrick Wade and Matt Pacheco hand-delivered the tiny satellite, just under 4 inches square, to California Polytechnic State University in San Luis Obispo for incorporation into the rocket payload last March.



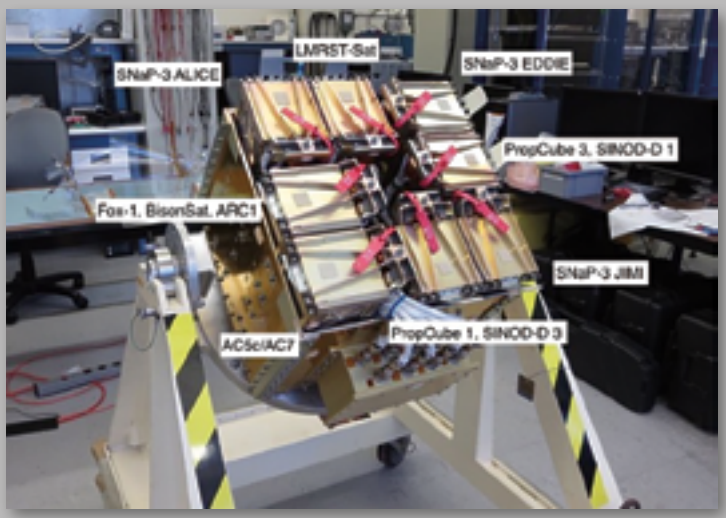
Engineering majors Jesse Frey, left, Morgan Johnson, center, and Patrick Wade hold the "cubesat" they designed and built as part of their work with the Alaska Space Grant program. The CubeSat launched into space on October 8, 2015, from Vandenberg Air Force Base in California.

Photo is courtesy of the University of Fairbanks—Todd Paris.

Work on the project started in 2009 under the tutelage of Denise Thorsen, director of ASGP and faculty advisor to the Space Systems Engineering Program at UAF. NASA developed the CubeSat Launch Initiative as a way to give universities access to space. Because they are so small, multiple cubesats can be packed in a rocket used to deploy a larger satellite.

Similar to NRO's previous cubesat rideshares, GRACE will reach orbit via an ATLAS V rocket, mounted to the aft-bulkhead carrier, located on the aft end of the Centaur upper stage. GRACE will carry a total of 13 cubesats, nine sponsored by the NRO and the four sponsored by NASA's CubeSat Launch Initiative. The CubeSats are ejected into space once the primary payload is safely on its way.

The team had turned down previous possible launch dates because the orbit wouldn't get the satellite to a high enough latitude in order to communicate with it from Fairbanks, Thorsen said. "There's no sense in having a satellite we can't talk to."



The entire package of CubeSats in position in their P-POD at the California Polytechnic Institute in March 2015, assembled in the payload.

This launch will put ARC-1 in an elliptical orbit at a latitude just north of Fairbanks and between about 310 and 500 miles from Earth.

ARC-1 will perform three tasks during its roughly one-year lifespan. An experiment activated at liftoff will collect data about temperature and vibration inside the rocket. The students will also evaluate a novel, low-power attitude control system they developed, and a camera will transmit back images of snow and ice cover. The students will track ARC-1 at the NOAA and NASA Fairbanks Command and Data Acquisition Station at Fox, which hosts a ground station for the students.

Once ejected from the rocket, ARC-1 will begin transmitting a beacon on a ham radio frequency. Any ham radio users around the world who pick up the signal will be asked to send an email message to Thorsen stating when and where they picked up the signal. Thorsen will send each respondent what's called a QSL card—a written acknowledgement and thanks for the information. Once the ARC-1 orbit is accurately characterized and the cubesat is being tracked, the UAF students will instruct the satellite to transmit information on a specific radio frequency.

"The main goal of our CubeSat was to monitor the rocket launch environment on the ride up," Thorsen said. "Our CubeSat will collect that data and store it. Once we have proved out the health of the CubeSat and it tells us how much data it collected, then we will give it the command to start downloading that data."

Information about how well the novel satellite attitude control project is going will be part of the beacon, Thorsen said.

"When ARC-1 is kicked out of the rocket, it's tumbling, we can tell that by the beacon data," Thorsen said. "Over time we hope the tumbling will stop and the satellite will be pointed in a particular direction." All the control and attitude adjustments are preprogrammed into the cubesat.

Thorsen said 36 UAF students have worked on this satellite since the project's inception. Five were graduate students, another five started as undergraduates who became graduate students. Thirty-two of the students who've worked on the project were undergraduate students. Two of the 36 were high school students; one of these is now a freshman at UAF.

Five students attended the launch at Vandenberg Air Force Base: Jesse Frey, Morgan Johnson, Chic O'Dell, Patrick Wade and Matt Pacheco. Thorsen and a graduate student will monitor the launch from Alaska.

The team used facilities within the College of Engineering and Mines and at the Geophysical Institute to make sure the Alaska Research CubeSat met NASA specifications.

What is the Alaska Space Grant Program (ASGP). The program is a consortium of public and private universities and non-profit organizations that sponsors a broad range of programs to enhance teaching, research, and educational outreach within aerospace and earth science, and other NASA related STEM disciplines throughout Alaska.

The Alaska Space Grant Program provides the conduit for education, and the development of a knowledgeable workforce and research infrastructure in support of NASA's mission.

Specifically, the ASGP mission is:

- *To promote Earth and Space Science and technology and other NASA relevant teaching, research, and public service throughout Alaska, with special emphasis on culturally responsive programs to engage native, minority, and non-traditional communities*
- *We are committed to engaging and creating ACCESS for all students and faculty in the state of Alaska to Alaska Space Grant Program's NASA related research and education opportunities (Goal 1). We will accomplish this through (i) the development and strengthening our relationships with Alaska's community colleges and rural campuses; and (ii) the development of distance education and summer opportunities targeted at increasing enrollment in STEM disciplines*
- *We are committed to supporting research and educational opportunities that are RELEVANT to NASA's mission and the states needs (Goal 2). We will accomplish this by providing (i) opportunities for authentic, hands-on student experiences in science and engineering; and (ii) research infrastructure development opportunities that enhance the collaboration between Alaska faculty and NASA scientist and engineers*
- *We are committed to enhancing PERMANENT connections between NASA's mission, and Alaska students, faculty, and citizens (Goal 3). We will accomplish this through supporting (i) opportunities that prepare our students for permanent employment at NASA or other aerospace industries; (ii) NASA related sustainable research infrastructure opportunities; and (iii) opportunities that enable the permanent incorporation of NASA educational materials in the states STEM curriculum*

The director of the Alaska Space Grant Program program is Denise Thorsen, who may be contacted at ***dlthorsen@alaska.edu.***

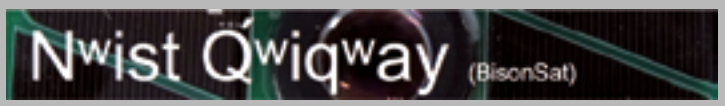
In the summer of 2010, a group of students and faculty at **Salish Kootenai College** began the work of designing a CubeSat.g.

Salish Kootenai College's CubeSat is named N̓ist Q̓iq̓ay in the Salish language and is commonly referred to as BisonSat.

The primary objective of this satellite is educational, with a secondary objective of demonstrating the acquisition of targeted 100-meter or better resolution visible light imagery of the Earth from a CubeSat platform.

