

SATCOM For Net-Centric Warfare – October 2016

MilsatMagazine

In Memory Of Jos Heyman

SATCOM @ Sea

*Belgian Navy Mine Counter Measures
Connecting The Sea Floor To Space*

Hosted Payloads Must Be Included

Supporting The Military's Critical Missions

SATCOM Managed Services

Equipping Defense Forces

Military Backup Services

Evolving Space Threats

Acquisition Reform

MEO Cost Efficiency

COMSATCOM Backup Services

Smallsats... A Revolution For Military Concerns



Cover photo is courtesy of Newtec.

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IN MEMORY OF JOS HEYMAN, SENIOR CONTRIBUTOR

We at Satnews were saddened to learn that our publication company's leading, senior contributor and globally-recognized journalist, Jos Heyman, passed away following extended illnesses in his home of Perth, Australia.

Jos succumbed to his illnesses on September 30th in Perth. He was born in Rotterdam, the Netherlands. His funeral was conducted on October 10th.

Jos was the Managing Director of Tiros Space Information, a Western Australian consultancy that specialized in the dissemination of information on the scientific exploration and commercial application of space for use by educational as well as commercial organizations.

An accountant by profession, Jos was the editor of the TSI News Bulletin and was also a regular contributor to the British Interplanetary Society's Spaceflight journal as well as to the daily news at satnews.com, *SatMagazine* and *MilsatMagazine*.

We thank Jos and his wife, Noni, for being a truly substantial part of the Satnews family and to Jos for his columns and expertise within the space and satellite worlds.

Many sincere comments were received regarding Jos' passing from dozens of his readers from around the world... here are but a few of those who took the time to write to us to express their thoughts about his life and work.

Jos was truly dedicated to communicating to the world the detailed aspects of Spaceflight which the day to day new media are never interested in. As President of the ASEA and writer and publisher of our magazine ASLEP for 21 years I am humbled by his unbelievable dedication and effort to continue his dream right to the end. The Space community and, indeed the world, has lost a wonderful man.—Graham Wolfe, President, ASEA



That's a real shock. While I didn't know Jos personally I subscribed to his 'Tirros Space Information' which was a mine of information and which I read avidly—and of course his contributions to your magazines. So sad a loss for Jos's family and friends, and for the whole global SATCOM community.—Bob Gough, Senior Contributor, Satnews Publishers

My sincere condolences to his family and the Satnews team—Igor Rozenberg, Space Association of Australia

I am Allan Okoth, from Nairobi, Kenya, where I received every monthly bulletin since 2011 (I think). I am very sad to learn of the passing away of Mr. Heyman. Please accept my deepest condolences for the loss that I am sure his entire family and friends are feeling. Mr. Heyman was gracious enough to relate to the world my ambitions for a small educational satellite mission for Kenya in his Tiros Space Bulletin for February 2013, that may enable Kenya, finally, space-faring status. That mention has enabled me open up discussions with IBM and IEEE-Kenya chapter about promoting Kenya's civilian space program. His writing and updates will be much missed and those of us who relied on his updates to keep abreast of developments have also lost a great champion and supporter of our efforts. Kind regards and deep condolences to his family, friends and audience.—Allan Okoth

I looked forward to receiving TIROS and have shared it with so many people—I would print it off for students in my primary school classes who were fascinated by space, shared it with NASA Flight Directors, retired NASA astronauts and sent the details of how to subscribe to many teachers and parents. I am saddened by his death and he will be sorely missed by all of us. My deepest sympathies.—Jackie Slaviero

My deepest sympathy for the loss of Mr. Heyman. Rest in Peace.—Miguel Cooper

We shall miss his presence... the Satnews family.

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DISPATCHES

USAF Releases An RFP For STPSat-6 Mission Launch Services

The US Air Force has released a Request for Proposal (RFP) for an Evolved Expendable Launch Vehicle (EELV) Launch Service supporting the Space Test Program (STP) 3 mission, which is scheduled to launch in June of 2019.

The draft RFP was released on August 19th to obtain industry feedback to inform the final RFP. After extensive industry engagements, the final RFP was released on September 29th—proposals are due back to the Air Force no later than December 2nd, in accordance with the solicitation instructions.

The Air Force will award a firm-fixed price contract that will provide the government with a total launch solution including launch vehicle production, mission integration and launch operations for the STP-3 mission.

The Air Force's acquisition strategy for this solicitation achieves a balance between mission success/operational needs, and lowering launch costs, through reintroducing competition for National Security Space missions. This will be a standalone contract for the STP-3 launch service.

The STP-3 mission consists of a primary space vehicle (STPSat-6) and a propulsive EELV Secondary Payload Adapter (ESPA) holding up to 6 payloads that will be identified no later than 12-months prior to launch.

The STPSat-6 space vehicle will host the National Nuclear Security Administration (NNSA), Space and Atmospheric Burst Reporting System-3



STPSat-2 being built. Photo is courtesy of Ball Aerospace.

(SABRS-3) payload, and the National Aeronautics and Space Administration (NASA) Laser Communications Relay Demonstration (LCRD) payload. Additionally, seven Science and Technology (S&T) payloads are manifested by the Department of Defense Space Test Program.

This is the third competitive launch service solicitation under the current Phase 1A procurement strategy. The Phase 1A procurement strategy reintroduces competition for National Security Space launch services.

The first STP-SIV spacecraft, STPSat-2 launched November 19, 2010, aboard a Minotaur IV from Kodiak, Alaska. That satellite is carrying a relay transponder for data collected by ocean buoys and a space phenomenology sensor. STPSat-3, the second STP-SIV spacecraft, carried five payloads and was successfully launched November 19, 2013, on a Minotaur I from Wallops Island, Virginia.

The US Air Force Space Command's Space and Missile Systems Center,



Artistic rendition of STPSat-2, courtesy of Ball Aerospace.

located at the Los Angeles Air Force Base, California, is the US Air Force's center of excellence for acquiring and developing military space systems.

The command's portfolio includes the Global Positioning System (GPS), military satellite communications, defense meteorological satellites, space launch and range systems, satellite control networks, space based infrared systems, and space situational awareness capabilities.

Lt. Gen. Samuel Greaves, the US Air Force program executive officer for Space and Space and Missile Systems Center commander, stated that through this solicitation for STP-3, SMC hopes to promote healthy competition in order to foster innovation while securing Assured Access to Space through multiple reliable, affordable and efficient launch service providers.



DISPATCHES

Lockheed Martin Enlists With USAF... For GPS III Satellites

The production of the ninth and tenth Global Positioning System III (GPS III) satellites has been awarded to Lockheed Martin (NYSE: LMT) by the US Air Force (USAF) with a \$395 million contract.

GPS III satellites will deliver three times better accuracy, provide up to eight times improved anti-jamming capabilities and extend spacecraft life to 15 years, 25 percent longer than any GPS satellites on orbit today. GPS III's new L1C civil signal also will make this the first GPS satellite to be interoperable with other international, global, navigation satellite systems.

The contract includes funding for long-lead items and full production for the next two space vehicles (SVs) in the Air Force's nexgen GPS III constellation. The first eight GPS III satellites are already under contract and in production at Lockheed Martin's GPS III Processing Facility outside of Denver.

The Lockheed Martin team is finishing up final testing and integration activities on the first GPS III satellite, GPS III SV01, and is preparing to deliver its spacecraft to the USAF later this year. The second satellite, GPS III SV02, is poised to have the major functional systems fully integrated into one space vehicle prior to the start of environmental testing. GPS III SV03 also is starting to take form in the company's production clean room as the major subcomponents are being assembled.

The GPS III team is led by the Global Positioning Systems Directorate at the U.S. Air Force Space and Missile Systems Center (SMC).

Air Force Space Command's 2nd Space Operations Squadron (2SOPS),

based at Schriever Air Force Base, Colorado, manages and operates the GPS constellation for both civil and military users.

www.lockheedmartin.com/gps

DISPATCHES

An Evolution For iDirect Government's SATCOM Platform

iDirect Government's (iDirectGov's) Evolution 3.4.1 software powers the company's nexgen 9-Series portfolio of remotes and defense line cards.

Evolution 3.4.1 delivers enhanced features in security, performance and efficiency to the 9-Series product line in support of the company's defense and government customers whenever and wherever they need effective satellite communications.

The software supports the 950mp, 900 and 9350 remotes as well as the DLC-T and DLC-R defense line cards—all from a single platform.

Offering the latest transmission security (TRANSEC) enhancements in the air, on land and at sea, the Evolution platform is Federal Information Processing Standards (FIPS) Level 3 certifiable.

The 9-Series remotes and DLC line cards support dual-domain TRANSEC. One-way TRANSEC is a new feature that secures broadcast traffic from the hub to a network of receive-only remotes.

The flexible and scalable 3.4.1 software enables 9-Series remotes to operate and coexist in future networks, helping defense and government customers to easily transition to future releases.

The flexibility of 3.4.1 simplifies the recovery of remotes without local manual intervention.

For airborne, maritime and land-based communications, the latest Evolution software drives the 9-Series with:

- » *Mission-critical applications, connectivity and security*
- » *Efficiency, mobility and ease of use*
- » *Full support of high-speed Communications-On-The-Move (COTM)*
- » *The ability to run two-way and one-way networks simultaneously (GBS capable)*
- » *Extended frequency ranges, which allow users to access the Wideband Global Satellite (WGS) constellation, as well as High Throughput Satellites (HTS)*
- » *A reduced footprint*

"Evolution 3.4.1 delivers a new, advanced level of satellite communications capacity to the field," said John Ratigan, president of iDirect Government.

"The SATCOM software energizes and elevates the 9-Series remotes and line cards, enabling iDirectGov's customers to connect, command and coordinate their critical assets in the field better than ever before. We are enthusiastic about the Evolution platform leading in proficient next-generation satellite communications deployment for airborne, maritime and land-based customers."



iDirect Government, LLC is a wholly owned subsidiary of VT iDirect, Inc., and delivers secure satellite-based voice, video and data applications with anytime and anywhere connectivity in the air, at sea and on land.

iDirect Government's satellite IP solutions are used for critical ISR, airborne, maritime and COTM communications to support force protection, logistics, situational awareness, disaster recovery and emergency response.

Building on more than 15 years of global satellite communications experience, iDirect Government provides the most bandwidth-efficient, scalable and highly secure platform to meet specialized applications of multiple federal, state and local government agencies, including the Department of Defense, both domestically and abroad.

www.idirectgov.com/



DISPATCHES

ULA's Vulcan Verification Pathway Now Has SMC Cooperation

Certification for United Launch Alliance' (ULA) Vulcan launch vehicle for National Security Space (NSS) missions continues unabated, as the company has now signed a Cooperative Research and Development Agreement (CRADA) with the USAF's Space and Missile Systems Center (SMC) as part of the company's effort to certify its new Vulcan launch vehicle for such use.

This cooperative, jointly-written agreement facilitates data exchanges and protects proprietary and export-controlled data. The CRADA will be in effect until all non-recurring design validation activities for Vulcan are complete. This CRADA enables the Air Force to evaluate the Vulcan launch system according to the Air

Force's New Entrant Certification Guide (NECG) and contains a detailed Certification Plan that specifies all of the non-recurring activities.

As part of the evaluation, SMC and ULA will look at flight history, vehicle design, reliability, process maturity, safety systems, manufacturing and operations, systems engineering, risk management and launch facilities. SMC will monitor at least two certification flights to meet the flight history requirements outlined in the NECG.

ULA will give the US Government specific levels of insight into the design and testing of the vehicle during its development; the breadth and depth of this insight allows for the number of certification flights to

be two. Once portions of the non-recurring validation are complete, the SMC commander may make a determination to grant certification. This approach is consistent with other CRADAs. While certification does not guarantee a contract award, it does enable a company to be awarded competitive launch services contracts.

In addition to the Vulcan CRADA, SMC anticipates entering into additional CRADAs with SpaceX for their Falcon Heavy rocket and with Orbital-ATK for their Next Generation Launcher. Currently, ULA's Delta IV and Atlas V, and SpaceX's Falcon 9 Upgrade are the only certified launch vehicles for sending NSS payloads into orbit.

www.ulalaunch.com

DISPATCHES

DARPA's Smarter Pixels

Picture a sensor pixel about the size of a red blood cell. Now envision a million of these pixels—a megapixel's worth—in an array that covers a thumbnail.

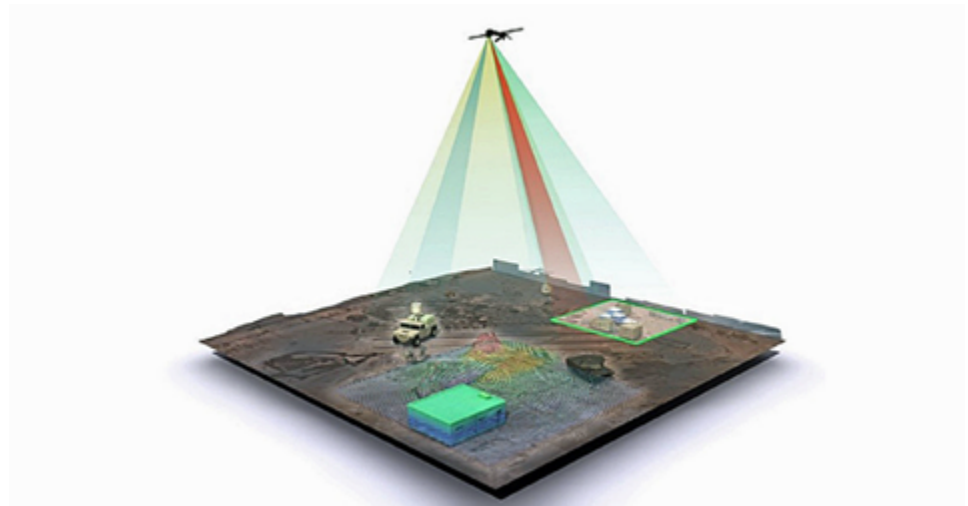
Take one more mental trip: dive down onto the surface of the semiconductor hosting all of these pixels and marvel at each pixel's associated tech-mesh of more than 1,000 integrated transistors, which provide each and every pixel with a tiny reprogrammable brain of its own. That is the vision for DARPA's new Reconfigurable Imaging (Relmagine) program.

"What we are aiming for," said Jay Lewis, program manager for Relmagine, "is a single, multi-talented camera sensor that can detect visual scenes as familiar still and video imagers do, but that also can adapt and change their personality and effectively morph into the type of imager that provides the most useful information for a given situation."

This could mean selecting between different thermal (infrared) emissions or different resolutions or frame rates, or even collecting 3-D LIDAR data for mapping and other jobs that increase situational awareness.

The camera ultimately would rely on machine learning to autonomously take notice of what is happening in its field of view and reconfigure the imaging sensor based on the context of the situation.

The future sensor Lewis has in mind would even be able to perform many of these functions simultaneously because different patches of the sensor's carpet of pixels could be reconfigured by way of software to work in different imaging modes.



That same reconfigurability should enable the same sensor to toggle between different sensor modes from one lightning-quick frame to the next. No single camera can do that now.

A primary driver here, according to Lewis, who works in DARPA's Microsystems Technology Office (MTO), is the shrinking size and cost of militarily important platforms that are finding roles in locations that span from orbit to the seas.