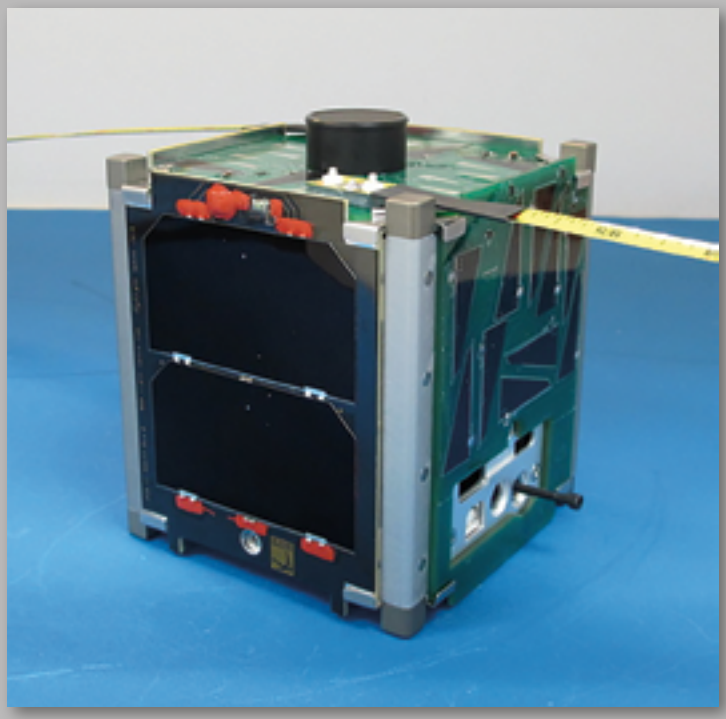
N̓ist Q̓iq̓ay was successfully launched by United Launch Alliance as a passenger payload in the NROL-55 mission.

The data collected by BisonSat will include several high resolution color images of the Flathead Indian Reservation which will be used to help get tribal college students and tribal communities in NASA's mission, BisonSat is the first CubeSat designed, built, tested, and operated by tribal college students.



For a thorough immersion in the smallsat market segment, consider attending the upcoming, two-day and extremely important **SmallSat Symposium**.

This highly informative symposium will be conducted on Tuesday, February 23, and Wednesday, February 24, 2016.



BisonSat photo is courtesy of Salish Kootenai College

The event will occur at the **Hogan Lovells Conference Center** in Menlo Park, California, and is sponsored by *Satnews Publishers* and *Hogan Lovells*.

For further details and to register, please visit
http://www.smallsatshow.com/

PARTNERSHIP FOR CRITICAL COMMS IN AFRICA... THE CAUSE + CALL FOR COMMUNICATIONS FUNDING

By Nicole Robinson, Corporate Vice President of Government Market Solutions, SES

In 2005, the United States established the Trans-Sahara Counterterrorism Partnership (TSCTP) fund in a significant and strategic move to reveal support for the various African nations combating terrorism in the pan-Sahel.

The initial spirit and intent of the program was to enhance the capabilities and effectives of anti-terrorist campaigns in Mauritania, Mali, Chad, Niger, Nigeria, Senegal and Burkina Faso. The TSCTP has been successful in slowly building capacity and cooperation even in the face of adversity; however there is much work that is yet to be done.

In their pursuit to strengthen their democratic institutions as well as their ability to bridge the digital divide, these African nations continue to strive to improve their ability to connect and gain access to technology. Perhaps most importantly, the men and women of these great nations seek to improve their ability to communicate for the purpose of achieving social, economic and security goals. In today's dynamic and dangerous geopolitical environment, access to ubiquitous telecommunications solutions is no longer an optional requirement for a rising free and democratic nation; it's a pre-requisite and essential element of foundational infrastructure.

Communication solutions strongly enhance the U.S. National Security Strategy, the U.S. Strategy toward Sub-Saharan Africa and serve as catalysts for social and economic development for a rising society. As such, attention to securing critical communications infrastructure should be a key focal point for the TSCTP and other relevant funding activities by both the United States as well as other partner nations in the very near term.

The contributions and commitments made by the United States are to be applauded, as are the ongoing pledges to maintain these efforts in the near term. Overseas, an increasing response and expression of support from the European Union holds strong promise for the prospect of enabling these capabilities.

In a recent announcement, President Juncker, the head of the European Commission, revealed a plan to help support countries to counter migration challenges experienced within their population. In the 1.8BEUR fund established by Member-States, countries in the Sahel region and Lake Chad that are likely to receive support include:

- *Burkina Faso*
- *Cameroon*
- *Chad*
- *Gambia*
- *Mali*
- *Mauritania*
- *Niger*
- *Nigeria*
- *Senegal*

The fund would also benefit the Horn of Africa, including..,

- *Djibouti*
- *Eritrea*
- *Ethiopia*
- *Kenya*
- *Somalia*
- *South Sudan*
- *Sudan*
- *Tanzania*
- *Uganda*

Finally, the program would benefit the North of Africa in..

- *Morocco*
- *Algeria*
- *Tunisia*
- *Libya*
- *Egypt*

The fund established by Member-States of the European Union signifies an incredible commitment toward establishing economic programs, education,

health, protecting against terrorism and the trafficking of human beings and smuggling of migrants.

As is the case with the TSCTP, communications capability is a clear thread that runs through the mission requirements of all of the needs established in these programs and serves as an essential means to accomplishing these critical goals.

Within the commercial satellite community, there are no limits to what can be done to aid in these efforts that at the end of the day are saving time, money and lives. To further our effort, sufficient time and resources must be applied to our communications challenges and investing in capabilities that are essential in meeting these needs.

Global satellite operator SES is and remains committed to this cause and encourages the prospective recipients of these programs to further highlight communications as a pivotal component of the capabilities required to bridge the digital divide, manage migration and defeat terrorism for the protection and development of the people of Africa.

Nicole Robinson serves as the Corporate Vice President of Government Market Solutions with global satellite operator, SES. In this position, she is responsible for the development of new products, go-to-market strategies and new business opportunities with global governments and institutions.

Ms. Robinson is currently serving in the elected position of Chair of the Hosted Payload Alliance and was the recipient of a 2012 Future Leaders Award by the Society of Satellite Professionals International.

She has spent 15 years in the Defense industry, with a Bachelor's in Communications, an MBA from Liberty University and is a graduate of the Senior Executives in National and International Security Program at Harvard University, Kennedy School of Government.

Mr. Ibrahima Guimba-Saidou has over 20 years of professional experience in the telecommunications industries worldwide. His expertise is in strategy, operations planning and management, market sizing, product marketing, business planning, Sales and Market development.

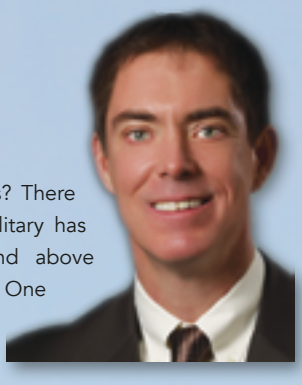
Ibrahima has been recipient of several CEO Awards throughout his career. He joined SES as Senior Vice-President Commercial-Africa in January 2012. Ibrahima is based in Johannesburg.

Prior to joining SES, Ibrahima was Senior Key Director and Managing Sales Director with Intelsat. Before taking up this role, he was Director of the Regional Marketing Management & Strategy team of Intelsat, a position he reached after having joined the company as a Communication Engineer in the Technical Operations Control Centre. Ibrahima was also the Managing Director of Intelsat in South Africa from 2004 to 2006. Prior to Intelsat, Ibrahima worked for Société des Télécommunications Internationales du Niger (the National operator in Niger) where he advised the Director General on new technologies.

Ibrahima holds an Electrical Engineering degree from Ecole Polytechnique of Montreal and a degree in Mathematics and Physics from the University of Niamey (Niger). He received his Master's degree in International Management as well as an MBA from the University of Maryland. He has completed several Executive programs with the Wharton Business School (Aresty Institute) and The Centre of Creative Leadership (Leadership Development Program).
A dual U.S. & Niger citizen, Ibrahima has had a high level sportive career: member of Niger National Basketball team, forward of Olympic Football of Niamey (winner of Niger Top football league) and as Brown belt in martial art (Judo). He has also led various student and social associations in Niger and Canada (President of Africa student association of Ecole Polytechnic of Montreal, President of Niamey-Baobab Junior Economic Chamber and Vice-President of Niger Junior Chamber International).