With multi-functional sensors like the ones that would come out of a successful Relmagine program, these smaller and cheaper platforms would provide a degree of situational awareness that today can only come from suites of single-purpose sensors fitted onto larger airborne, ground, space-based, and naval vehicles and platforms.

And with the more extensive situational awareness, Lewis said, would come the most important payoff: more informed decision-making.

DARPA also expects to post a Broad Agency Announcement that specifies the new program's technical objectives, milestones, schedule, and deliverables, along with instructions for researchers seeking to submit proposals.

One key feature of the Relmagine program is that teams will be asked to develop software-configurable applications based on a common digital circuit and software platform.

During the four-year program, MIT-Lincoln Laboratory—a federally funded research and development center (FFRDC) whose roots date back to the WWII mission to develop radar technology—will be tasked to provide the common reconfigurable digital layer of what will be the system's three-layer sensor hardware.

The challenge for successful proposers ("performers" in DARPA-speak) will be to design and fabricate various megapixel detector layers and "analog interface" layers, as well as associated software and algorithms for converting a diversity of relevant signals (LIDAR signals for mapping, for example) into digital data.

That digital data, in turn, should be suitable for processing and for participation in machine learning procedures through which the sensors could become autonomously aware of specific objects, information, happenings, and other features within their field of view.

One reason for using a common digital layer, according to Lewis, is the hope that it will enable a community developing “apps” in software to accelerate the innovation process and unlock new applications for software-reconfigurable imagers.

In follow-on phases of the program, performers will need to demonstrate portability of the developing technology in outdoor testing and, in Lewis’s words, “develop learning algorithms that guide the sensor, through real-time adaptation of sensor control parameters, to collecting the data with the highest content of useful information.”

That adaption might translate, in response to visual cues, into toggling into a thermal detection mode to characterize a swarm of UAVs or into hyper-slow-motion (high-frame rate) video to help tease out how a mechanical device is working.

“Even as fast as machine learning and artificial intelligence are moving today, the software still generally does not have control over the sensors that give these tools access to the physical world,” Lewis added. “With ReImagined, we would be giving machine-learning and image processing algorithms the ability to change or decide what type of sensor data to collect.”

Importantly, he added, as with eyes and brains, the information would flow both ways: the sensors would inform the algorithms and the algorithms would affect the sensors.

Although defense applications are foremost on his mind, Lewis also envisions commercial spinoffs.

Smart phones of the future could have camera sensors that do far more than merely take pictures and video footage, their functions limited only by the imaginations of a new generation of app developers, he suggested.

www.darpa.mil/

DISPATCHES

Marines Rely On Comms For Annual Exercise Success



Unwavering heat, storms and strong winds failed to halt approximately 90 Marines during a field exercise conducted by Alpha Company, Marine Wing Communications Squadron 28 aboard Marine Corps Air Station Cherry Point in early fall.

The two-week exercise occurs annually to satisfy training and readiness requirements and serve as an opportunity for the Spartans to reaffirm previously learned skill sets.

Alpha Company is using enablers such as Very Small Aperture Terminals (VSAT) Large and Tactical Elevated Antenna Mast Systems allowing the squadron to deliver transmissions between satellites

Gunnery Sgt. Curtis Myers, the staff NCO in charge of the exercise for Alpha Company, said, “We have a transmissions section that locks-on to satellites for us, radio Marines that handle our single channel radio networks with the wire sections handling telephone support from the field and data Marines setting up Internet or Internet based capabilities.”

This field exercise allowed Marines to enhance and reaffirm lessons learned during previous training. By conducting this exercise the company of Marines was able to showcase their ability to support units while forward deployed and affirm their state of readiness.

While conducting the exercise, Alpha Company aimed to simulate a deployed environment throughout the exercise. By simulating being forward deployed, Marines are able to gain knowledge that will be beneficial when put in a real world situation.

Myers said it was important for the junior Marines to get hands-on experience, but no matter what, there’s always room for improvement.

A problem often faced when working from tents, as opposed to cement buildings, is unpredictable weather. Wind, water, and other elements can impact the care of the equipment.

According to Cpl. Michael Lorrey-Every, a data systems technician with MWCS-28, without communications, coordination in the field almost comes to a halt.

“It’s the little things like making sure cords are plugged into the right ports and getting the Marines used to what they need to be looking for when troubleshooting,” said Lorrey-Every. “We want to uphold our training and readiness standards. [The field exercise] gives us the opportunity to be tested and ready when we come across unexpected situations in the field.”

“Marines who aren’t directly involved with communications may not realize there’s a lot of work that goes in to establishing communications,” said Myers. “Call for fires, medevacs need communications to communicate back and forth to talk between the infantry side and wing side so they know where they need to go and where the planes are at. Until you go out and do it, you don’t see the reasoning for it.”

Story by Cpl. Jason Jimenez,
Marine Corps Air Station, Cherry Point

DISPATCHES

A Core Solution For Wireless Network Transmission Of Classified Info

Unifying and securing the management of wireless command posts for the US Army has led to the selection of PacStar®, a developer and supplier of advanced comms for the DoD, to integrate their IQ-Core® Software with CSfC (Commercial Solutions for Classified) Plug-in into the systems.



As a result, the US Army will enhance their ability to securely transmit classified information (up to top secret) over wireless networks that warfighters rely on for in-theater operations.

CSfC is a National Security Agency (NSA) program that enables DoD organizations to leverage commercial products in layered solutions to protect National Security Systems data.

The US Army's decision to adopt wireless for mission communications is enabled by the CSfC program, which recently developed security standards for classified network access over satellite, Wi-Fi, and cellular communication networks, using commercial products from companies such as Aruba (an HP Enterprise Company) and Cisco Systems.

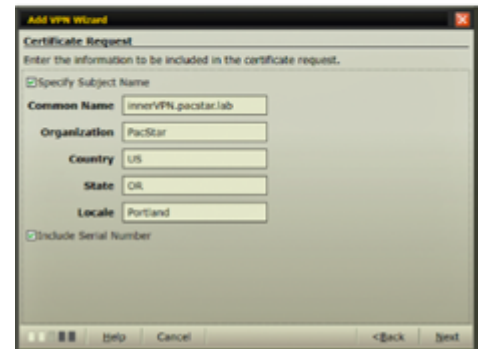
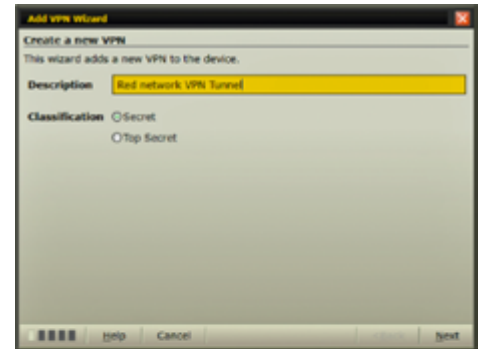
During combat operations, Army forces must often move or "jump" base locations to outmaneuver enemies or avoid attacks.

PacStar IQ-Core Software with CSfC Plug-in addresses set-up, configuration and monitoring challenges associated with CSfC implementations in the wireless command posts, while delivering key benefits:

- » *Rapidly and reliably simplifying setup and configuration of IPsec VPNs*
- » *Managing certificates, publishing and distribution of certificate revocation lists and more, which is otherwise intractably difficult to accomplish*
- » *Accessing multiple, independent vendor equipment and software through a single user interface, reducing training and speeding operations*

IQ-Core Software and IQ-Core Software with CSfC Plug-in are now available for use with PacStar-designed tactical and enterprise systems, as well as separately for integration on OEM systems and insertion into existing programs of record.

According to Peggy Miller, the Chief Executive Officer of PacStar, rapidly assembling and implementing secure networks at command posts and similar in-theater environments is normally a complex, manual operation typically performed by highly trained specialists.



View of simple step-by-step wizard-based setup screens

PacStar IQ-Core Software with CSfC Plug-in removes that complexity, providing rapid, intuitive communications management in order for the US Army to extend their ability to securely transmit classified information from controlled 'wired' network locations to wireless networks.

For a number of years, PacStar IQ-Core Software has supported WIN-T's Increment 1 program, focused on providing expeditionary communications and delivering this new capability furthers our commitment to solving key DoD warfighter communications challenges.

www.pacstar.com

DISPATCHES

WIN-T Increments Testing Goes Well For General Dynamics Mission Systems

New and improved versions of two, key, Warfighter Information Network-Tactical (WIN-T) Increment 2 capabilities have begun the test and evaluation process at US Army installations across the country by General Dynamics Mission Systems.

Integrated on HMMWVs instead of five-ton FMTVs, both the Tactical Communications Node-Lite (TCN-L) and the Network Operations and Security Center-Lite (NOSC-L) feature a greatly reduced footprint and improved transportability for expeditionary operations (C-130 roll-on/roll off and CH-47 sling loadable).

The TCN-L and NOSC-L provide the same networking and network management capability to command posts while reducing the complexity to install, operate and maintain the Army's mobile tactical communications network.

Mission Systems has delivered four TCN-Ls and two NOSC-Ls to the Army to begin the test and evaluation process as part of the lead up to more formalized operational testing at the Army Network Integration Evaluation 17.2 in 2017.



This testing includes wide area network transmission performance, safety and environmental and electromagnetic interference testing.

Additionally, Mission Systems is performing preliminary logistics and software evaluations on a TCN-L and a NOSC-L. Four additional TCN-Ls and one NOSC-L are currently in production and are expected to enter the test and evaluation process by the end of October.

WIN-T Increment 2 is the Army's wide-area tactical communication network that delivers voice and data services across the battlefield.

WIN-T Increment 2 entered full rate production in June of 2015 and has been fielded to seven division headquarters and 14 brigade combat teams.

According to Bill Weiss, the Vice President and General Manager of the Ground Systems line of business at General Dynamics Mission Systems, these capabilities provide the Army a more agile network capability and greater expeditionary reach.

Additionally, the smaller footprint will result in reduced maintenance and logistics costs, which is crucial in today's resource-constrained environment.

General Dynamics Mission Systems is a business unit of General Dynamics (NYSE: GD).

gdmissionsystems.com



DISPATCHES

Aurora Enrichment For Canadian Department Of Defense By Newtec

Newtec has been selected by General Dynamics Mission Systems-Canada to provide their MDM9000 Satellite Modem to the Canadian Department of National Defence (DND) for use on the Aurora fleet as part of the Aurora Incremental Modernization Project Block IV upgrades.

The fleet contributes significantly to the security of Canada and North America, and supports the restoration and maintaining of peace and security in regions around the world.

Under the contract with General Dynamics Mission Systems-Canada, Newtec will deliver the MDM9000, a

the most advanced satellite modem certified to operate on Wideband Global Satcom (WGS) constellations.

The Newtec MDM9000 airborne modem on the aircraft will communicate with a similar MDM9000 modem on the ground.

The Newtec MDM9000 Satellite Modem is a versatile nexgen modem, optimized for use in a wide range of government and defense applications over satellite, such as intelligence gathering, fixed and mobile miltacom deployments on WGS and commercial constellations.

The modem is typically installed at both ends of a point-to-point satellite link or at the remote sites of a star network and integrates seamlessly with terrestrial networks and equipment.

Koen Willems, the Market Director for Government and Defense at Newtec, related that the Newtec MDM9000 modem is a nexgen product that embodies the latest technologies, such as DVB-S2X and Newtec's Bandwidth Cancellation (BWC), and is available for deployment today.

By selecting both the MDM9000 on the aircrafts and on the ground for operations, Canada's Department of National Defence will benefit from the highest throughput at maximum service availability, allowing the relay of HD video and sensor data from its Aurora fleet to increase operational efficiency and enhance the decision making process.

www.newtec.eu



The CP-140 Aurora is a long-range patrol aircraft operated by the Royal Canadian Air Force for domestic and international defense missions and is used in a wide variety of operations, including strategic airborne surface (sea and land) and subsurface missions, as well as maritime, overland Intelligence, Surveillance and Reconnaissance (ISR) and Search and Rescue (SAR) missions.

ruggedized, ATR-size airborne modem to provide High Data Rate (HDR), Beyond Line-Of-Sight (BLOS) airborne communication between the airborne platform and the DND ground network.

The Newtec modem is equipped with the most advanced DVB-S2X and S2 waveforms, Newtec's end-to-end FlexACM® technology for performance and fast link acquisition, is compliant with DO-160 and MIL-STD 810E standards, and will become



The Royal Canadian Air Force CP-140 Aurora long range patrol aircraft.

A CHAIN IS ONLY AS STRONG AS ITS WEAKEST LINK: A NEWTEC PERSPECTIVE

By Koen Willems, Senior Contributor

I recently witnessed a demo by the Belgian naval force where they tested different types of autonomous and unmanned vehicles for their mine counter measure (MCM) operations.

Thanks to these unmanned MCM modules, crew safety can be increased as mine hunting vessels can remain at the outside of a minefield.

For decades clearing mines was a dangerous and close-up business. Specialized ships, divers and even trained dolphins had to go right into the minefield.

Today, mine hunter operators will send unmanned robotic assets into the minefield under water and on the surface. These unmanned systems will typically carry a variety of sonars, cameras, sensors and target recognition systems to perform these mine counter measure operations.

MCM OPERATIONS & SATELLITE

How are MCM operations and satellite communications related? Unmanned submarine vehicles do not have the form factor to carry SATCOM terminals nor antennas. They mostly operate under water and at the bottom of the sea and typically use underwater acoustic modems.





These acoustic modems transmit up to 40 kbit/s sensor video and data from the unmanned system to the unmanned surface vehicles (USV) inside the minefield or to a gateway at the border of the minefield. The reach of these modems is only 1,000 to 2,000 meters before the signal starts to fade. Satellite communications will be used on board these gateways and USVs when operating in Beyond-Line-Of-Sight (BLOS) MCM missions.

In a typical set-up, an MCM vessel should be able to simultaneously control remote mine-hunting systems looking for mines and one USV sweeping them. Meanwhile, the MCM vessel stands back at a safe distance from not only the minefield but also from any nearby enemy forces.

In addition to mine counter operations, the remote mine-hunting/multi-mission systems (RMMVs) and USVs are deployed for different types of tasks ranging from Intelligence, Surveillance & Reconnaissance (ISR), Anti-Submarine Warfare (ASW), mapping and terrain navigation to harbor security, Search & Rescue (SAR), recovery, first

responder and diver support, as well as hull and maritime infrastructure support.

As the sensors and the cameras onboard these unmanned vehicles become more powerful to reveal more granularity and details to the MCM operator the data rates will increase substantially. Most of the RMMVs and USV have local storage capabilities but in dangerous missions a situational awareness live link is required.

The operator on board the MCM vessel will process the incoming sensor data and video and guide the unmanned devices into the minefield. They depend on reliable, secure and efficient communications to successfully complete their missions.

However, a chain is only as strong as its weakest link. If the satellite link fails or does not provide enough throughput, the entire operation can go adrift and expensive RRMV or USV gear can get lost.

THE BANDWIDTH BOTTLENECK

Naval mission operators are regularly confronted with SATCOM bandwidth bottlenecks that force them to reduce the scope of their missions or complete their operations in an ineffective way. High detail images and sensor data should be provided to the MCM operator to distinguish mines from rubbish drifting in the sea.

Furthermore, satellite links are used to exchange tactical, situational and ISR information between vessels and the headquarters. Welfare and e-health programs have equally been made part of the SATCOM communication package.

Different programs were introduced onboard the navy vessels in order to recruit young personnel that were born in the digital age and to respond to e-health requirements imposed by navy unions. For the last few years naval vessels have been pushing the limits of existing satellite platforms.

Until now, navy vessels and USVs were forced to rely on low-end TDMA services or expensive narrow-band and SCPC circuits that lacked the performance and flexibility to meet their needs. Today, the satellite industry is enjoying a period of unprecedented growth and innovation both in the space and the ground segment.

With the advent of HTS, nexgen VSAT systems and electronically steerable flat-panel antennas, the promise of ubiquitous, high-speed connectivity is closer than ever. HTS will provide significantly more capacity at lower costs, dramatically improving the user experience.

First-generation VSAT platforms brought important innovations like beam switching, Quality of Service (QoS), uplink power control, and dynamic bandwidth allocation. Unfortunately, as most of those features operated independently, with primitive logic, the combined results were unpredictable and difficult to manage at scale. Also, the early VSAT modems did not bring the throughputs that were required by bandwidth-hungry applications onboard naval vessels and USVs.

IMPROVING NAVAL EFFECTIVENESS & EFFICIENCY

Nexgen VSAT platforms—such as the Newtec Dialog® multiservice VSAT platform—will fundamentally improve the effectiveness and efficiency of naval operations.

The Newtec Dialog platform supports a wide range of applications (ISR, MCM, welfare, situational awareness, tactical, etc.) and services (video conferencing, sensor relay, voice, data, etc.), with unprecedented scale. Powerful spot beams demand more advanced transmission standards, while also creating new challenges for on-the-move applications.

Beam switching logic must become multidimensional, allowing network operators to continually manage factors like load balance, regulatory restrictions, cost and weather. With the advanced beam-switching engine called the Newtec Dialog Mobility Manager, all aspects of beam switching will be orchestrated through a central process at the hub location.

The efficiency of the satellite link has an immediate impact on the efficiency of the naval operations. Link efficiency translates in to higher throughput and maximum service availability. The powerful DVB-S2X forward and Newtec MX-DMA® return waveforms onboard the Newtec Dialog platform already increase throughput rates by 30 to 50 percent in the same satellite bandwidth when compared to legacy TDMA and SCPC systems.

As such, an operator of naval networks has the choice to increase throughput rates, maximize service availability, grow user-experience, cut the gained bandwidth and allocate budgets to other naval applications or a combination of these elements.

Innovative technology such as seamless beam switching and the highly resilient Newtec Mx-DMA return waveform go hand in hand with market proven technology, such as Newtec's FlexACM®, in order to maximize the service availability. In adverse conditions such as rain fade, interference and shadowing effects, the satellite link needs to be maintained for mission critical communications.

If traffic patterns or link conditions change, the Newtec Dialog VSAT platform will adapt these satellite links in a seamless, dynamic and efficient manner. Losing the link or dropping packets is not acceptable as it could endanger naval missions and human lives.

With the Newtec Dialog platform operators of naval networks have the possibility of connecting multiple platforms (such as MCM vessels, USVs, frigates, command ships, aircraft carriers etc.) to a single hub for regional operations or to a global network on a single platform. Modem types, throughput rates, QoS and priorities can be flexibly adapted according to the type of naval platform.

DEPLOY ANYWHERE, ANYTIME

The global maritime domain and the role of naval power have changed significantly in recent decades. Navies around the world are regularly doing things for which they were not designed. Naval forces are finding themselves increasingly engaged in enforcing sanctions, chasing pirates, interdicting narcotics and providing humanitarian support.

The modern context translates in to complex operating environments. With the introduction of new technologies such as unmanned multi-purpose and MCM vehicles, as well as the growing importance of welfare and healthcare programs onboard the vessels, navy operations have become increasingly dependent on satellite communications.

However, a chain is only as strong as its weakest link. If the VSAT system does not meet the throughput and QoS requirements or if the VSAT platform is not adapted to the complex naval operational environment, it will impact the efficiency and effectiveness of these naval missions in a negative way.

Today, SATCOM innovations, such as HTS, nexgen VSAT systems and efficient terminals, are in naval forces' reach. The Newtec Dialog multiservice VSAT platform embraces the complexity of modern naval assignments and will increase an operator's efficiency, scalability and flexibility, allowing naval SATCOM operators to engage in operations anytime, anywhere.

www.newtec.eu

Koen Willems holds the position of Market Director for Government, Defense and Humanitarian SATCOM for Newtec, a Belgium-based specialist in satellite communications. He is responsible for global market and business development, strategy and Newtec technology evangelization.

Koen is also vice-president for the Belgian Security and Defense Association with the main objective to represent, safeguard and promote member companies in Belgium and abroad.

THE HPA CORNER: WHY HOSTED PAYLOADS MUST BE INCLUDED IN THE SPACE ENTERPRISE VISION

By Hayley McGuire, Deputy Director, Boeing Advanced Government Space Systems



When the Commander of the Air Force Space Command, US Air Force General John Hyten, announced the Space Enterprise Vision (SEV) last spring, his goal was to direct focus on ways to make national security space more resilient to increasing space threats and to provide a framework for the future of national security space.

In his Commander's Strategic Intent, General Hyten said, *"We must move away from slow, expensive, "Big Bang" deliveries of capabilities that are late to need. In the face of continuously adapting adversaries, evolving threats, and increased needs for operational agility, our future operational enterprise must and will be different than today's."*

The Space Enterprise Vision incorporates an integrated approach across various mission areas to aid the warfighter in the face of a contested and congested environment. Although the role of hosted payloads is not specifically addressed in the SEV, hosted payloads can, and should, play an important role in the implementation of this vision.

Space is now a contested environment, with the ever-increasing need for resilient systems. Federal budget pressures, the increasing amount of international partnerships, and the sophistication and proliferation of commercial satellites have begun to make us evaluate what capabilities we need and have opened the door to new procurement options. In addition, federal budget pressures have motivated lawmakers to evaluate how they can meet their mission needs with the most cost-effective solutions.

An effective response will require reassessing how our systems are built and deployed to draw from a wider range of capabilities, including more commercial products and services and international assets. This will ultimately provide an affordable and highly resilient set of space systems that will continue to provide assured access to meet the needs of the Warfighter and intelligence community.

The benefits of hosted payloads include:

- *Increased flexibility offered by hosted payloads could be an important solution to augmenting programs of record*
- *Hosted payloads are more responsive, with some developed and fielded in as little as 12 months*
- *The incorporation of hosted payloads can help complicate the adversary's calculus*

The Space Enterprise Vision offers a unique opportunity for the inclusion of hosted payloads as a means to help accomplish its critical goals.

As long as hosted payloads are implemented cost effectively, using the commercial industry model, and unburdened by Government procurement overhead and oversight, they will achieve the desired result and should be a required element of resilient architectures going forward.

This column's question for HPA Members is...

In what ways can the implementation of hosted payloads help enact the Space Enterprise Vision?

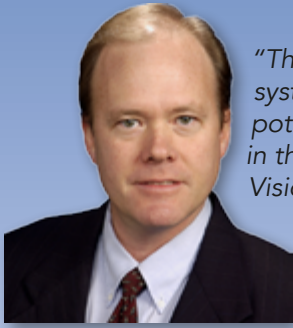


"As demonstrated in the Air Force's Commercially Hosted Infrared Program (CHIRP) hosted on SES-2, commercially hosted payloads are viable options for future resilient space architectures. Not only did CHIRP

demonstrate that commercial satellite owner-operators could host military payloads, it also proved hosted payloads' affordability (CHIRP's cost was just 15 percent of the cost of a dedicated Air Force infrared satellite) and responsiveness (39 months from contract to launch), both are attributes of future resilient architectures.

"Further, by operating hosted payloads as part of future architectures such as the Space-Based Infrared Follow-On, Protected Satellite Communications Services, Space-Based Surveillance System Follow-On, and the Space-Based Environmental Monitoring programs, commercial owner-operators can enable the Air Force's Space Mission Force—allowing the repurposing of military satellite operators, traditionally used to "fly" military satellites and payloads, to focus on training, planning, and executing space operations in a high-threat environment, further enhancing resilient attributes of the Space Enterprise Vision."—

Todd Gossett, Senior Director of Hosted Payloads, **SES Government Solutions**



"The emphasis on a space system's resiliency to potential adversary threats in the Space Enterprise Vision reflects a new

paradigm for space system solution providers because many US military space systems have

historically been designed without threats in mind. General Hyten stated, "Without the need to factor in threats, longevity and cost were the critical factors to design and these factors were applied in a mission stovepipe. This is no longer an adequate methodology to equip space forces.

"Large complex satellites that provide exquisite capabilities, however, are limited by cost to a single (or even several) platforms have been compared to Fabergé eggs — inherently fragile and very expensive both in terms of dollars and time.

"An adversary's calculus becomes simple arithmetic. Take one out and the reward is high. The inclusion of hosted payloads and small satellites in a space system architecture enables disaggregation that complicates an adversary's equation.

"Hosted solutions and small satellites offer diversity in terms of platforms, location, communication links, and cyberspace to name a few. Consequently, these alternative approaches to deploying space capabilities will likely play a vital role in realizing the Space Enterprise Vision for affordable and timely space system resiliency."—**Sid Stewart**, Portfolio Manager, Satellite Solutions Group, Space and Intelligence Systems, **Harris Corporation**

hostedpayloadalliance.org/

HOW COMMERCIAL SATCOM MANAGED SERVICES SUPPORT THE MILITARY'S CRITICAL MISSIONS

By Harrison Donnelly

Angered by a satellite news network's critical story during the Arab Spring, the Egyptian government jammed satellite transmissions, thereby preventing the nation's citizens from receiving the information.

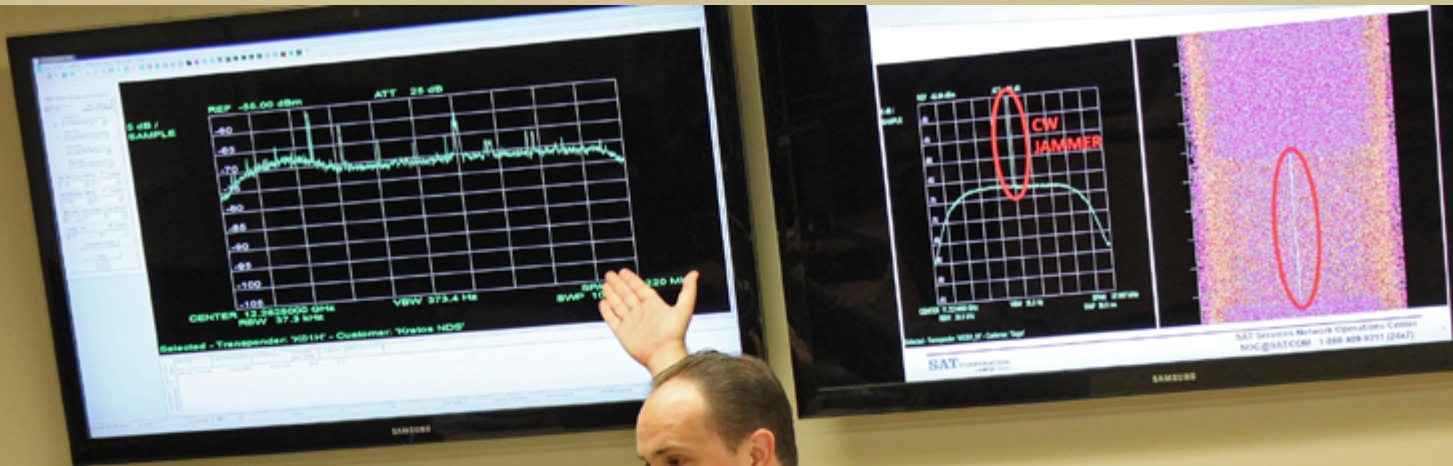
When Egyptian officials denied they were involved, commercial geo-location technology designed to locate interference with satellite communications enabled analysts to show that Egypt was, in fact, responsible—the country quietly dropped their interfering efforts.

At the request of the commercial news organization, that geolocation capability was provided by Kratos' managed SATCOM services. As RFI events are common to both the military and commercial sectors, Kratos provides such services, and more, to a host of commercial and government organizations.

Such growing commercial/military cooperation is not limited to RFI monitoring and interference detection, but also includes commercialization of the Air Force's Wideband Global SATCOM (WGS) system and the use of commercial launch vehicles to place DoD satellites into orbit, among others.

In a panel discussion at the 2015 SATCON conference, Retired Major General Jay Santee, US Air Force, shared his view of an infrastructure in which military satellites were supported by commercial SATCOM technology to provide mission critical satellite communications.

One example of this cooperation is Kratos' work with the Air Force Joint Functional Component Command for Space (JFCC Space.) A component of the US Strategic Command (USSTRATCOM), JFCC Space is responsible for executing continuous, integrated space operations to deliver theater and global effects in support of national and combatant commander objectives. This includes protecting the



Kratos Spectral Services NOC Supervisor Mike Felix briefs staff on an active EMI event during a recent Operations Center shift change.

commercial satellite bandwidth leased by the US Department of Defense (DoD) to support a variety of critical mission needs, such as reconnaissance, surveillance and broadband communications between commanders and field units.

PROTECTING DOD BANDWIDTH

Under a contract with JFCC Space, Kratos is providing RF interference monitoring and geolocation services for US Department of Defense (DoD) leased commercial satellite bandwidth. The program offers a telling example of the growing interest and potential of closer military-industry partnerships in all aspects of space operations.

The program also embodies the increasingly important concept of government agencies utilizing managed services, in which companies don't sell equipment or software to the military, but instead assume responsibility for operation of key functions, thus enhancing efficiency and flexibility.

As reflected in the Space Enterprise Vision (SEV) recently outlined by General John Hyten, commander of Air Force Space Command, leaders of that service are looking closely

at a variety of ways to restructure space operations, including expanding commercial partnerships. Under the SEV, military missions that don't require a military operator will be transferred to managed services providers. As a result, military personnel will be able to focus on the most vital missions, such as Space Protection and Navigation Warfare.

Although Hyten made clear that certain vital functions will always remain directly in military hands, officials are examining new roles for industry in such areas as ground control stations and developing the successor to the military WGS system.

Meanwhile, the government is currently conducting a wide-ranging study of potentially major changes in how it operates in this area, including a closer look at the use of managed services. The supplemental COMSATCOM support provided by Kratos and other companies is especially important in light of the fact that an estimated 80 percent of US military satellite communications are carried by commercial satellite operators, rather than by MILSATCOM systems.



A MILSATCOM RENAISSANCE?

On Capitol Hill, Representative Jim Bridenstine (R—Oklahoma) has emerged as a leading advocate for new approaches to industry's role in military space. He is the sponsor of the "*American Space Renaissance Act*," which calls for comprehensive changes in all aspects of space policy, including commercialization, with the goal of securing the role of the United States as the "*preeminent spacefaring nation*."

The defense authorization bill passed by the House includes 10 provisions from Bridenstine's proposal, including one requiring that the analysis of alternatives for the successor to the WGS program includes a fresh look at commercial business models and technology insertion plans.