THE MILITARY'S NEXT PARADIGM: LEVERAGING COTS FOR COMMUNICATIONS

By Karl Fuchs, iDirect Government



As the military's communications needs evolve, a decision must be made as to the best way to put cutting-edge technology into the hands of communicators.

There are two approaches to the problem. The first is to fund a specialized development, while the second is to leverage Commercial-Off-The-Shelf (COTS) equipment. Historically, especially when dealing with satellite communications, the funded, specialized development has been favored. However, the specialized development of communications equipment can become a costly and time-consuming endeavor.

Government engineers must write up stringent specifications and requirement documents for the technology. They must go through the RFI and then RFP process. They invest a great deal of time and money, and in the end, after a vendor has been chosen and at the conclusion of the development cycle, they will have a product which meets all the specified requirements.

This RFI and RFP approach may be the most practical when the needs are highly specialized to the government market, for example, protected or anti-jam waveforms. Then again, it may not be.

If you take a close look at the DoD communications requirements now and in the future, you will see there is a great deal of overlap with commercial organizations' requirements. This overlap gives the DoD an excellent opportunity to leverage COTS products.

There are several benefits to leveraging COTS technologies. Arguably, the primary benefits are the requirements, the best implementations and strongest technologies that have been selected not by an RFP review committee, but by the market. The vendor with the best solution will almost always be easily identifiable by the market share it has attained.

When a funded development approach is used, the technology selected to meet the DoD needs may not be the technology that has been widely embraced by industry. There are many examples throughout the history of communications where standards bodies and others have commissioned a technology which was never widely adopted.

OSI vs. IP routing comes to mind, as does RCS in the satellite world. Adopting a cul-de-sac technology often leaves the DoD with what is, in essence, a proprietary technology, even if it is based on "open standards."

Following a COTS approach ensures a continuing technology roadmap and quite often allows for competition. Leveraging COTS equipment also breaks the cycle of development and change order cost overruns. A communication program based on COTS equipment has a much more deterministic budget.

The costs of a COTS deployed solution are more predictable and the total cost of ownership will be much lower when employing COTS equipment. The main reason for these factors are that, instead of technology development costs being shouldered exclusively by the DoD, development is amortized across countless commercial customers.

What about the special DoD requirements? There is no getting around the fact that the military has some extremely specific needs over and above the requirements of commercial entities. One of the requirements of some DoD organizations was mentioned earlier, anti-jam—numerous other DoD requirements center on security and encryption. Can these specialized needs be met by commercial vendors leveraging COTS gear? In most cases, the answer is a definite ***yes***.

Two specific examples in satellite communications exist today. One example of COTS equipment being enhanced to meet DoD requirements is Transmission Security (TRANSEC) and the other Security Content Automation Protocol (SCAP). TRANSEC, which obfuscates traffic analysis information from an adversary, has no applicability in the commercial world whatsoever. However, COTS manufacturers have developed ideal, robust, TRANSEC-enabled satellite systems without the DoD having to bear the upfront costs of development. The vendor simply monetizes the capability through licensing.

This vendor-financed development will not work in all cases. The vendor must see significant market demand and, internally, must build a business case. The DoD does have the option of funding a Non-Recurring Engineering (NRE) project to obtain a specific feature set leveraging the COTS technology if a commercial manufacturer cannot build a business case on market size alone.

At first glance, some of the specialized DoD requirements such as anti-jam may seem a bridge too far for COTS gear. Typically, anti-jam employs frequency hop spread spectrum. In frequency hop spread spectrum, the transmitted signal hops many thousands of times per second. The demodulators needed for this type of hopping are too expensive and sophisticated for COTS gear.

However, most COTS satellite equipment does support Direct Sequence Spread Spectrum (DSSS). It is theoretically possible to obtain the same coding gains from DSSS as can be acquired with frequency hop spread spectrum. The move to a COTS solution may require some out-of-the-box thinking, but that's what commercial providers are superb at accomplishing, and have proven such capabilities on countless occasions.

Leveraging COTS equipment for DoD satellite communications will dramatically reduce development costs and ensure cutting-edge technology is moving to the warfighter far more quickly. As the requirements of DoD communicators have so much in common with commercial communications, there is little sense in following the development philosophy of weapons programs that have no commercial applicability.

Karl Fuchs serves as Vice President of Technology for iDirect Government (iDirectGov). He joined iDirectGov in 2004 as the director of sales engineering, just as the satellite-based IP communications company was expanding its very small aperture satellite (VSAT) market presence into the federal government and IP networking world Contact him at ***kfuchs@idirectgov.com****.*

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ADVANCED SATCOM SOLUTIONS FOR MOBILE APPS

By Cristi Damian, Vice President, Business Development, Advantech Wireless, Inc.

Mobility for SATCOM users in a Military or Government Agency application context has always been a hot topic. The ability to maintain a satellite link while on the move, or to quickly deploy teams in the field that can easily and reliably establish communication anywhere in the world, have imposed many challenges on designers and system architects.

This, by itself, adds a new class of users and potential applications to the traditional Fixed SATCOM market and solidifies the unique position of satellite based communication in the overall global Military Communication offering.

At this stage, the identification and definition of the various classes of mobile users is important to present.

1. *By far the most attractive application, and the most challenging, would be the one identified as SATCOM-On-The-Move (SOTM). By deploying this technology, the users will be able to close a satellite link while moving either with a ground vehicle, or in an aircraft. Maritime applications would also be part of the same group.*

2. *A second group of users would be those who require fast deployment, and do not have the option of traveling with a vehicle. These would be users that would hand carry portable satellite terminals, man packs, or even flyaway, with extremely fast deployment time, and ability to log almost instantaneously into a satellite network. In a real world environment, one can envision the close interaction between these two classes of users, and to a point, their similarity.*

The designer challenges are multiple;

- Mobile users will need to switch satellites, gateways or beams. This requires sophisticated algorithms at the gateway and at each remote.
- Bandwidth management has to be done in a very intelligent way, in order to avoid cost overruns. In the last 10 years, military conflicts in Iraq and Afghanistan have identified Satellite Bandwidth as a major cost factor. Without proper planning, bandwidth costs can easily grow exponentially, or worse, bandwidth shortage can occur with the collapse of entire communication networks.
- Trying to estimate or "guess" today the bandwidth needs of the future users is close to impossible, and proved to be really damaging from both the technical and financial point of view. Many networks have been deployed as SCPC dedicated high capacity links, to be used only a fraction of the time, in a very inefficient and costly way. Other networks have been estimated as pure TDMA networks, burst mode, low traffic, to be later declared unusable as soon as the traffic requirement is growing.

With this in mind, today's users are demanding flexible network architectures where the same terminal can be used as a pure SCPC terminal, for high QoS, high data rate applications, or as a high bandwidth efficiency TDMA terminal, for lower data rates applications.

This will guarantee, by design, the most efficient way of using bandwidth and will release the system planners from the burden of deciding on which technology to select;

- Size and efficiency is important, if not critical. SOTM terminals, man packs, flyaway terminals have to be light weight, small size, and low energy consumption. This is a key criteria for true mobility.
- Network agnostic. Mobile users should be able to log into multiple satellites, multiple gateways, and switch them as required. They need to share the gateway and all resources with fixed users, and have interoperability capabilities. Open standards are in this case preferred, as DVB-RCS, while proprietary networks are at evident disadvantage.

The proposed Advantech Wireless solution addresses, in a pragmatic way, the aforementioned challenges.

A. THE COMPACT TRANSPORTABLE NEXT GENERATION RAPTOR HUB

The network architecture is based around the RAPTOR hub, with ASAT-IITM® (Adaptive Satellite Access Technology) capabilities.