FLEXIBLE & SECURE ARCHITECTURE

For Bridenstine and others, the benefits of military-industry cooperation include cost savings and greater responsiveness to changing technology as well as a more resilient architecture in the face of potential attacks on space systems by a sophisticated adversary in some future conflict.

"If you look at the WGS architecture, in the future we could have up to 10 of these satellites, which are our geostationary satellites that provide over-the-horizon communications for the military, and are owned and operated by DoD," Bridenstine observed in a recent interview. *"Those 10 satellites are important, but we need to distribute the architecture in a way that will complicate targeting for an enemy. If we look at the commercial satellites that are in geostationary orbit, then we have 150 satellites. The goal is to complicate targeting for our adversaries, while at the same time providing resilience for our warfighters."*

Bridenstine also notes the benefits of managed services. *"The government doesn't have to invent its own architecture, but can go to a commercial operator and say it has a certain number of bits that need to go from one particular location to another. Then the commercial operator can create the solution, and the government doesn't have to invest on its own. The chief advantage is that the government doesn't have to create its own networks, which in some cases will end up being only temporary."*

"On the other side, the commercial operators can provide government specific requirements and service level agreements," he continued.

"So if Special Operations Command wanted to have an agreement with a commercial operator, they could purchase a temporary Service Level Agreement (SLA) that gives them priority. When it comes to managed services, an SLA provides the government a level of efficiency that we don't currently have."

"When you use commercial services, you have the power of the market helping to keep costs down," noted Phil Carrai, President of Kratos Technology and Training Division. *"In*

our case, we have operators who are doing it for a living and don't require training or have high turnover. When you put uniformed personnel in a position, they usually need to be trained on the systems they are operating, and then they move on after a few years. Because the types of services we provide don't require a military person, we're augmenting the ongoing mission activity. The military and government are driving toward putting operations in place that are run by experts in a commercial field so uniformed personnel can focus their attention on critical mission related activities."

"It's also leveraging the infrastructure of commercial enterprises," said Greg Caicedo, Kratos' Vice President who oversees the program. *"In the case of the services that we're providing for JFCC-Space and others, we have a global infrastructure that we maintain, and have developed the products that we deploy. So we can install new software or features that would benefit the government, which doesn't have to worry about maintaining and operating the infrastructure."*

CONGESTED ENVIRONMENT

The push for closer partnerships is also occurring at a time of significant transformation within the satellite world, as it moves from fixed-satellite-service to high-throughput satellites, which can provide many times the capacity of older systems. As a result, satellite operators will be able to offer a new range of services and also reach end-users directly, moving away from the traditional method of selling capacity to resellers that then repackage it.

"These satellites are changing the business, and that will change how the military buys what it needs, as well as how we can support and monitor it, including sensors designed for HTS spot beam monitoring, using data analytics to assess HTS performance and enhanced situational awareness of monitored satellites, beams and related collateral signals. At the same time that the satellite industry is going through that transformation, we're developing a way to ensure that the government is getting the best value from providers," Carrai added.

The explosive growth in the satellite business has greatly increased the need for EMI monitoring such as that provided by Kratos to Central Command (CENTCOM) and Pacific Command (PACOM) under their contract with JFCC. With so many satellites operating on common frequencies and orbital slots, there are frequent opportunities for SATCOM interference.

The majority of the interference is unintentional, due to a variety of factors. Operators may be using faulty equipment, systems may be incorrectly positioned or operators may not be in compliance with regulations. Sometimes broken equipment can put out excessive or misdirected power, creating interference for other users on that transponder, explained Caicedo. Adjacent satellites can also be a problem due to the close proximity of satellites.



Spectral Services Operation Center is manned 24/7/365 providing EMI migration, Pro-Active monitoring of Satellite Transponders and Geolocation services to DOD and Commercial customers.

The goal of EMI monitoring is to ensure that the SATCOM is delivering needed capacity, and that the government is able to respond whether someone is accidentally interfering or intentionally jamming transmissions.

Although the US government has some capability in this area, officials found that they needed additional coverage. That led to the agreement with Kratos, which already provides such services extensively to commercial operators.

RFI MONITORING & DETECTION

The Kratos infrastructure comprises an extensive global network of RF monitoring and interference detection sensors and geolocation systems. The current configuration includes 16 worldwide monitoring sites hosting more than 40 antennas with visibility to more than 40 satellites, 80 beams and 100 transponders. In addition, five dedicated steerable dual-antenna geolocation systems support Ku- and C-band with visibility to more than 80 percent of fixed satellite service systems. The overall network is scalable, and Kratos executives anticipate 2016 growth that will more than double the current monitoring capacity.

The service includes Kratos' Monics® carrier monitoring product whose sensor infrastructure covers their customers' fixed satellite service beams and uses state-of-the-art

technology to take high-speed, accurate measurements of critical satellite communication signals.

"Monics uses a high-speed digital signal processing capability that makes carrier measurements against a monitoring plan, so that our team gets notified whenever there is any change to our customer's terminals or bandwidth," Caicedo explained. "Our other primary product is satID®, which is a highly accurate system to locate the interference. We use a time-difference-of-arrival and frequency-difference-of-arrival method to perform geolocation that is typically accurate to within 5km of the interference location."

In addition, the company's Compass® Monitoring & Control (M&C) and NeuralStar® network management products keep tabs on the health and performance of all devices supporting the services. With these products, RF analysts can remotely control all the systems around the world from a facility in Colorado Springs, Colorado, where they are able to turn antennas and make sure that all systems are operating.

The Network Operations Center employs a dedicated workforce skilled in RF spectrum management, geolocation and data analysis, supporting government and commercial customers on a round-the-clock basis. The personnel can ebb and flow as needed across fluctuating customer

requirements, apply consistent skills and utilize broad databases and solution sets, allowing Kratos to offer a highly efficient application of resources to its customers.

That staffing flexibility provides significantly lower personnel spending than the government would need to maintain its own workforce dedicated specifically to the mission. It also reduces training, permanent-change-of-station, infrastructure and other operations and maintenance costs.

"Not only do we perform a real-time function, identifying and responding to interference that may be affecting communications, but we also look to resolve it," said Caicedo. *"We leverage our relationships with satellite owner/operators around the world, to geolocate interference, perform analysis or work with partners to mitigate the impact of the interference. We also collect data and analyze how SATCOM is performing over time."*

ENHANCING UTILIZATION & EFFICIENCIES

In addition to EMI monitoring and interference detection, Kratos also helps its commercial and government customers enhance bandwidth utilization by providing them with reports on bandwidth usage and trends over time.

"We can provide our customers with data collection and analysis services, looking at bandwidth utilization and providing them feedback on how to possibly consume bandwidth more efficiently. We get information on how they plan to use the bandwidth, and compare that to how they performed against that plan, to assess the utilization of that bandwidth," said Tom Zehringer, Kratos Operations manager.

"Satellite operators can use the information to provide feedback to their customers on how they are utilizing their bandwidth, so they can be informed consumers the next time they need to buy," he continued. *"It's like your cellphone bill, where your provider gives you usage information, so that you can use data most economically. This provides awareness they didn't have before—information to make decisions that they didn't have in the past."*

For Carrai, the implications of such cooperation are clear: *"Kratos and other commercial SATCOM enterprises are demonstrating how valuable a commercial service can be. We are providing a service that is both comparatively inexpensive and of real value, and we're doing it with skill and speed."*

"The government can trust and depend on commercial entities for the kind of support activities that they've done in-house before, allowing them to focus more of their resources on mission success," Carrai concluded.

www.kratosdefense.com



The Kratos Operations Center utilizes the NOC Spectrum application to simultaneously monitor a large range of Satellite Transponders of interest providing near real-time Space Situational Awareness."

EQUIPPING DEFENCE FORCES FOR ASSURED ON-THE-MOVE COMMUNICATIONS

By Dr. Rowan Gilmore, Chief Executive Officer, EM Solutions

Broadband communications anywhere, anytime, anyplace can only be provided by satellite communications.

However, when communications are mission-critical, how can they be made more assured, resilient, and resistant to hostile or environmental interference?

Interference mitigation through exacting terminal design against the effects of weather, satellite congestion, frequency jamming, and motion itself all add toward this objective.

In fact, assured communications is similar to an onion with numerous protective layers in its skin. Those layers include maximizing link availability through good design, use of redundancy, frequency stealth, coding, limiting radio emissions in unwanted directions, and protection against interferers.

These are particularly difficult to achieve with satellite communications while on the move, but often it is while on the "run" that communications is most critical.



Consider each layer. First, improving link availability by maximizing the link budget is a good place to start. The link budget determines the allowable fade margin, which can be maximized by using the highest power transmitters possible, most sensitive receivers, steered antennas to maintain maximum antenna gain, and best pointing accuracy to minimize pointing loss.

Time on satellite is probably the biggest contributor to the availability equation: minimizing the time for a SOTM terminal to acquire or reacquire the satellite is critical, as is maintaining that link during violent motion conditions.

Second, redundancy can be improved in satellite communications through the use of multiple transmitters, as Block Up Converters (BUCs) are usually the most failure prone component in the link. The use of multiple satellite systems also assists with this need.

Frequency stealth might entail switching or spreading either the modem output frequency or the RF frequency. Changing to a lower frequency band can also protect against weather effects that can cause loss of the satellite link at the higher Ka-band frequencies.



An Australian Cape Class ship that defends the nation's coastline.

Third, coding and other security precautions, such as encryption at the data layer, can protect against theft of data.

Fourth, ensuring that the radio signal is highly directional with minimal RF spillover or sidelobes and protecting against interfering signals through careful electromagnetic design and analysis, is required and will avoid 'theft' of signals or intrusion upon the radio layer.

Such signals can also be unintentional or non-hostile but still cause link failure—for example, nearby radar systems often result in a total loss of communication capabilities.

This article will initially cover the basic parameters that determine the link budget and then describe how such features can be engineered into a highly assured and robust terminal with almost no increase in the total cost of ownership when compared to lower cost platforms.

MAXIMIZING THE LINK BUDGET

Shannon's famous equation gives the maximum capacity C of a general communications channel in bits per second as

$$C = B \log_2 (1 + \text{SNR})$$

where B is the used transponder bandwidth in Hz and SNR is the signal to noise ratio at the receiver.

Of course, B also determines the receiver noise, so SNR varies inversely proportional to B , thus maximum capacity does not always increase linearly with bandwidth. However, for typical values of SNR achieved at a ground satellite terminal ($1 < \text{SNR} < 20$), Shannon's equations tells us that if the signal power drops by half, the bandwidth needs to double to maintain roughly the same capacity C .

In their excellent paper [1], Murthy and Svesko point out the impact that a reduction in signal level can have. Noting that if the ground terminal EIRP is backed off by 3 dB (in their example, to prevent inter-satellite interference due to a pointing error of 0.5 degree in the terminal), the bandwidth needed to maintain the same bit rate doubles, and consequently the cost to lease the increased bandwidth.

Although rarely specified by a customer, total cost-of-ownership (TCO) for a communications network should be a critical determinant in the selection process for an on-the-move or on-the-pause antenna terminal.

In their example outlined in [1], even if a terminal with more accurate pointing error (< 0.2 degree) costs \$100k rather than \$50k for a less accurate terminal, after approximately six years of operation the terminal with the higher initial procurement cost will be a more cost effective network solution.

Any reduction in link gain impacts TCO in exactly the same way. The simplest expression for the link equation for a one way satellite link (in dBW) is

$$P_R \text{ (dBW)} = \text{EIRP} + G_R - L_o$$

where P_R is the received power, G_R is the receive end antenna gain, EIRP is the Equivalent Isotropically Radiated Power (equal to $G_T P_T$) of the transmitter, and L_o the one way channel and spreading loss.

For a geostationary satellite, the spreading loss component of L_o is 201.5 dB in X-band, 206.5 dB in Ku-band and 213 dB in Ka-band on the uplink. Therefore, P_R normally ends up quite close to the receiver noise floor so any increase in L_o (for instance, through poor pointing or rain attenuation) or any reduction in terminal G_R (or G_T , *i.e.*, EIRP if transmitting) can cause the received signal power to drop below threshold, and the link will be lost or at best, severely degraded. G_R is determined by the size of the antenna and, in the case of flat panel antennas, the angle of incidence as well, losing 3 dB at 45 degrees orientation from normal.

As Shannon's equation highlights, such a drop of 3 dB in P_R causes either the bit rate to halve (eventually forcing it to zero), or requires the bandwidth (and cost) to double to maintain the same capacity.

Of course, TCO is secondary when assured communications are at stake, but it is interesting that the same measures that improve link availability (and assist with assured communications) **can also reduce the total cost of ownership, all other elements (such as link capacity) being equal.**

As just described, both the gain and pointing performance of a SATCOM antenna system are important in preserving link availability. In [1], pointing performance is defined by the unit's ability to keep the antenna boresight pointed directly to the satellite during operation. However, it is more than that—performance also relates to the time taken to initially acquire the satellite.

For SOTM applications, these requirements are challenging due to the complex engineering required to steer the antenna's transmit beam directly to the satellite with high availability during vehicle motion. Only 'monopulse' technology is able to maintain lock on the satellite without deliberately introducing an intentional mis-pointing error off boresight to search for the beam maximum.

Monopulse technology is a closed-loop system that measures the relative level in a higher order mode in the antenna feed, typically the TE21 mode from the satellite signal. The system uses that mode's sharp null along boresight to derive a very accurate corrective pointing vector to force the antenna back in line, without the need to introduce any deliberate pointing loss to determine whether the antenna is aligned for maximum receiver power, as happens with conical or step scan systems.

As a monopulse system directly measures the TE21 signal which is proportional to the deviation off-axis, such a technology also has the benefit of being able to accurately monitor and report the instantaneous pointing error to the user. This ensures the BUC is only muted when the antenna is confirmed as being off-axis, rather than, for instance, if the received beam is measured as temporarily weak, such as due to a passing cloud.

Figure 1 below shows the total pointing error off boresight in millidegrees experienced by EM Solutions' new Cobra terminal in severe sea state conditions, where a closed-loop monopulse system stabilizes the system and compensates for the ship's motion.

The underlying motion is recorded by the terminal's three angle encoders in the base of the terminal, in the angular directions of azimuth, elevation, and cross-elevation, all in degrees.

Figure 2a on the next page shows the total pointing error as a polar plot in the elevation and cross-elevation directions vs time, while *Figure 2b*, also on the following page, shows the same data as a histogram.

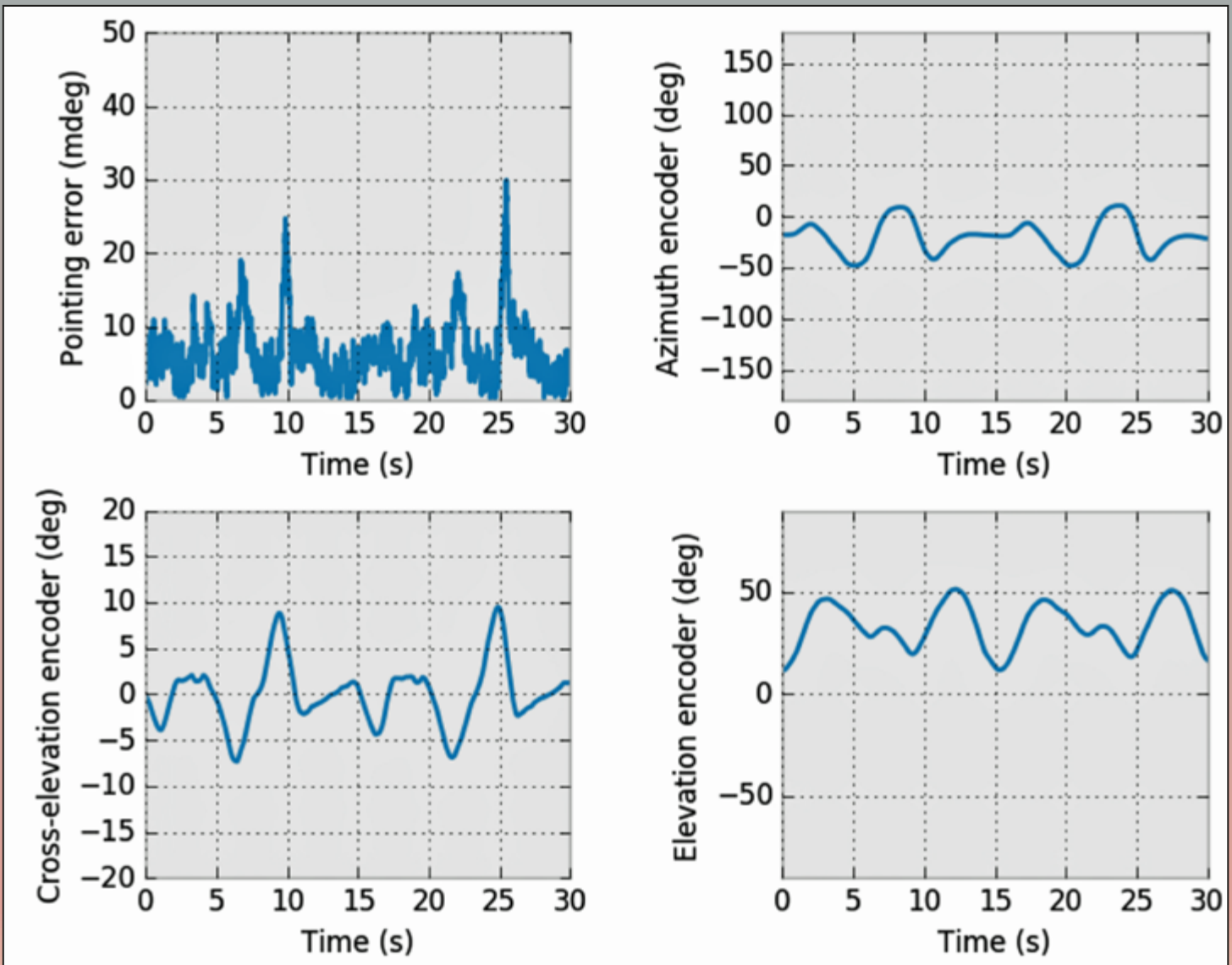


Figure 1. A sea-state motion profile, measured by cross-elevation, azimuth, and elevation angle deviations (degrees) in time, and the resulting stabilized terminal pointing error (millidegrees, top left)

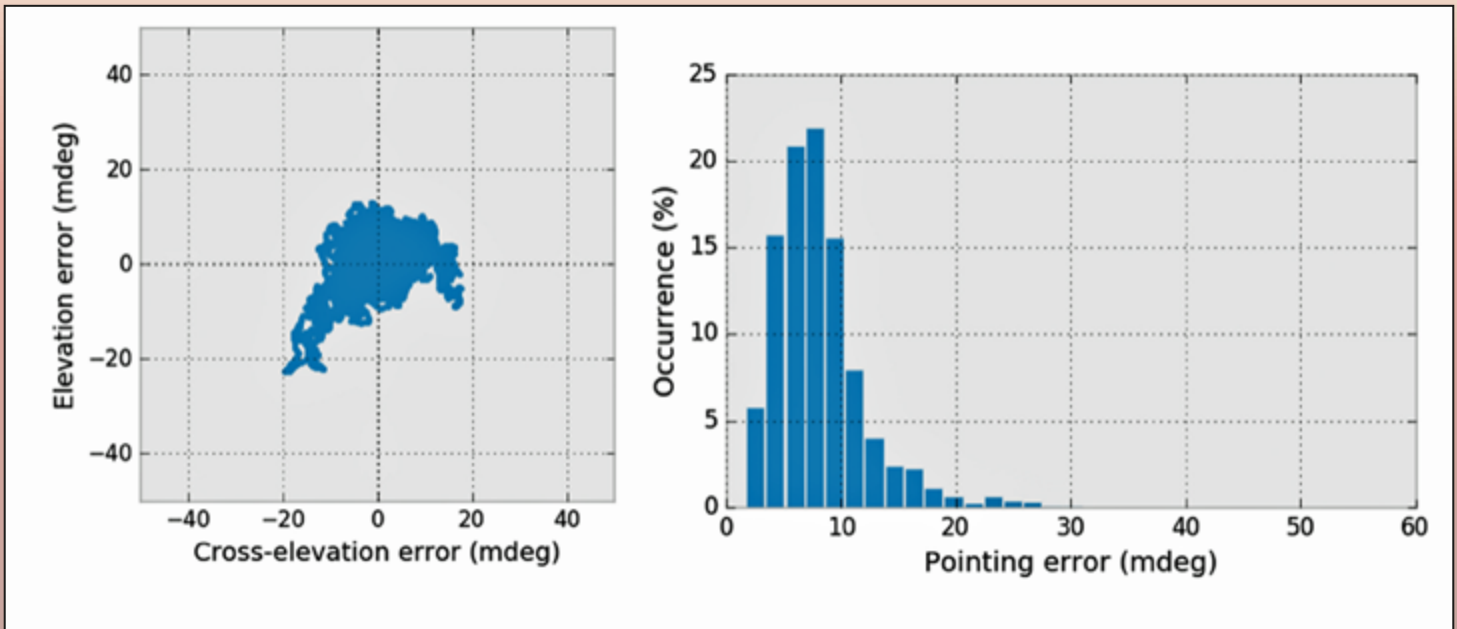


Figure 2a (left). A typical polar plot of the pointing error as measured by deviation from true boresight in elevation and cross-elevation angles (millidegree) vs. time.

Figure 2b (right). The total pointing error experienced by the terminal plotted as a histogram over all time samples. Note that the pointing error rarely exceeds 20 millidegrees.

The pointing error is maintained at less than 10 millidegrees for 75 percent of the time, and to less than 20 millidegrees for 97 percent of the time, subtracting almost nothing from the link budget. This is comfortably less than the maximum pointing error of 200 millidegrees specification on the WGS constellation.

Furthermore, the monopulse system and motion algorithms used to acquire the link and re-establish it after blockage result in tracking performance that has been reported by customers to be the best in the industry. All these features, together with a steered parabolic antenna that always gives maximum gain irrespective of pointing direction, ensure the link equation is optimally tuned for maximum uplink time, availability and link capacity.

REDUNDANCY

However, there is still more that can be done to assure satellite communications. Redundancy in hardware, frequency and satellite selection are three additional ways to introduce resilience into the link. The choice of satellites and use of multiple bands mitigate against weather effects, jammers, interferers, congestion, and even the loss of a satellite.

The approach taken at EM Solutions is to engineer a satellite terminal that automatically switches between any of three satellite bands on different satellites, even while on-the-move. Although maritime terminals already exist with either commercial or military Ka-band capability, or with dual X-band and military Ka-band capability, none offer universal on-the-move capability (on land or sea) in a convenient size package, simultaneously operating in both X- and Ka-bands, or with fall back to commercial Ka-band on demand.

This requires the use of separate BUCs for X-band and Ka-band, but this is beneficial since the pair then adds increased hardware redundancy on top of the improved link redundancy. Such a combination brings the benefits of assured communications whenever a satellite is visible without manual changeover of hardware.

ASSURED COMMUNICATIONS

The EM Solutions team's approach in developing an assured satellite communications on-the-move terminal has been to work closely with the customer, represented by the Australian Defence Science and Technology Group (DST), to understand their requirements, and cooperate with several collaboration partners. These included Inmarsat Global Government, who provided support during the type approval process, and Intellian, who modified their GX modem and below deck unit to pass signal control information between the Inmarsat Operations Centre and the EM Solutions transmitter equipment and stabilized platform.

The design was based on EM Solutions latest generation military Ka-band Taipan class COTM (Communication-On-The-Move) terminal, in which pointing using monopulse beacon tracking was first perfected. However, that system was land based and with its squat profile did not give the negative elevation angles required from a maritime terminal to compensate for ship roll below the horizon.



Figure 3. The first of the Ka-multiband terminals on board an Australian Border Force vessel.

Using the same powerful direct-drive brushless motors, balanced three-axis gimbal design, and a new “Cobra” style pedestal offering greater elevation range, the new system provided minimum mechanical play and thus maximum position accuracy in a very robust and strong platform. The monopulse pointing system and tracking algorithms were ported and tuned to the new pedestal and proved to be extremely fast and accurate, equally capable of maintaining the link in rough sea profiles as they had off-road.

Now type approved for Inmarsat GX and operational on Cape Class ships defending Australia’s coastline (Figure 3, next page), the Cobra-class terminals are providing—for the first time—broadband services to the crew, capable of using either the military or commercial bands—the choice depends on satellite availability and network congestion. Simultaneous operation on both X- and Ka-bands has also been tested on

calibration plots the system can generate, and shows the signal’s carrier to noise density level around boresight.

This particular plot shows that a pointing error of 1 degree would result in a 3 dB reduction in signal power from 52 to 49 dB Hz. Clearly, useful assumptions about the cause of a reduction in signal level can only be made if pointing error can be ruled out as a possible cause, as can be done with this system.

Using a 1 meter diameter parabolic reflector, the terminal has a footprint of only 0.75 meters and can be deployed on a range of vessels, from small patrol boats to large ships. At the same time, re-engineering efforts have been applied to reduce cost, top weight, and overall terminal volume consistent with the other operating constraints. The newly developed terminal shown in Figure 5 meets both WGS and

the military payload of the Optus C1 satellite, with WGS certification being the next step.

The greatest innovation in the latest Cobra X/Ka-multiband terminal is the antenna feed system. Optimized for its electromagnetics, the system generates antenna pointing vectors from both the X- and Ka-band beacons of the WGS satellite and communicates in the traditional manner at Ka-band, all the time supporting simultaneous communications on the satellite’s X-band transponder, whenever required to protect against rain fade or to provide added capacity.

In addition, the system can then fall back to tracking and operating on the alternative Inmarsat GX satellite system in the case of congestion or for operational reasons.

When to do so can be determined manually or by monitoring the receiver carrier to noise ratio.

Figure 4 on the following page is one of the

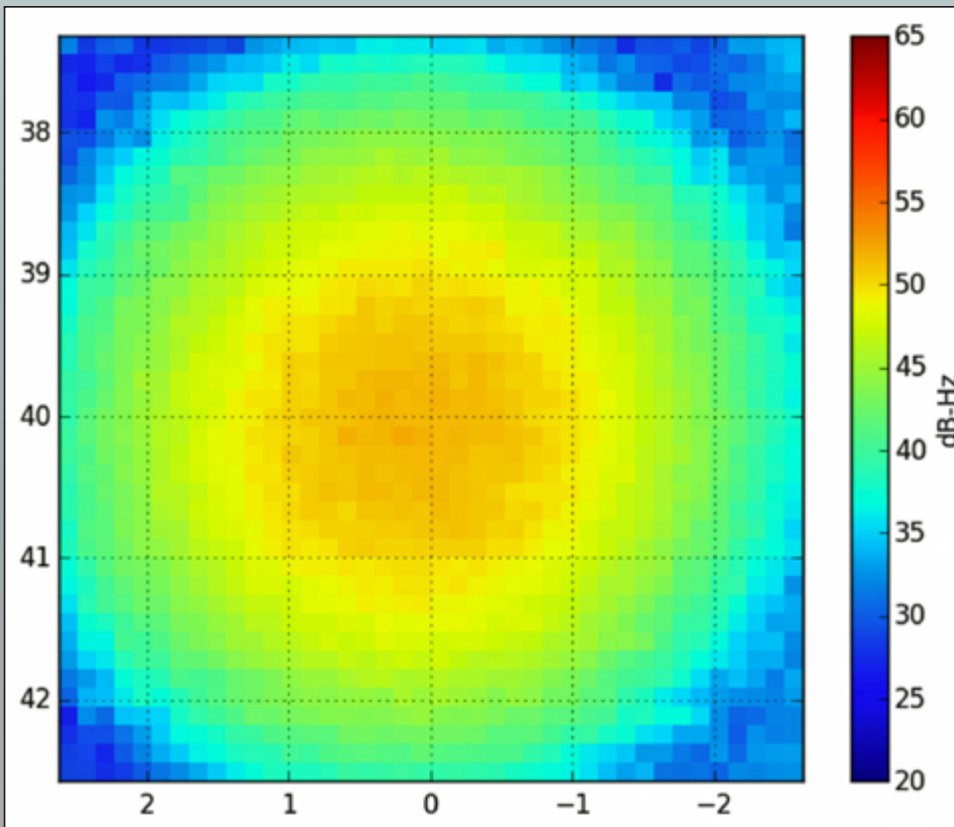


Figure 4. A typical "heat map" produced by the terminal, showing the C/No of the received signal (measured in X-band, right axis) plotted against elevation angle (Y-axis) and cross-elevation angle (X-axis).

Inmarsat specifications. Compared with older terminals, the benefits of the new Cobra multiband terminal include:

- Network survivability with assured communications in a contested environment
- Rapid and automatic self-healing in the event of rain fade or other link outage by switching satellites or frequency band
- Fully transportable and operational on-the-move capability with unparalleled satellite tracking capability in three bands across all ranges and types of motion (land or sea)
- Support for broadband communications (data rates up to several Mbps) without using excessive satellite transponder resources that would be consumed by a very small terminal
- Fall-back to a fully integrated commercial capacity in the event of failure or congestion of the military network
- Configurability for a range of platforms to suit either a small or medium vehicle or vessel, with simplified field repair and cost optimization
- Universal stabilization to the most severe motion conditions, i.e., the terminal can be used either on land or at sea
- All X-band and Ka-band electronics are integrated within the radome in a single RF "can", avoiding the need for expensive and lossy waveguide runs to external equipment racks, and simplifying maintenance

No longer a pipe dream, high availability SATCOM is now available in a single terminal whose total cost of ownership is no greater than conventional single-band, non-redundant terminals.

EM Solutions roadmap includes extending the system to Ku-band and to airborne platforms for even more versatility—watch this space...

www.emsolutions.com.au/

Reference

[1] SOTM & SOTP: Satisfying VMES, Rohit Murthy and David Svesko, General Dynamics Mission Systems, MilsatMagazine Jul/Aug 2016, pp. 32-35



Figure 5. Under the cover — the Cobra multiband X-/Ka- terminal in test at the EM Solutions factory

**EVOLVING SPACE THREATS REQUIRE
EVOLVING POLICIES AND STRATEGY**

The Joint Interagency Combined Space Operations Center (JICSpOC) should make potential enemies think hard about any potential attack on the United States in space—so should the Geosynchronous Space Situational Awareness Program (GSSAP).