The RAPTOR Hub is a ruggedized, military grade, advanced multiple access wave form Hub, currently operating under the WGS constellation of satellites. It incorporates key technologies that allow this Hub to be at the heart of a typical SOTM network. Among them, the most important ones are:

- The only Hub in the world with built in triple access mode (ASAT-II™). The Hub can operate as a STAR/MESH SCPC hub, TDMA hub, or Burst Mode FDMA hub. Each remote can switch from any access mode to any access mode, without user intervention, just by analyzing traffic profile and data requirements. Each remote can become a very high data rate SCPC terminal, and switch to different classes of burst mode access, when traffic profile is changing. This allows maximum bandwidth efficiency, and standardization among all network users, without the risk of wrongly assumed initial traffic profile. It has been demonstrated that this approach can easily reduce the bandwidth cost by 50 percent.

- The RAPTOR hub incorporates highly advanced Beam, Gateway and Satellite Handover techniques, either based on location, or on link performance.

- The hub updates its user profiles every 26 msec, this is the fastest way in the industry, and extremely important when the same user can completely change its access profile, or it has to do network beam or gateway/satellite handover

- The Hub is always hardware ready to its maximum capacity. No hardware cards or hardware upgrades have to be installed in the field, when users are added. No extra hardware inventory, prepaid, has to be kept in stock. More carriers can be added instantaneously. Everything is being upgraded via software keys, which is a major improvement over all existing hubs in the field. The necessity to dispatch teams in the field to upgrade hubs with hardware, in a war environment, with long delays and incertitude, is therefore removed now.

B. THE REMOTE TERMINAL

At the remote site, the main modem technology is included in the Advantech Wireless S6000 series. This powerful modem line, incorporates the ASAT-II™ technology, and the Beam, Gateway, satellite Handover intelligence, all in a DVB-RCS/DVB-S2 standard environment.

In several applications, the modem is ruggedized, outdoor type, for increased resilience in challenging environmental applications.

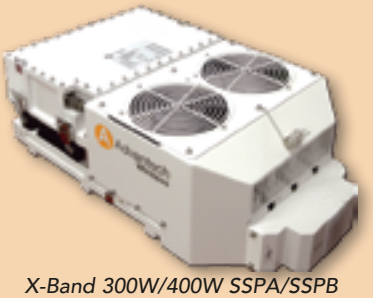
C. THE GAN SSPA SECTION

Starting with 2010, Advantech Wireless has launched a new line of extremely powerful GaN based SSPAs. These units exceed in RF power, linearity, and efficiency of any existing technology, either solid state, or TWT based. The GaN technology allows us a dual approach:

- We can now build extremely powerful SSPAs for the gateways, to work in full integration with the RAPTOR Hub. Systems over 6 KW power levels in X-band were delivered and are in operation worldwide today. This huge amount of power enables the very large amount of data traffic that Military SATCOM networks require. These systems can be mounted outdoors, with full built-in redundancy, or indoors. In this context, a powerful teleport can be built in a transportable trailer, enabling mobility even at a large command centers level.

- We can now build extremely small power amplifiers, which are the key for SOTM, manpack SATCOM, and FlyAway. Up until now, this would not be possible with any existing technology.

X-Band 25W SSPA/ SSPB Second Generation GaN Technology.



X-Band 300W/400W SSPA/SSPB SapphireBlu™ Second Generation GaN Technology.

100W Ku-Band AIRBORNE Grade SSPB Advanced GaN Technology.

X-Band 6,600W Rackmount Modular SapphireBlu™ Series Second Generation GaN based SSPA/SSPB.

- Using GaN, a new generation of SOTM terminals was released, designed to work in extremely harsh environments, as defined by Mil Std 810F. These units can handle a wide operating temperature range, high levels of shock and vibration, as well as perform with very high linearity and efficiency. These units are currently operating in the WGS environment.

Below is a list of several Gan-based SSPAs, specifically designed for mobile applications, including SOTM:

- *25W X-Band GaN, miniature unit, WGS certified*
- *50W X-Band GaN , miniature unit, Second Generation GaN, higher linearity and higher efficiency*
- *400W X-Band GaN, Second Generation, for mobile trailers, SOTM for Navy*
- *6KW X-Band GaN, Second Generation, powerful unit for mobile Teleports*
- *50W Ku, 50W X-Band, 20W Ka-Band, GaN based, for SOTM on military vehicles, WGS certified*
- *100W Ku-band GaN, Airborne Grade, DO106G compliant for SOTM on aircrafts*
- *200/250W Ku-Band GaN, Second Generation, for military mobile trailers*
- *300W C-Band GaN, Second Generation, SOTM for Navy*

D. MOBILE TERMINALS

If we extend the term "Mobility" to applications others than SOTM, the obvious candidates would be all terminals that allow fast deployment, and geographical location changes.

These terminals require mobility, and the same access techniques and bandwidth sharing as the SOTM terminals.

The list will then include...

- *Man pack terminals*
- *Flyaway terminals*

In this context, it is worthwhile mentioning the Advantech Wireless 65cm ManPack solution, which includes X-Band, Ku-Band, or Ka-Band antenna reflectors and feed, the corresponding GaN BUCs, and the ASAT-IITM triple access mode series modems. Integrated together, this is an ideal solution for intervention teams which do not have the option of traveling by a vehicle. The 65cm terminal is fully independent, with battery and battery chargers, including solar panels.

In the second case, the Advantech Wireless 1.2m X-Band, Ku-Band, or Ka-Band FlyAway terminals, allow much higher data rates, and it is ideal for remote command centers. Equipped with the same GaN based RF line of BUCs, ASAT modems, and antenna controller, the terminal includes IP routers, a complete set of test equipment, and location finding equipment, battery and chargers, all in ruggedized military grade transportable cases.

In a real war scenario, a typical network architecture will, in this case, be based on one or several RAPTOR hubs, deploying several true SOTM terminals either on vehicle, aircraft, or navy, combined with mobility at soldier level via man packs, and at local command level via flyaways, or fixed terminals.

The major advantage would be in standardization of all of the above terminals, and the ability to manage bandwidth resources in a truly efficient way, by switching access techniques without any user intervention in the field, covering multiple hubs, and multiple satellites.

The RAPTOR hub and its associated remote terminals, is therefore in our opinion, ideally positioned to define the future network architecture for Military SATCOM applications.

www.advantechwireless.com/

SatFinder

Satellite Database & Calculation Software

DATABASE

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

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

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

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

CALCULATION

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

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

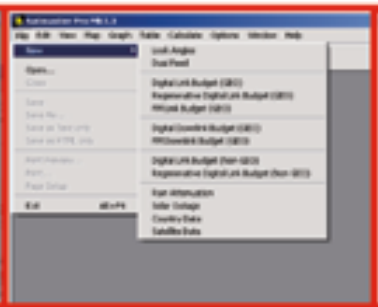
Calculates atmospheric losses and rain fade margins for any desired availability on uplink and downlink.

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

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

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

UPDATED QUARTERLY!



http://www.satnews.com/satfinder

MOVING MILITARY + GOVERNMENT SPACE ASSETS TUGGING AT THE POSSIBILITIES...