"The US is prepared for space threats," Admiral Cecil Haney said recently while addressing the Space and Missile Symposium meeting in Huntsville, Alabama.

The JICSpOC will *"serve to enhance the nation's deterrent posture by demonstrating the United States is prepared when our space capabilities are threatened,"* said Haney, head of the US Strategic Command.

Prepared to do what? A symposium panel cited *National Security Space Defense and Protection*, a report authored at the US National Academies prepared for Congress that said there is an "urgent need to create relevant national policies to guide the creation of responses to these threats."

The report acknowledged the importance of commercial space satellites in the world's economy, as well as in the public's daily lives. The National Academies' scholars wrote that *"policy issues include declaratory policies with regard to attacks on the national security space architecture, including commercial space systems that provide national security functions, as well as appropriate responses to attacks on significant commercial systems."*

The report said a reason for that is *"what was once only a realm of exploration and national security has grown to include a commercial element that has become so ubiquitous that it has led us to fundamentally redefine the term national security space."*

The report also stated that while government spending on space shrank to less than a quarter of a total market of \$330 billion in 2014, commercial spending on communications and sensors has burgeoned and continues to do so. This is being driven in part by worldwide growth in mobile phones and the Internet.

**OPEN ARCHITECTURE OPENS
OPPORTUNITIES FOR ACQUISITION REFORM**

There has been a steady stream of recent ideas to reform military acquisition—Nickolas Guertin and James P. Craft have proposed one of the most intriguing.

"One technique for speeding up the acquisition process is to use open system architecture (OSA)," they write in "The Cyber Implications of Acquisition Speed: Part IV," published recently in *Signal Magazine*.

This is an idea Intelsat General Corporation has long advocated as a way to advance the capabilities of customer legacy systems and is also one reflected in the open architecture of Intelsat Epic^{NG}, industry's most advanced high-throughput satellite (HTS) platform. The second of the constellation, Intelsat IS-33e, launched on August 24. Three more Epic^{NG} satellites are scheduled to launch in 2017.

In a recent SatCom Frontier article, Intelsat General President Skot Butler gave the primary reason for the value of open architecture in communications satellites. *"(Customers) don't want to change out their communications architecture ... they don't want to pay that bill ...,"* Butler said. *"But ... they do want to increase their throughput. ... We've got to be able to accommodate this, and new architectures like Intelsat Epic^{NG}, that kind of high throughput architecture is going to allow that."*

The post goes on to say, *"Open architecture is a concept industry needs to embrace to be nimble enough to accommodate demands of both commercial customers – who are themselves nimble—and the military."*

Guertin and Craft espouse this nimbleness across all of the military's systems, using an example from the US Navy's OSA strategy, published in 2011. The Navy has since collaborated with industry in implementing changes.

"The execution of this OSA strategy addressed improved competition; incentivized better performance; and measured increases in speed," they wrote.

"Both speed and flexibility are crucial to product development today. Systems must be updated quickly to address warfighting needs and to manage a capability gap. They also must address constantly changing cyber threats. This necessitates a new way of doing business."

This new way is facilitated by open systems architectures facilitating rapid innovation and quicker technology updates. Industry becomes more constrained by closed systems in developing that technology and competing for

Though “the list of human activities that are dependent on space systems contains most of the major functions that are vital to modern society,” the report says, the public is not as aware of the need for space security as it should be. Awareness should be raised and the public as involved as much as practicable in formulating policy.

Today, DoD follows the clear policy statements in the *National Space Policy of 2010* and *National Security Space Strategy* on 2011. In April, Doug Loverro, Deputy Assistant Secretary of Defense for Space Policy, said the Pentagon was in the early stages of revising DoD policy. Still, “what has not been present is a focus on achieving the stated policy goals, with resources, programs, and people devoted to the task of improving space system protection and defense,” the report said.

The National Academies also warned that over-classification of space security and protection could have adverse consequences in developing workable interaction with the public, with industry and among the services.

Threats in space have evolved beyond our current policies in space. What’s needed are updated strategies and concrete plans to deal with new challenges.



It’s clear that General John Hyten, head of Air Force Space Command, was working in that vein when he said the GSSAP program was declassified “to make sure we send a message to the world that says: Anything you do in the geosynchronous orbit we will know about. Anything.”

The challenge in space has been recognized. The task that remains to be done is formulating policies and strategies for acting upon that knowledge.

new business. The challenges of military risk-aversion and cultural silos are better handled when open architecture is used to help knock them down.

Open Systems Architecture isn’t completely new to the military. Once called the “Modular Open Systems Approach,” it has existed in DoD since 1994, but the closed systems of the F-22 Raptor and the Distributed Common Ground System are examples of resistance to its overall adoption. With these programs and other areas, silos remain.

In part, that’s because of the proprietary intellectual property involved in the systems. Some companies resist exposing that technology to the open interfaces needed to bring innovation to legacy systems. This resistance can impede development of technology to advance the system and it’s past time for such resistance to be overcome.

Intelsat General’s Chris Hudson described in detail the advantages of open architectures for new HTS systems in a story last year.

“Only when the department manages this as an ecosystem through a well-publicized intellectual property strategy will it be able to functionally change how it interacts with industry,” Guertin and Craft wrote.

They anticipate this happening. “Eventually [changing to wide-spread OSA] will change the underlying architecture of the Defense Department’s warfighting systems from a large collection of uncoordinated, non-interoperable systems built on unique design constructs to a cost-effective and coordinated enterprise product-line environment,” they wrote.

That’s when acquisition and system improvement will move fast enough to be effective in a rapidly changing—and increasingly dangerous—space environment.

Editor’s Note: Our thanks to Intelsat General Corporation for giving us permission to repurpose these articles from their SatCom Frontier infosite.

<http://www.intelsatgeneral.com/management-team/satcom-frontier/>

CONNECTING THE SEAFLOOR TO SPACE WITH PERSISTENT, UNMANNED, SURFACE VEHICLES

By Justin Manley, Just Innovation, and Vas Podorean, Director, Maritime Surveillance & Security, Liquid Robotics

The Wave Glider™ is a unique wave and solar energy powered Unmanned Surface Vessel (USV).

The Wave Glider's two-part design makes the unit well suited for towing instruments at depth. Towing payloads behind a Wave Glider provides excellent isolation from surface and mechanical noise.

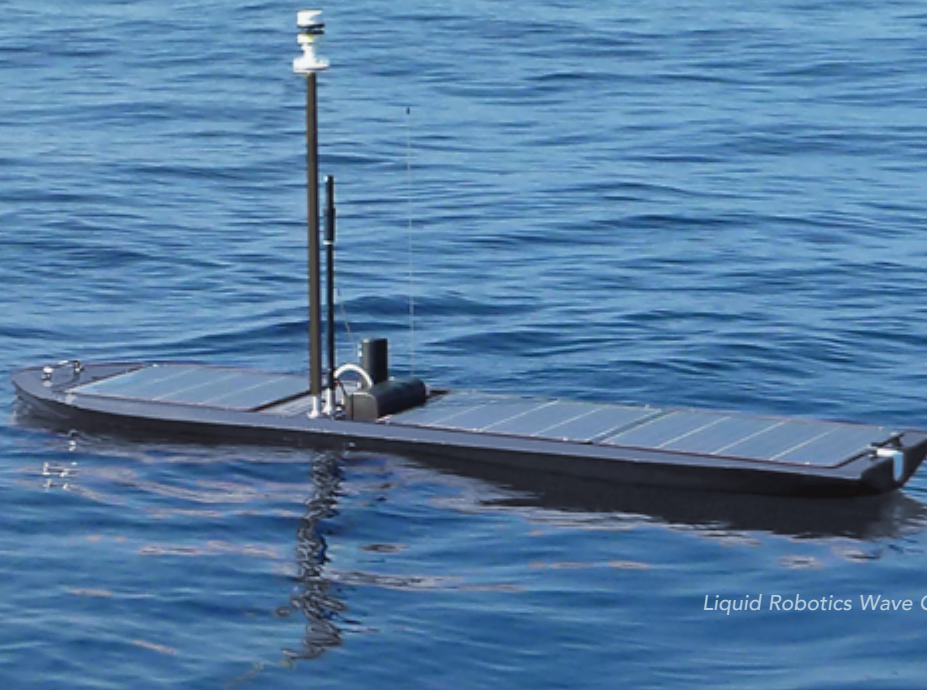
Also provided is a persistent, long-endurance, option for sensor deployment. Numerous applications have been demonstrated using towed bodies behind Wave Gliders.

In this article, the use of the platform as a gateway between undersea systems and surface telemetry—especially satellite communication—is presented. The role of the USV in Maritime Domain Awareness (MDA) is also discussed and a vision for a networked ocean is presented.

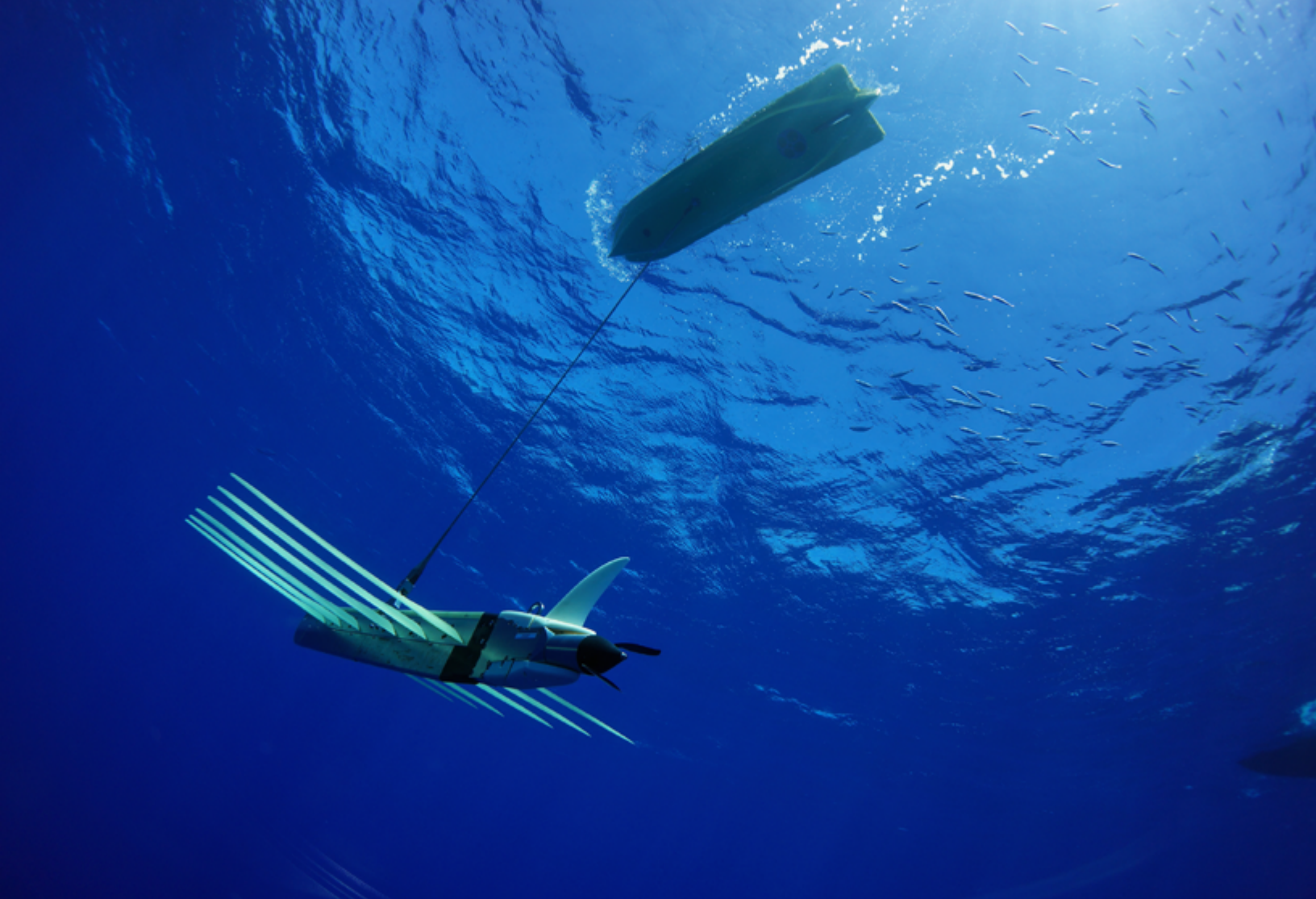
The Liquid Robotics Wave Glider™ consists of a surface float connected to a submerged sub by a flexible umbilical. Just as an airplane's forward motion through the air allows its wings to create an upward lifting force, the submerged sub's vertical motion through the comparatively still waters allows its wings to convert a portion of this upward motion into forward propulsion.

Lithium ion batteries recharged by solar panels provide power for system electronics, communications, and sensor payloads. The system reports back in near real-time via two-way Iridium communications as well as via cell network when in range. The Wave Glider can follow complex series of waypoints, fixed directions, or can be actively piloted in real-time or near real-time.

There are many locations for sensors to be attached, with available power and communication connections, including mast-mountings, various locations in, on, or below the float, attached to the sub, or towed behind the sub. The Wave



Liquid Robotics Wave Glider™.



Glider can be deployed in the most remote areas of our oceans for many months at a time.

THE WAVE GLIDER AS A COMMUNICATIONS GATEWAY

The Wave Glider is a natural gateway between undersea assets, the surface of the ocean, and space. It enables integrated seafloor to space system connectivity and provides in-situ compute and data processing. These capabilities provide real-time, or near real-time data exfiltration, which increases communication reliability by allowing data to be sent back based on available bandwidth, and enables built-in redundancy.

The navigational precision of the Wave Glider, which allows it to station keep above a subsea system, can reduce the energy used by that system to communicate with the surface. For subsea sensors and platforms that rely on batteries, lower energy consumption for data transmission can extend their useful life.

The mobility of the Wave Glider permits a wide field of data collection and allows it to harvest data from a vast area containing multiple sub-surface nodes or undersea vehicles. Faster, lower cost data retrieval from subsea sensors and systems allows organizations to maximize the return on investment (ROI) of related assets.

The technical solution for a gateway application typically employs a real-time relay at the surface to satellite, cellular and other top side communication systems allows the Wave Glider to serve as a best in class gateway.

Early efforts, as far back as 2010, have demonstrated the value of the Wave Glider as a communications gateway. More recent results of the gateway application have been demonstrated by the Scripps Institute of Oceanography (SIO) Autonomous Deployable Deep Ocean Seismic System (ADOSS). In this effort SIO performed two week-long tests in shallow water (1000 m) and a three-month test in the deep ocean (4500 m) off-shore La Jolla.

In these trials a Wave Glider with acoustic telemetry communicated with a fixed seafloor node designed to monitor seismic activity. Initial data recovery rates were excellent, and several local and teleseismic earthquakes were recorded in near-real-time.



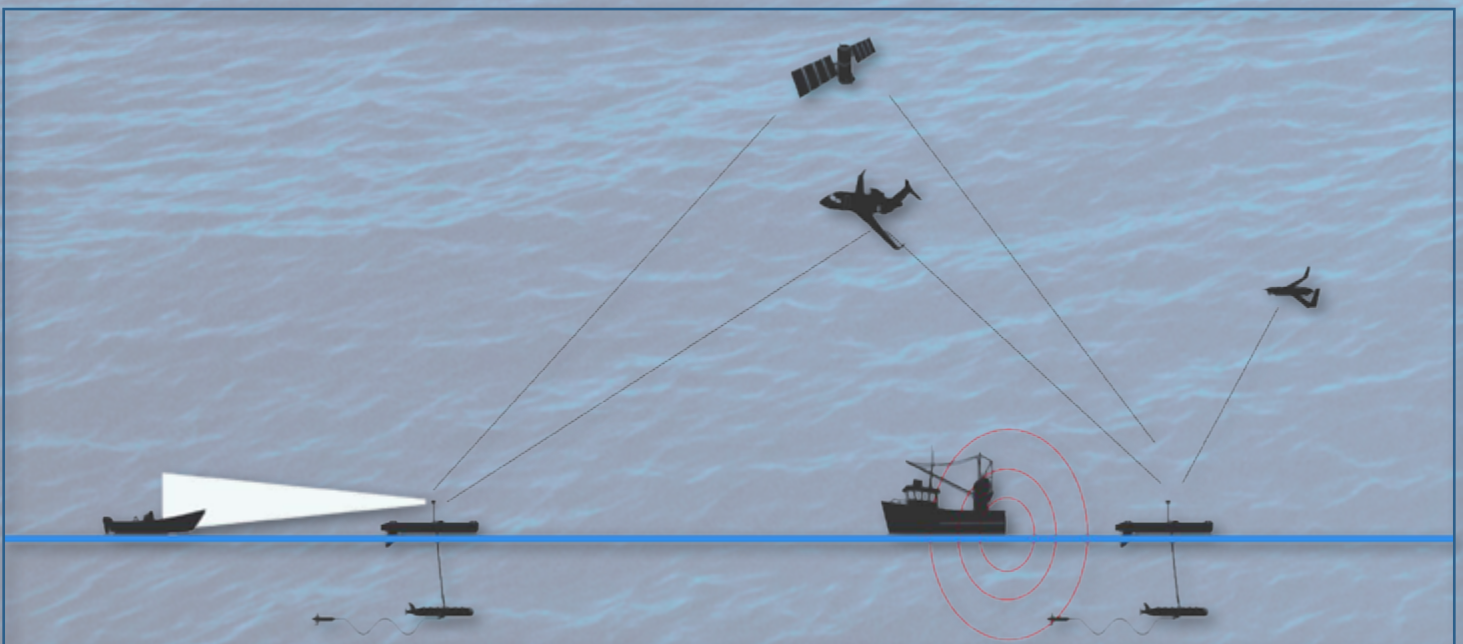
Tests of the surface gateway in 4,350 meters of water demonstrated an effective solution for connecting the seafloor to shore, via Iridium satellite communications.

MARITIME SURVEILLANCE

There are numerous challenges with maritime surveillance, including vast ocean expanses to patrol and monitor, limited resources and assets to employ, increasing complexity and cost of conventional approaches (vessels and airplanes), as well as motivated and informed adversaries.

Wave Gliders can be used independently or in concert with satellite systems to monitor activity and detect threats using passive acoustic arrays, capture surface imagery with still or video cameras, measure oceanographic conditions and communicate with other assets including satellites, vessels, aircraft, and other unmanned systems.

The Wave Glider offers additional benefits in this application including long duration, persistent surveillance, and cueing of other assets and ultimately provides for improved protection and stand-off range, reduced costs, and increased detection probability.



The passive acoustic application most commonly employed by Wave Gliders capitalizes on the relatively quiet environment around a towed payload that hosts an acoustic array. The original application that inspired the development of the Wave Glider was marine mammal monitoring off the coast of Hawaii.

In addition to such research uses, there are numerous maritime security and surveillance applications that can utilize passive acoustics including the monitoring of marine protected areas (MPAs), exclusive economic zones (EEZs), offshore test ranges, illegal fishing surveillance, and general theatre awareness.

A typical Wave Glider configured for maritime surveillance includes a towed, passive acoustic hydrophone sensor (PAS), an automated vessel identification system (AIS) receiver, a high definition camera, a weather station, and other vehicle sensors depending on mission requirements.

Wave Gliders equipped with these sensors create contact reports that can tip and cue additional assets. The benefits, therefore, include:

- *Capability multiplier by extending coverage and reducing gaps*
- *Persistent (24x7x365) surveillance*
- *Force multiplier increasing asset effectiveness*
- *A budget multiplier reducing operational expenses and managing scalability*

Wave Gliders have demonstrated their utility in patrolling remote marine protected areas. Together with the UK Foreign Commonwealth Office a Wave Glider monitored Pitcairn Island, a UNESCO World Heritage site in the remote South Pacific.



Vessel captured by Wave Glider camera and sent by Iridium satellite. High-res images are available when bandwidth permits.

During this evaluation program to monitor a marine protected area of 322,009 square miles a determination was made that the Wave Glider approach offered an order of magnitude cost savings as compared to a manned vessel patrolling the same area.

ENABLING A DIGITAL OCEAN

Liquid Robotics envisions a networked ocean, connecting billions of sensors, manned and unmanned systems and satellites for immediate access to information.

Nations could affordably protect their coastlines against illegal fishing and environmental risks such as tsunamis and hurricanes. Businesses and nations will uncover new economic opportunities in places where it was too costly or risky to go before. Scientists could improve their models to better understand climate change and weather patterns.

With new tools such as persistent USVs such as the Wave Glider, and established capabilities provided by satellite communications we will extend our networks across the two-thirds of our planet covered by ocean.

www.liquid-robotics.com

Justin Manley is a technologist and executive with experience in startup, public corporation, academic, and public sectors. Mr. Manley is a recognized leader in unmanned systems development and operations. After professional roles at MIT, supporting NOAA and in the private sector he founded Just Innovation in mid-2015 where he supports a variety of clients with a focus on unmanned and undersea systems.

Mr. Manley has demonstrated accomplishments in professional organizations including MTS and IEEE. He is a member of the U.S. Integrated Ocean Observing System (IOOS) Advisory Committee. He is also dedicated to innovation, advising startup companies and was a judge for the Wendy Schmidt Ocean Health XPRIZE.

Vas Podorean leads the Maritime Surveillance & Security business at Liquid Robotics. He previously led the Liquid Robotics research, development, test & evaluation facility in Hawaii. This facility has established itself as one of the leading USV development facilities in the world. He has unique insights into the challenges that organizations face when integrating unmanned systems into their strategic and operational plans.

Vas has planned, overseen and participated in countless USV deployments, missions and demonstrations for nations around the world such as Indonesia, Korea, and Japan, public organizations in the USA like NOAA, NASA, US DoD, and a range of private companies. He has a strong background in maritime operations, marine engineering and ocean technology and serves as a volunteer on the Pacific Integrated Ocean Observing System (PaCIOOS) Governing Council.



MEO COST EFFICIENCY

By Ryan Schradin, Executive Editor, GovSat Report

Each quarter, the Naval Postgraduate School (NPS) facilities at California National Guard's Camp Roberts play host to events organized by the Joint Interagency Field Experimentation Program (JIFX), under the sponsorship of the Office of the Secretary of Defense and the Department of Homeland Security.



These events provide the military with the ability to conduct field experiments on new resources and technologies to assess if they could potentially improve operations for the military, disaster response, and emergency management. They also provide a cooperative learning environment where military personnel come together with other federal, state and local agencies to identify best practices and new ways in which technology improves operational efficiency, effectiveness and mission assurance.

Earlier this month, I had the opportunity to attend a JIFX event at Camp Roberts that was testing out the use of the SES O3b Medium Earth Orbit (MEO) satellite constellation for the distribution and dissemination of 4K video. The project—entitled the *NPS Video Cloud System Project*—was intended to test interoperable communication solutions in network-denied disaster response environments.

Effectively, the government was looking to use advanced computer hardware and video codecs, in conjunction with MEO satellite services, to, "...stream live 4K video via satellite from remote locations in support of military public affairs organizations."

Connectivity for NPS, as well as a large proportion of current military operations, occur in remote, network-denied regions. This makes streaming live video over MEO satellites

COMSATCOM BACKUP SERVICES

By Kevin Benedict, Vice President, Business Development, SES Government Services

Devastating emergencies such as earthquakes and tsunamis wreak havoc on local infrastructure and existing communication capabilities—this has been more than evident with Hurricane Matthew's destructive paths through the Caribbean and along the east coast of Florida.



Deployable satellite communications (SATCOM) enables critical voice connectivity, large data file transfer and high-definition (HD) video streaming to assist in recovery and assistance operations.

SATCOM also enables drones to relay real-time intelligence and situational awareness, identification and communication of ingress and egress routes and facilitates assessments detailing whether emergency responders could be in immediate danger.

These volatile situations also require video conferencing capability between emergency personnel and senior leaders so that they can evaluate conditions on the ground. Given the likely destruction of pre-existing capabilities, SATCOM may be the only alternative.

SATCOM BRINGS THE BACKUP

We saw in the wake of many recent disasters and emergencies that radio communications and networks can be brought down due to damage to terrestrial infrastructure or the simple overloading of networks. This was especially true following Hurricane Matthew's, Superstorm Sandy and 9/11 in and around New York City, where the sheer number of family and friends trying to check on their loved ones overloaded networks and made it impossible to connect via mobile device to anyone on the ground.

for public affairs purposes, or Intelligence, Surveillance and Reconnaissance (ISR) purposes, critical.

CHALLENGES

The JIFX test—which proved to be extremely successful—is an indication of things to come for America’s military. Data distribution and sharing requirements are increasingly important in everything that the military does and will only grow in the future. As such, the types and sizes of files being sent are shifting rapidly.

Today’s military is looking for ways to send more data than ever before. Even with advanced codecs, compression technologies and specialized hardware, essential communication capabilities such as video teleconferencing (VTC), 4K video and real time mobile applications use much more bandwidth than what the military traditionally sent over its networks in the past.

The ability to transmit and receive these files efficiently and with zero packet loss is why MEO satellite constellations are such an attractive option for the military. These satellites have the same ability as GEO satellites to deliver data, voice and video into practically any geographic location—particularly to those with no or little terrestrial network infrastructure.

However, in contrast to GEO satellites, MEO satellites are approximately one quarter the distance from Earth. This proximity enables the constellation to deliver higher throughput (up to 600 Mbps/600Mbps) with much lower latency (less than 200 milliseconds, end-to-end). This equates to delivery of a fiber-like connectivity from space.

This is a real concern that can derail a coordinated emergency response effort, and is only exasperated by the natural restrictions of radio networks—including line-of-sight limitations.

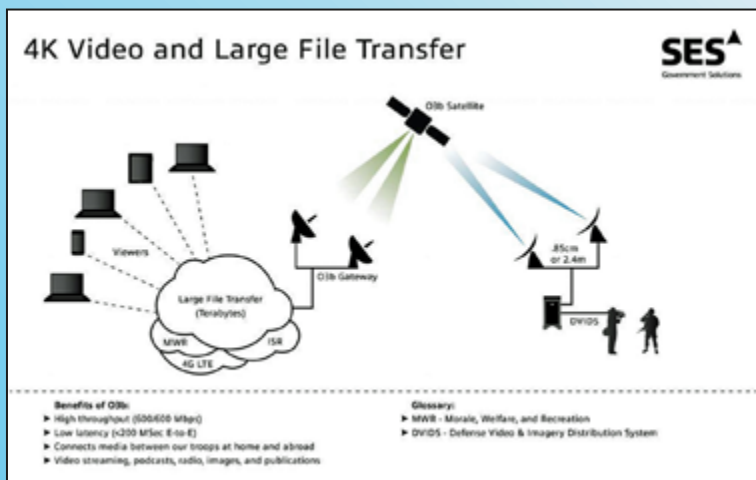
That’s why Commercial SATCOM (COMSATCOM) is becoming a desirable back-up for nations looking to build redundancy and resiliency into their disaster and emergency response communications networks.

Satellite communications aren’t restricted by line-of-site requirements and can be more resilient than radio networks.

By deploying mobile terminal systems, satellites will continue to operate through earthquakes, tsunamis, hurricanes, floods, terrorist attacks and any other emergency situations – ensuring that the flow of information is never compromised.



Select this direct link to view a SES Techcom Services video that reveals how Emergency.Lu provides humanitarian assistance via satellite.



The JIFX test focused on transmitting 4K video for public affairs teams, however this application is just one of many for this technology in the military. Here are a few more:

- *ISR—Delivering 4K and HD video reconnaissance and intelligence to and from battlefields to improve situational awareness*

EMERGENCY.LU

Emergency.lu is a global multi-layer platform for the international humanitarian community that aims to improve the worldwide preparedness and rapid response capacity by filling the communication gap in the first hours and days after a disaster.

When a natural disaster strikes, it is vital that those needing help have access to a system that provides efficient and critical communications. But with terrestrial services often damaged, disrupted, or becoming overloaded by people phoning for help, providing a connection with the rest of the world is often a difficult and lengthy process.

This is where emergency.lu comes in. Since emergency.lu is a multi-layer platform consisting of satellite infrastructure and capacity, communication and coordination services, satellite ground terminals for rapid as well as long-term deployment and transportation of equipment to the disaster area within the first 12 to 20 hours.

- *Large file transfer—Transmitting of today's large files (100 GB in 27 minutes) – from video to large datasets – between warfighters in the field and senior decision makers.*
- *Interactive, real-time applications—Powering the use of mobile applications that request data in real-time for full effectiveness and capability.*
- *4G LTE bubbles—Using MEO satellites for mobile backhaul to power pockets of 4G connectivity and enable the use of military mobile devices and other technologies.*
- *Morale, Welfare and Recreation (MWR)—Delivering Internet connectivity and social media access for warfighters in the field*

The successful JIFX test proved that MEO can deliver connectivity in network-denied areas. It is clear that current and future military technologies require the bandwidth that MEO can deliver. But, can the military afford it?

ANALYZING THE TCO FOR MEO

MEO satellite constellations are built for delivering large amounts of data with low latency. MEO delivers that capability efficiently and cost effectively, which is essential for the military today. In fact, there are multiple concepts of operation (CONOPs) that are ideal for MEO satellite constellations, most involving the transfer of large amounts of data traffic (100 Mbps).

In these specific large data application scenarios, the military has examined the TCO of MEO—and they like what they see.

MEO constellations are built for high bandwidth applications. In contrast to GEO constellations, MEO offers a much lower cost per megabit alternative. Considering how much bandwidth could be used transmitting real-time data or live streaming 4K video, the bandwidth per Mb price truly comes in to focus.

Overall, the use of MEO satellite constellations for high bandwidth implementations can save as much as 25 to 50 percent of what it would cost for the same amount of throughput on a GEO constellation. Over a very short time (less than six months), this results in significant savings for the US government, making year-over-year operation extremely economical as compared to GEO.

That being said, MEO satellites will never replace GEO for all military implementations and uses. In many CONOPS, GEO is still the better solution.

WHEN GEO BESTS MEO

Having spent the better part of 900 words extolling the benefits of MEO satellites, it would be a disservice to readers if I didn't mention that MEO constellations are not the superior choice in all instances. In fact, legacy GEO satellite constellations, as well as newly emerging High Throughput Satellite (HTS) constellations, will continue to break new barriers in service.

Emergency.lu can restore communication capabilities quickly and thus enable efficient rescue efforts or information flow from those affected to their loved ones.