By Dr. Jared Squire, Senior Vice President, Research, Ad Astra Rocket Company

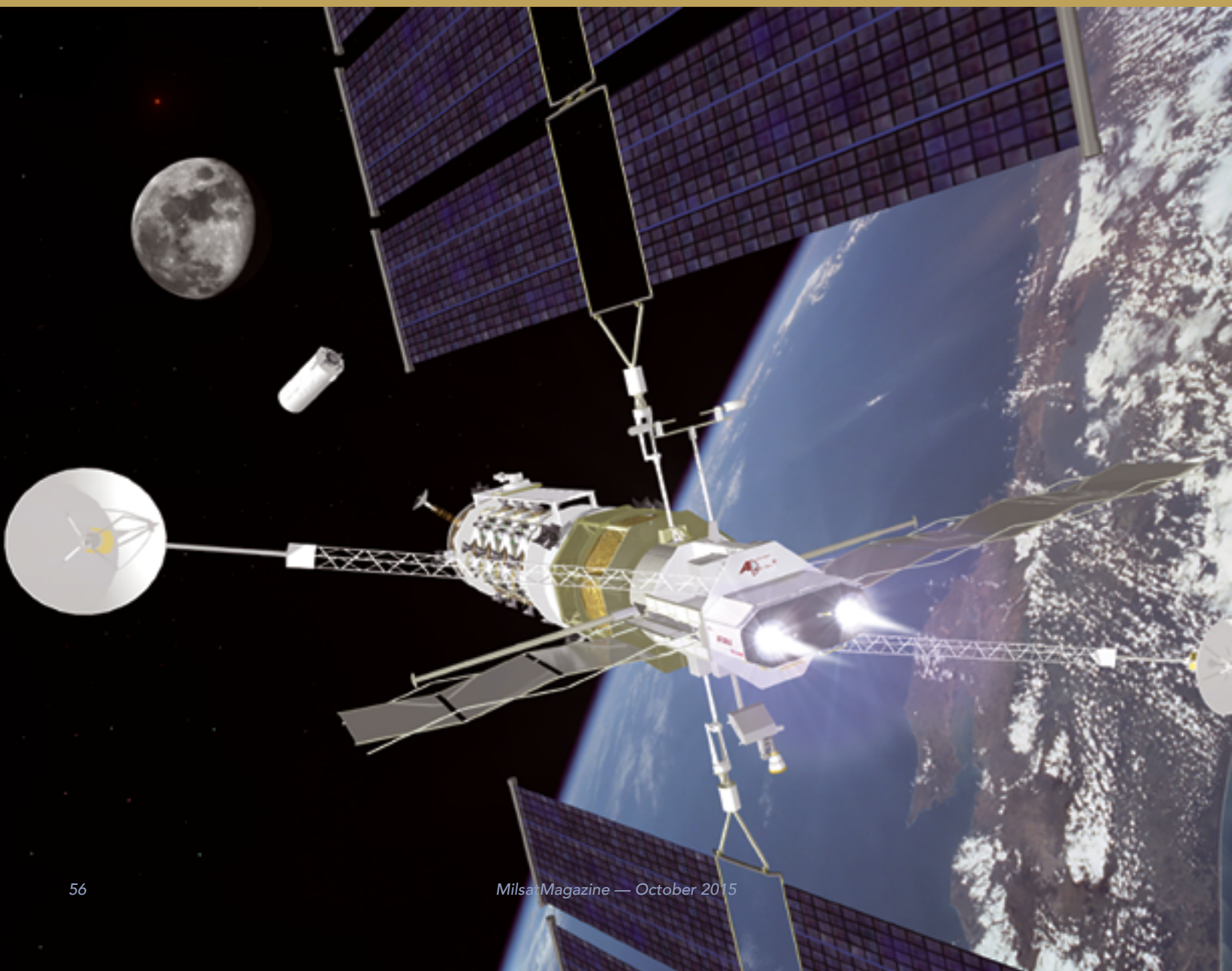
Throughout history, improved and flexible logistics for moving assets have been critical in conquering new frontiers.

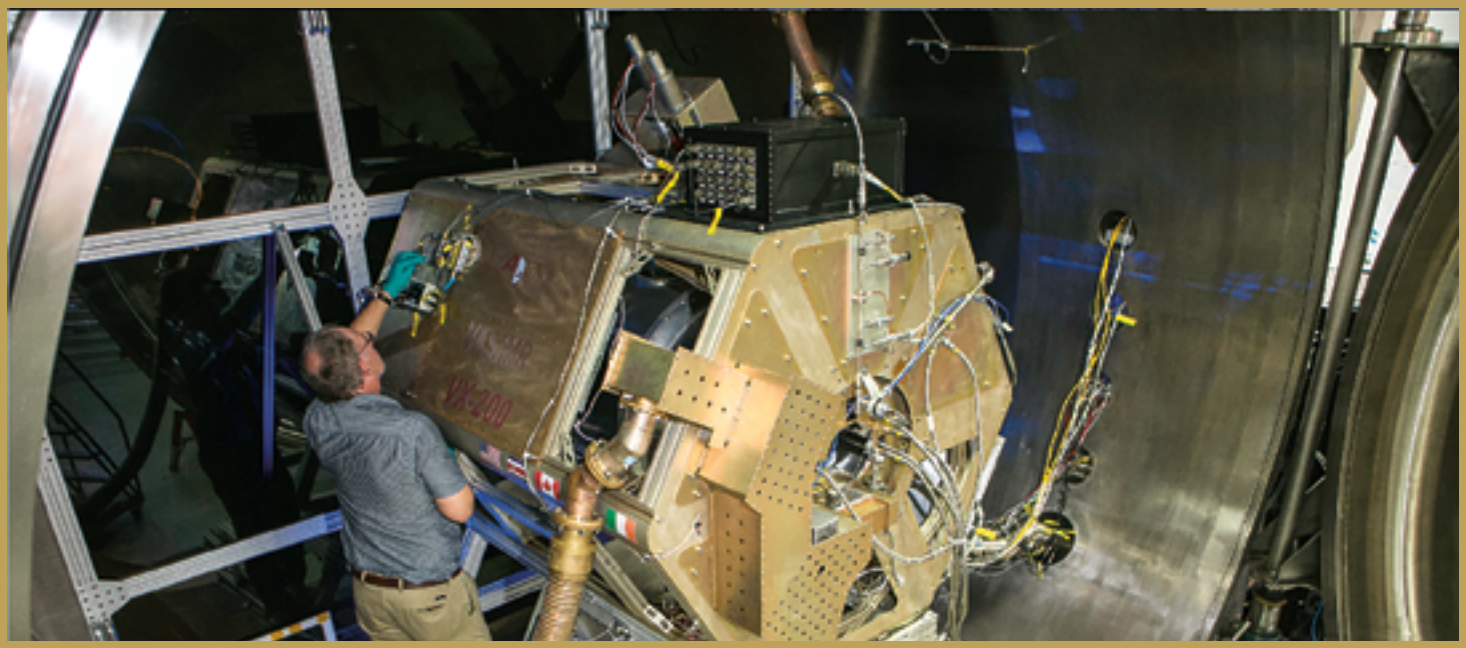
The frontier of space is no different. Innovations in-space propulsion capabilities are key to cost effectively station greater payload mass at high orbit and to enable the servicing, repositioning and repurposing of large space assets. Enhanced cargo delivery capabilities are needed to sustainably expand the horizon of human space exploration. Traditional chemical rockets are not practical for accomplishing these missions.

A new "in-space tug capability" will emerge when powerful electric vehicles are developed to efficiently use recent advances in solar electric power for space. Variable Specific Impulse Magneto-plasma Rocket (VASIMR®) engines will be vital for these tugs in much the way that powerful diesel engines are for moving goods on the ground. For more background on this topic, please watch the documentary, "***Crossing the Space Frontier***" at ***www.adastrarocket.com/aarc/video***.

A VASIMR® engine provides steady-state thrust using an electrical power source to create a directed plasma jet. VASIMR® technology is much different from other electric propulsion systems based on the familiar Hall or ion engines. Instead of using a direct current bias, VASIMR® engines ionize the propellant and accelerate the resulting plasma using Radio Frequency (RF) waves. These waves couple power into naturally occurring resonant modes that heat the magnetized plasma to temperatures of millions of degrees, comparable to interior regions of the sun. The strong magnetic fields in the VASIMR® design protect material surfaces from these temperatures.

The very high temperatures in the VASIMR® plasma produce jet exhaust velocities (or specific impulse) more than ten times higher than the best liquid hydrogen-oxygen engines available. This high specific impulse allows





orbital maneuvers using one tenth the propellant that would otherwise be needed using chemical engines.

With very high specific impulse, the propellant mass no longer dominates the total mass of the spacecraft and entirely new options become available to solve orbital mechanics problems. In contrast with chemical propulsion, the power source for a VASIMR® engine is also completely independent of the propellant. This independence makes power available for non-propulsive purposes and allows complete reuse of power and propulsion assets with only chemically inert propellant needed for resupply.

The VASIMR® engine somewhat uniquely allows its specific impulse and thrust to be tuned over a wide range while maintaining a constant input power. This capability allows mission flexibility and operational resilience.

The specific impulse range can also be tailored to support a particular mission by choosing the propellant from a variety of materials without significant changes in the technology. A propellant with lighter ion mass results in a higher range of specific impulse with lower thrust, while heavier ions provide a lower range of specific impulse with higher thrust.

For example, argon or krypton stored at mildly cryogenic temperatures (argon freezes below 83 K, krypton below 115 K) provide excellent performance with specific impulse ranging from 2500 s to more than 5000 s. Xenon can also be used for propellant, if very low specific impulse and high thrust is required, but xenon is typically a poor choice for VASIMR® engines because it is expensive and requires more powerful magnetic fields than lighter gases.

Possible alternatives without cryogenic storage include iodine substituting for xenon and bromine substituting for krypton. Other compounds that provide lighter propellant ion mass, like ammonia or water, may also serve as possible propellants.

THE HIGH-POWER REGIME

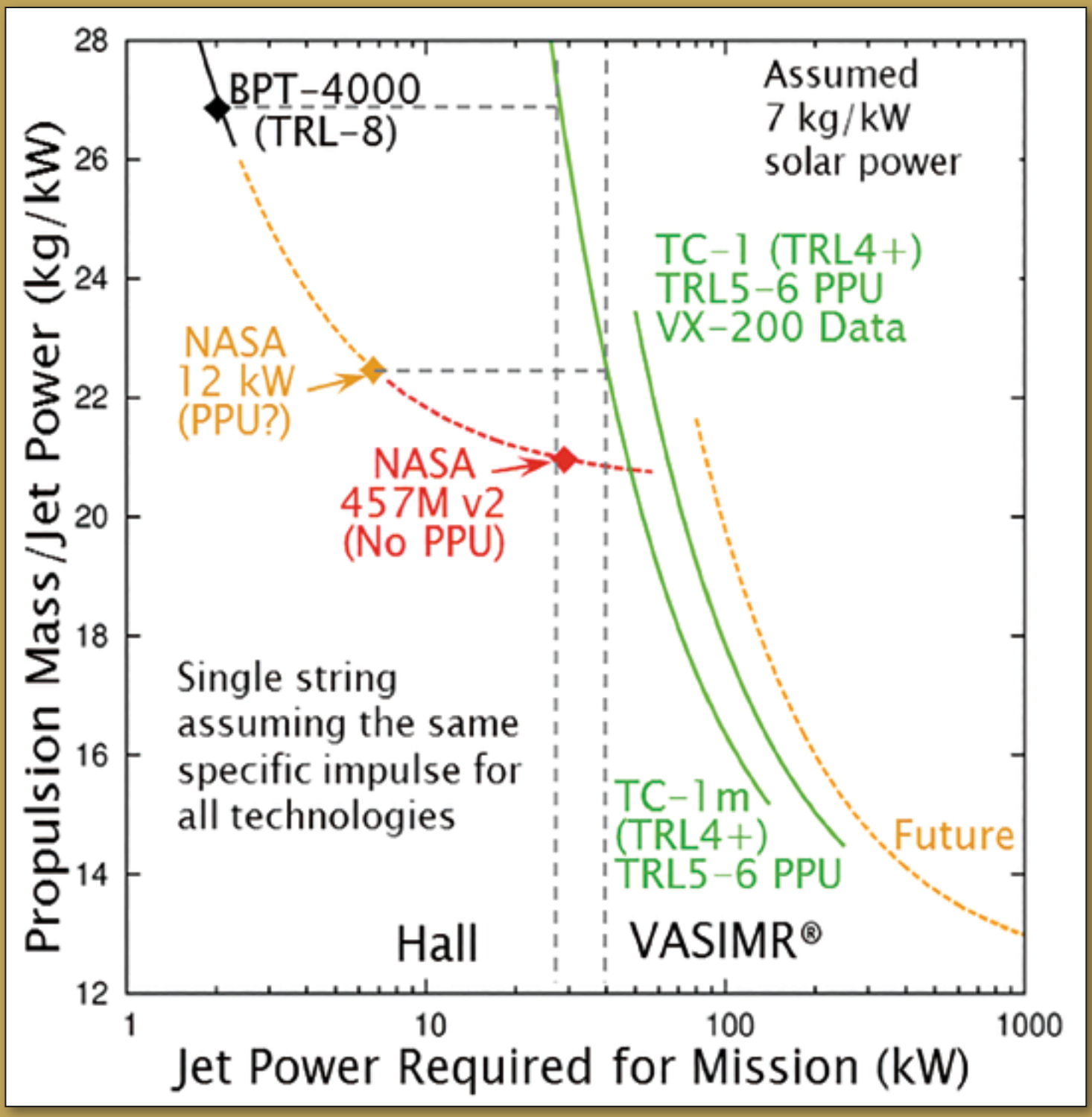
VASIMR® engines have advantage in the high-power, greater than 50 kW, realm for electric propulsion. A convenient way to visualize the natural power regimes for VASIMR® and Hall technologies is to plot the ratio of total propulsion mass to jet power versus the jet power required to accomplish the mission.

The comparison must account for the total mass of the propulsion system including the solar electric power plant, the power processing unit and the thruster itself. The goal is, of course, to reduce the overall propulsion system mass as much as possible. By assuming the same specific impulse for both systems and the same weight for the solar array, the salient features of the two technologies can be assessed side-by-side and favorable power regimes for each can be identified.

From ***Figure 1*** on the following page, it is evident that different technologies have advantages in different power regimes. The controlling physics behind each technology is responsible for this difference.

Hall technology uses a weakly magnetized direct current discharge with space-charge limitations on density and power, while VASIMR® technology exploits naturally occurring resonant behavior in a strongly magnetized plasma with no space-charge limits. The technological trade-off is the investment required in a strong magnet to enable VASIMR® power levels.

With present-day magnet technology, a Hall system has an advantage for power levels well below 50 kW, but above 50 kW, the VASIMR® system is clearly the better choice. This transition to the VASIMR® power regime will shift to lower values of power as the thin-film technology supporting high-temperature, superconducting magnets continues to improve. The mass of the solar electric power plant, assumed here to be 7 kg/kW, will also begin to dominate the total mass of the propulsion system as magnet technology improves and as power levels increase.



VASIMR® technology has additional operational advantages. One is the very high power-to-thrust conversion efficiency, which allows more than 65 percent of the solar electric power to be converted into thrust-producing jet power.

Other advantages are the absence of any direct current bias and the nearly linear behavior of the underlying RF wave physics. These attributes minimize coupling between the plasma, the RF power processing units, the solar arrays, and other parts of the vehicle.

The DC to RF power processing units are also straightforward, single stage and robust, using extremely efficient field-effect transistor technologies widely utilized throughout the commercial broadcast industry. More information about the VASIMR® mass scaling can be found at ***http://adastrarocket.com/infographics/VASIMR-Hall-Power-Niches-07-03-14.pdf, www.adastrarocket.com/IEPC13-149_JPSquire_submit.pdf***, and at ***www.adastrarocket.com/Jared-Space2014.pdf*** .

ORBITAL DEBRIS REMOVAL

Removal of many large orbital debris objects in a single mission exemplifies the innovative mission capabilities enabled by solar electric propulsion in the VASIMR® high-power regime. Specifically, accessing and de-orbiting many spent upper stages jettisoned in multiple orbit planes during the long history of satellite launches to polar orbit requires propulsively extreme maneuvers. Mathematical tools for the 'traveling salesman' problem were used to optimize the specific impulse for a mission while minimizing mission time and propellant usage for a solar electric tug equipped with a 200 kW VASIMR® engine.

The resulting concept was able to capture 19 known rocket upper stages (Zenits for this example) and de-orbit them in a controlled manner over the Pacific Ocean. Each upper stage debris object is large, approximately 4 m in diameter, 10 m long, and weighs approximately 8 tons.

The concept outfits the solar electric propulsion tug with a specialized service module containing a tray holding 20 solid rocket motors and a detachable chemical robotic pod. The tug, with service module, climbs to the altitude of a drifting upper stage, approximately 800 km, and positions itself at a safe distance from the debris.

The chemical robotic pod then detaches, carrying a solid rocket motor with it, to perform the proximity operations needed to stabilize the upper stage. The pod attaches the solid rocket motor to the upper stage's exhaust nozzle and tows the now cooperative upper stage back to berth and lock onto the solar electric tug.

The tug's VASIMR® engine is then used to efficiently lower the orbit of the upper stage to approximately 400 km, a location from which the implanted solid rocket motor can detach and complete the controlled atmospheric reentry of the upper stage into the Pacific. The VASIMR® engine then repositions the tug with its service module at the next upper stage and the de-orbiting process is repeated 18 more times before the VASIMR® engine requires a resupply of propellant from the ground. This same tug could be used for movement of other space assets to a variety of destinations.

The optimum specific impulse range for this debris de-orbiting mission was found to be between 4,500 and 5,000 seconds, well suited for a VASIMR® engine operating with low-cost argon propellant. Lower specific impulse cases resulted in a substantial increase in the initial mass of propellant launched to Low Earth Orbit (LEO) for the mission, which dramatically increases the time and overall cost of the mission.

The high performance of a VASIMR® engine for this application makes the debris removal both faster and cheaper than with other electric propulsion technologies. For more information, read http://adastrarocket.com/infographics/VASIMR-Orbital-Cleaner.pdf or watch the video at http://www.adastrarocket.com/aarc/media-and-gallery.

Mark Carter, Senior Vice President for Technology Development, in front of the VASIMR® engine. Photo courtesy of Ad Astra Rocket Company.

VASIMR® ENGINE DEVELOPMENT STATUS

Since its inception in 2005, Ad Astra Rocket Company has advanced the Technical Readiness Level (TRL) of the VASIMR® engine almost exclusively with private funding. In 2013, after more than $30 million in private capital investment, the company completed more than 10,000 successful high power firings of its most advanced VASIMR® prototype, the VX- 200™, in Ad Astra's Houston vacuum chamber facility.

These tests with argon propellant demonstrated the engine's excellent firing repeatability and performance (6 N thrust, 5000 s specific impulse, and a thruster efficiency greater than 70 percent) with no measurable signs of engine wear. To optimize company resources at the time, these earlier tests were all of short duration, less than 1 minute, but sufficient to reliably establish the rocket's performance and measure thermal loads. Technical information about Ad Astra's VX-200 experiment performance is available at ***www.adastrarocket.com/Ben-JPP-2014.pdf***.

Ad Astra Rocket Company was recently selected by NASA as one of the winners of its Next Space Technologies for Exploration Partnerships (NextSTEP). Authorization to proceed was granted on August 7, 2015 and work is now well underway. This three-year partnership with NASA, valued at approximately $9 million, will advance the VASIMR® engine to a TRL greater than 5, a major step closer to spaceflight. The project will build and demonstrate a fully integrated system, the VX-200SS™ laboratory prototype, by operating continuously at 100 kW for a minimum of 100 hours. The long duration test under the NextSTEP program will thoroughly evaluate the engine's new proprietary core design and thermal control subsystem. The test will also provide a better estimate for component lifetime.

Visit Ad Astra Rocket Company at ***www.adastrarocket.com*** to find out more about the development of the VASIMR® engine.

SPACE RESILIENCY—AVOIDING THE MAGINOT LINE IN SPACE

By Philip Kwong, Businesss Development Advisor, Intelsat General Corporation

A relic of the past and the abandoned bunkers are the physical remains of a failed idea.

The Maginot Line was a linear defense of concrete fortifications that France constructed during the 1930s to provide time for the French military to mobilize and prepare for a decisive fight with Germany. Drawing from the trench warfare lessons of World War I, the French concluded that a static defense was the best method to defeat an invasion from the East.

The Maginot Line was a technical wonder. Impervious to most forms of attack including aerial bombing and tank fire, it also had underground railways for resupply and state-of-the-art accommodations for the garrisoned troops that included air conditioning. But when the Germans invaded France in 1940, they simply went around the line and through Belgium.

The Germans invaded on May 10 and the French signed an armistice six weeks later. The line had held but France had fallen. The Maginot Line now is synonymous with a strategy that people hope will prove effective but instead fails miserably.

Is the United States government doing the same thing today as it grapples with the best way to defend the nation's space systems?

In 2015, the United States operated more than 40 percent of all known satellites. Estimates suggest that 80 percent of American communications and intelligence comes from satellites, making the United States the most space-dependent country in the world. It is not an exaggeration to say that space is not only the front line in defense but also communications, intelligence, and commerce.

While it is encouraging to hear senior leaders in government, military, and industry talk about the importance of space and the need for protected and secure systems, we need to be careful that we do not build our own Maginot Line in space. To avoid that we need to focus on the following:

We must consider not only robust systems (that are able to overcome certain attacks) but also resilient systems by using traditional and small satellites in Geostationary, Medium, and Low Earth orbits so that we can bypass affected systems and continue to operate.

We must improve our space architecture to better integrate MILSATCOM and COMSATCOM systems AND operations to provide greater resilient capabilities. Only by routinely working together can we work more effectively in a crisis. Our "silo" approach in the past where MILSATCOM and COMSATCOM were segregated may have been efficient within the silo but will not be effective in the future as the U.S. government will be required to respond faster to rapidly developing events using all available tools.

By taking this approach the U.S. government will be better prepared to protect its space capability not only from adversary attack but also system failures, environmental challenges, and debris.

The lessons of the Maginot Line are clear—when you are facing a smart adversary, resilience, not robustness, is the key to success.

www.intelsatgeneral.com/

Editor's note: Our thanks to Intelsat General Corporation for allowing us to republish both Mr. Kwong's article (above) and Ms. Diamante's article, which follows, from their SatCom Frontier blog. To read additional insights from this blog, please access www.intelsatgeneral.com/management-team/satcom-frontier/

CONVERGENCE + DISAGGREGATION: THE GOVERNMENT NEED FOR COMMERCIAL SUPPORT

By Claudia Diamante, Senior Manager, Satellite Services + Business Development, Intelsat General Corporation

Convergence on the ground. Disaggregation in space. They are more than just buzzwords in Air Force Space Command, and both concepts—considered key in the future satellite communications networks of the United States military—are going to be dependent on the commercial community to make them work as efficiently and effectively as needed.

Intelsat General Corp. (IGC) is in a position to take on that challenge. The Space Services group has managed launch support, Tracking, Telemetry & Control (TT&C), Transfer Orbit Support Services (TOSS) and In Orbit Testing (IOT) missions for Intelsat's as well as third-party satellites for more than 50 years in the case of Intelsat's own satellites, and more than a decade for third-party satellites. IGC's TT&C network accesses more than 550 antennas at 30 locations worldwide to support numerous customers.

The company's TT&C service provides long-term satellite monitoring and control for a variety of customers, while the TOSS service supports satellite transfers into their geostationary positions after launch, and several follow-on activities are conducted, including rehearsals and IOT, to make sure the transfer is completed successfully. By leveraging a global network of 24/7 full-motion TT&C antennas in 18 locations around the world, IGC can support multiple TOSS missions simultaneously.

The Air Force is currently looking at converting disparate ground operating systems into one common ground network that flies their satellites more efficiently and economically. Concurrently, the Air Force is seeking to shift TT&C responsibilities for some satellite programs to commercial operators. By turning satellite ground operations, or TT&C, over to the commercial community, Air Force and other government personnel can concentrate on their mission-specific requirements while significantly reducing costs.

Intelsat currently flies more than 75 satellites, about one third of them for other companies, from redundant and highly automated operations centers in California and Virginia. Our satellite controllers average decades of experience and undergo regular training to ensure they are top in their field.

Intelsat General Corp.'s Fillmore Teleport.

This is the kind of background and training that can be critical in a workplace, where a lapse in control or downtime in coverage can cost a life in the field. Commercial personnel don't rotate in and out, thus averting constant retraining and orientation as military enlistments are completed or duty assignments change.

Future demand for satellite services is not limited to the U.S. military. Companies also turn to us to help them launch new satellites. We offer an extensive range of professional space services, providing expertise in satellite construction oversight and launch management, and long-term satellite operations.

Those capabilities are going to be in high demand, according to a Euroconsult report that was released on August 25 which states that an average of 140 satellites with a launch mass greater than 50 kilograms will be launched annually worldwide over the next decade.

Governments in 60 countries, some of them new to the satellite business, will be responsible for 75 percent of the $255 billion in revenues generated by the production and launch of these 1,440 platforms, which will include 550 satellites in the commercial sector.

The need for services such as hardware design, proposal evaluation, manufacturing consulting, testing and hosted payload integration will be acute in this run up to space capability.

These are services Intelsat General Corp. is uniquely positioned to provide due to the depth of its personnel and operations, its long experience in the satellite services field and its eye to the future, which includes a commitment to innovation and the continuing development of state-of-the-art technology and infrastructure.

As satellite capabilities grow, in the government and commercial sectors, so too will the need for the services required to use those capabilities in a race in which the customer is the ultimate winner.

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Editor's note: Our thanks to Intelsat General Corporation for allowing us to republish both Ms. Diamante's article above and Mr. Kwong's article on a previous page, from their SatCom Frontier blog. To read additional insights from this blog, please access www.intelsatgeneral.com/management-team/satcom-frontier/

FY 2016 FUNDING UNCERTAINTY REMAINS FOR U.S. SPACE PROGRAMS... + THEN THERE'S CLIFFORD...

By Elliot Holokauahi Pulham, Chief Executive Officer, Space Foundation

Unfortunately, as this is written, Congress and the administration are still grappling with how to fund the federal government for Fiscal Year 2016.

A short-term Continuing Resolution (CR) has been agreed upon, which will extend the current budget into mid-December. Also in that timeframe, there will need to be a vote on the raising of the debt ceiling.

This month, October, there will be a hectic scurry to see who will succeed outgoing House Speaker John Boehner. What's more, failure to reauthorize the Export-Import Bank already has caused American aerospace businesses to lose sales and jobs.

As all of this goes on, various American space programs continue with uncertainty about how the rest of the FY 2016 will be adjudicated in terms of funding and policy.

This results in a demoralized workforce, hurts the ability to do smart, long-term planning and undermines America's ability to lead in space. As the CEO of the Space Foundation, I am no stranger to competing interests. However, we as an industry are often able to come together to solve larger challenges. I urge our political leaders of all stripes to work through their differences and do the same.

Now, onto some fun stuff... does anyone know where we can find a space suit for a 25-foot-tall dog? Clifford The Big Red Dog™, a canine favorite of young children everywhere and mascot of Scholastic Books, will be calling the Space Foundation Discovery Center home for the next few months. We were hoping to interest Clifford in a trip to the International Space Station, but finding life support systems for a two-story-tall dog has not been easy to accomplish.

Clifford's three-month-long visit to Colorado is actually a joint effort of the Space Foundation and the Pikes Peak Children's Museum, (PPCM). The Space Foundation Discovery Center is the only space and science center museum in the Pikes Peak region, and offers formal and informal educational opportunities for all ages.

STEM education supporters, such as Northrop Grumman, Lockheed Martin, AGI and Raytheon, have helped us create tremendous environments and facilities to advance our education mission. Our partnership with the Pikes Peak Children's Museum creates a special opportunity to reach the youngest of learners, and expose them to the wonders of reading, and, while they're here, the wonders of space.

Author Norman Bridwell and Scholastic produced 80 Clifford books between 1963 and 2015, and the franchise has spawned video games, books about puzzles, reading, thinking, music and phonics. The Scholastic/PBS television series aired 65 episodes, a 39-episode prequel, and a Universal Pictures movie that will be released in April. His visit to the Space Foundation Discovery Center will mark Clifford's first adventure in space.

We're pretty thrilled with our partnership with the Pikes Peak Children's Museum. Colorado Springs is one of the largest cities in the United States that does not yet have a children's museum, and the PPCM and their supporters are working hard to change that.

By bringing one of the country's favorite kids' exhibits to our region, PPCM is providing a great service to families, while demonstrating the kind of thing that a good children's museum can accomplish in our community. Since we established our Discovery Center, the Space Foundation has been tremendously active in bringing education opportunities to Colorado—including STEM education and the arts. Reading, which Clifford promotes from a very young age, is fundamental.

Having Clifford in our house will help promote pre-school education and a life long love of reading, while also giving the PPCM a leg up in its efforts to create a permanent home in Colorado Springs. (Hmmm. Perhaps "leg up" isn't the best metaphor in a story about a dog!)

From our point of view, this also creates an opportunity to introduce a new generation of learners, and their families, to the miracles and wonders of space, and to the tremendous educational programs of the Space Foundation. We've offered pre-K programs for teachers and students for nearly a decade now. While we haven't been chasing our tails (Oh!), Clifford will be helping us to increase our appeal to this youngest group of learners.

If you're young, or just young at heart, I hope you'll make the time between now and the end of the year to come and visit with Clifford The Big Red Dog™—a 25-foot-tall space suit is not required. You can learn more about the STEM and STEAM education programs of the Space Foundation, and you can learn more about the Pikes Peak Children's Museum.

If you're too "adult" for all that, then mark your calendar to join us on November 14 for our popular "21+" event: Rocket In My Beer! Now in its third year, Rocket in My Beer! offers a look at how space technology makes beer drinking better—as well as an opportunity to sample the products of 16 Colorado craft breweries.

www.spacefoundation.org

Named chief executive officer of the Space Foundation in 2001, Elliot Pulham leads a premier team of space and education professionals providing services to educators and students, government officials, news media and the space industry around the world. He is widely quoted by national, international and trade media in coverage of space activities and space-related issues. Before joining the Space Foundation, he was senior manager of public relations, employee communication and advertising for all space programs of Boeing, serving as spokesperson at the Kennedy Space Center for the Magellan, Galileo and Ulysses interplanetary missions, among others.

He is a recipient of the coveted Silver Anvil Award from the Public Relations Society of America—the profession's highest honor. In 2003, the Rotary National Awards for Space Achievement Foundation presented him with the coveted Space Communicator Award, an honor he shares with the late legendary CBS News Anchor Walter Cronkite and former CNN News Anchor Miles O'Brien. Pulham is a former Air Force Civic Leader and advisor to the Chief of Staff and Secretary of the Air Force and a recipient of the U.S. Air Force Distinguished Public Service Medal. He serves on the editorial board of New Space Journal.

Editor's note: Thanks to Space Foundation for allowing us to republish Elliot's column from their Space Watch infosite: ***www.spacefoundation.org/media/space-watch***.

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