The 24/7 basis of the emergency.lu platform is an innovative, end-to-end service for the international humanitarian community. This pioneering platform has improved the effectiveness of rapid response.

NEXGEN EMERGENCY COMMS

With the emergence of high throughput satellites (HTS), and next-generation LEO and MEO constellations that offer incredible throughputs and low latency, COMSATCOM has become a viable alternative for delivering voice, video and data—regardless of how much bandwidth is required.

Today's disaster and emergency response is more effective than ever before. It works quickly to stem the amount of property damage, reduce the number of casualties and works to ensure the safety of the emergency responders providing relief.

To accomplish this, emergency response teams rely on constant communication and collaboration. Nations are increasingly turning to COMSATCOM to deliver the resiliency and redundancy they need to ensure the networks driving communication are always on and always available—regardless of the conditions on the ground.

www.ses-gs.com/govsat/

Kevin Benedict serves as the Vice President of Business Development at SES Government Solutions, where he leads a team of exceptional business development professionals tasked with providing the US government with a suite of satellite services and end-to-end satellite communications solutions.

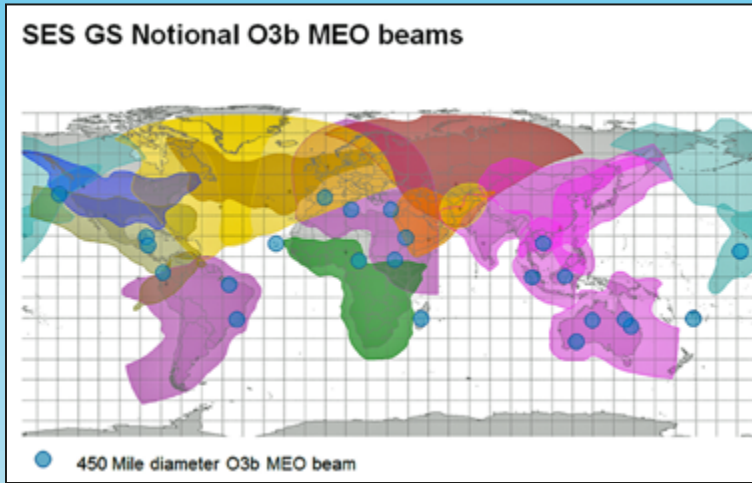
PAGO PAGO NWS

Anyone who has ever witnessed the ferocity of a hurricane, or the terrifying devastation of a tornado knows all too well the destructive ability of Mother Nature.

Luckily, when natural disaster threatens the United States, we have an agency responsible for providing warning so that citizens can prepare, take shelter or even evacuate, if necessary.

That agency is a component of the National Oceanic and Atmospheric Administration (NOAA) called the National Weather Service (NWS), and its ability to effectively accomplish its mission really can be the difference between life and death for American citizens.

Evident in the image below, MEO beams (450 miles diameter) cover significantly less area than GEO beams. This means that any CONOP that requires moving over large distances will obviate the need for GEO. GEO beams cover so much geography that any movement within a relatively large area will still be covered—most likely by the same GEO beam.



GEO connectivity is important to the military, since warfighters, camps, and vehicles that require connectivity do not always stay in one place. In fact, they are often mobile over a wide geographic region. In these instances, the small coverage area of a MEO satellite beam is trumped by the more ubiquitous GEO beam.

IT and data are essential for our modern military, and the bandwidth demands of the next generation solutions and IT capabilities that the military is utilizing in the field are rising. The military needs high throughput connectivity in network-denied areas. MEO is the only solution that can deliver the fiber-like connectivity the military needs, without the physical fiber—and without breaking the bank.

www.ses-gs.com/govsat/



In June of this year, the National Weather Service Office (NWSO) at Pago Pago, American Samoa signed a contract with SES GS for a new tool to help them accomplish their very important mission—a highly reliable, low latency link for passing critically important weather information between the NWSO in Pago Pago and the NWS headquarters Office on Ford Island in Honolulu, Hawaii.

This contract with SES GS was notable for two reasons.

First, the satellite constellation that the NWSO in Pago Pago would be utilizing would not be the company's GEO constellation. Instead, the satellite constellation carrying information between American Samoa and Hawaii would be the newer O3b MEO constellation of satellites, which promise fiber-like throughputs and lower latency.

Second, the contract signed between the NWSO in Pago Pago and SES GS was not just for the lease of some satellite capacity, but rather for a complete satellite managed service. This decision to move forward with satellite as a managed service is a revolutionary, innovative step forward for the federal government, since managed services are widely considered the more economical and efficient acquisition model that is the future of the satellite industry.

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These articles are republished, courtesy of GovSat Report (ses-gs.com/govsat), and Executive Editor Ryan Schradin. He is a communications expert and journalist with more than a decade of experience and has edited and contributed to multiple, popular, online trade publications that are focused on government technology, satellite, unified communications and network infrastructure. His work includes editing and writing for the GovSat Report, The Modern Network, Public Sector View, and Cloud Sprawl.



His work for the GovSat Report includes editing content, establishing editorial direction, contributing articles about satellite news and trends, and conducting written and podcast interviews. Ryan also contributes to the publication's industry event and conference coverage, providing in-depth reporting from leading satellite shows.

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PURSuing AFFORDABLE ACCESS TO SPACE: A MAROTTA CONTROLS PERSPECTIVE

By Bryan Reid, Director, Business Development, Space Systems, Marotta Controls, Inc.



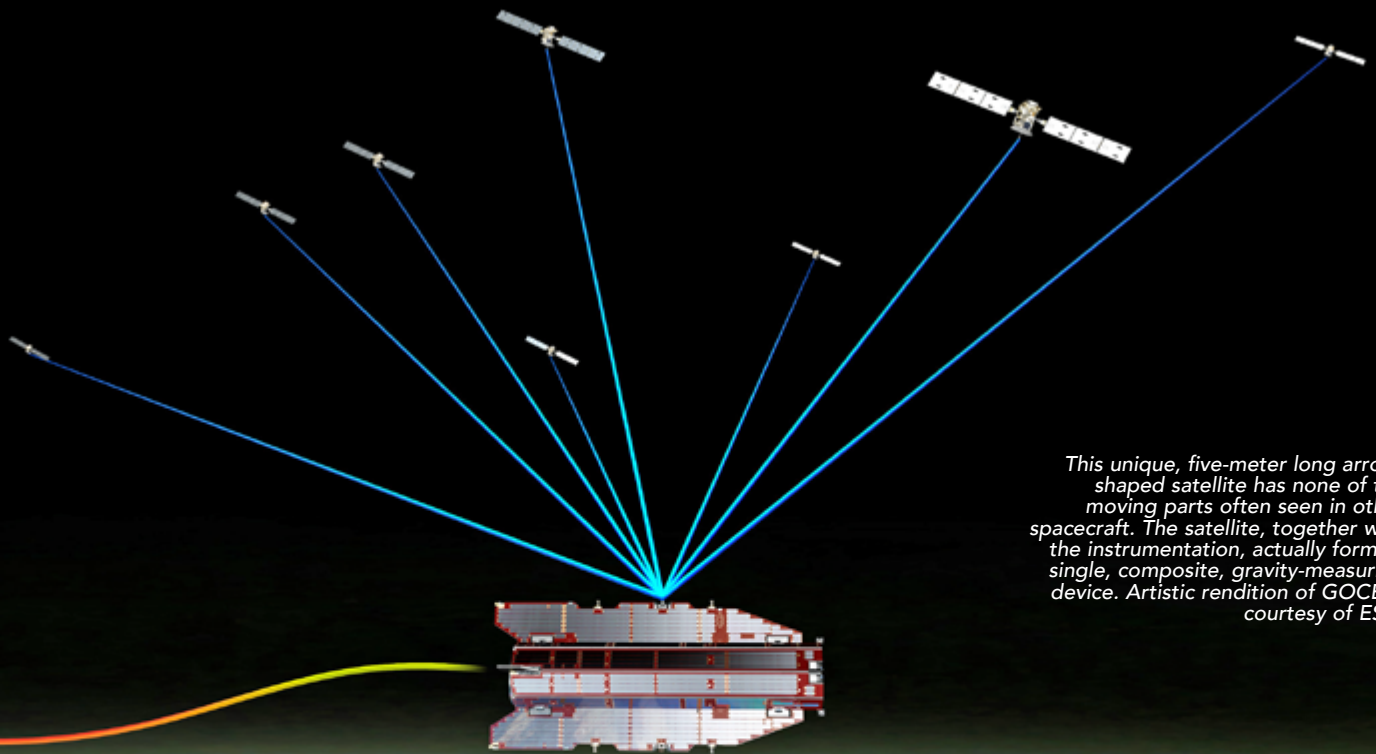
Today's space race is becoming defined by the quest for more affordable launch capabilities for the military, government and commercial environs—reusability is a potent means to reduce costs as well as to secure market leadership.

Reusability places an even greater value on reliability—heritage firms that specialized in aerospace technologies and systems since the days of Apollo are now playing a pivotal role in enabling the new space economy.

HERITAGE IMPACT

Heritage technology originally carried Americans into space. Quite an achievement, of course, but even more remarkable when one considers that certain design tools and optimization technologies were not yet available for use.

Saturn V, Apollo's launch vehicle, would no doubt be lighter and more powerful if the rocket had been produced using the same extraordinary advancements in engineering tooling that benefit today's space system developers. Saturn V's actual size and performance capabilities were defined by the computational power of its era—resulting in extremely robust design as the mechanism to protect human life and hardware investments.



This unique, five-meter long arrow-shaped satellite has none of the moving parts often seen in other spacecraft. The satellite, together with the instrumentation, actually forms a single, composite, gravity-measuring device. Artistic rendition of GOCE is courtesy of ESA.



Today, the high reliability associated with these man-rated designs aligns perfectly with current goals for long lifecycle reusability. Developed for robust performance in the earliest days of the space program, these proven components are inadvertently ready for today's new space innovators. They are inherently more reliable and reusable because they are not necessarily operating at the limits of their capacity.

ENABLING PERSPECTIVES ON REUSABILITY

By calling on a rich history of human space flight—breakthrough advances that defined the success of Apollo, Saturn and even milestones such as breaking the sound barrier—new space innovators have access to flight-qualified technology that can shape their competitive goals.

Heritage engineers (and their specific knowledge of the kinds of proven systems and technologies available) are coming onboard new space programs and creating a path to affordability by exploring what kinds of systems can be built using existing hardware.

Whether or not reusable technology is determined to be suitable for human space flight, man-rated systems have an impact on the affordability equation. The same reliability enables flexibility for new space competitors, allowing them some creativity in how to approach their individual reusability strategies.

This is an unexpected upside. Systems are poised for multi-use, combining the high reliability associated with man-rated technology with the conservatism of design and robustness inherent to the early days of space system development. Onboard systems and components can be used with performance operating up to critical limits, or below critical limits as a means of extending lifetime and therefore reusability.

BRIDGING NEW CULTURES

It is, however, necessary to bridge expertise, resources and even cultures for relative newcomers to capitalize on what has already been developed and proven without spending billions on engineering new technologies from the ground up.



A launch from Kennedy Space Center. Photo is courtesy of NASA.

Dynamics between the two realms—the upstarts of new space and the ‘elders’ of heritage technology—can add a new competitive edge, although institutional developers must think beyond the scope of a commodities broker.

Responsiveness is required, driving more institutional firms to decide whether they can and want to thrive in new space projects. This includes all facets of operations, from design and manufacturing to sourcing and pricing components.

One company, Marotta Controls of Montville, New Jersey, is ideally positioned to service both new space and institutional programs; the firm is privately owned, with a deep catalog of flight-qualified hardware, and an agile decision-making process that reflects a lean and flexible management structure.

Industry-wide, these capabilities largely depend on the culture and personality of the company, as well as the firm’s willingness to be proactive and adapt to new budget constraints.



Photo of Virgin Galactic's ‘captive carry’ flight test, during which VSS Unity remained mated to the firm's WhiteKnightTwo mothership (VMS Eve) for the entire flight, from takeoff to landing. Photo is courtesy of Virgin Galactic.

REDEFINING THE MARKET

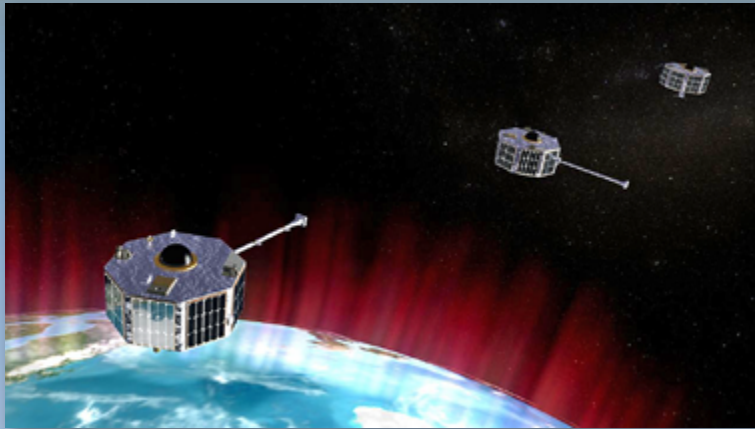
SpaceX and Blue Origin have already successfully landed and recovered first stage engines; SpaceX is close to executing their first launch of a reused first stage, while Blue Origin’s New Shepard sub-orbital vehicle has relaunched five times with only minor refurbishment between launches.

First stage reuse likely offers the most return on investment, with second stage reuse considered worthwhile. While all reusable technology should create a program advantage through hardware savings, viewpoints differ on just how much of a cost reduction is possible in the future.

Progress toward price reduction continues in general, and reusable technology will amplify and accelerate the pace. For example, SpaceX’s Falcon 9 launch cost is currently ~\$60M, while Ariane 5 is ~\$120M with two satellites onboard; Ariane 6 promises to reduce per-kilogram prices by 40-50 percent to be more competitive with Falcon 9. With a reusable option, Falcon 9’s costs will also drop; published estimates suggest a 30 percent reduction in its launch costs.

Because satellite launches comprise significant market share, including military, commercial and scientific missions, the market is responding strongly to the prospect of more affordable launch vehicles. Leaders in the constellation segment—ranging from hundreds to thousands of small, cost-effective satellites—are poised to benefit significantly from cost reductions enabled by reusable technology.

Smaller constellation providers will no longer have to wait for a ride as a ‘piggyback’ on a larger rocket, putting a crimp in business plans and revenue strategies. The benefits include not only reduced launch costs, but also a faster route to services and profitability.



An artistic rendition of NASA's ST5 smallsats, launched to test and validate new technologies for future science missions. Image is courtesy of NASA.

RELIABILITY ADVANCES REUSABILITY

More affordable space launches are critical to revitalizing the space industry, increasing availability of military and commercial constellation deployments, long-term scientific missions, national defense as well as the future of space tourism.

Just as important is the need to capitalize on the role of heritage technology in new space programs. Flight-qualified designs that got us to the moon and back offer intrinsic reliability, the key factor in launching hardware into space more affordably.

Today, the space industry's predecessors' robustly designed components enable the confidence required to commit to reusability. They also validate the need to mesh heritage and new space cultures as a new model for space design and development.

marotta.com/

Bryan Reid has more than 30 years of experience in the international Aerospace and Defence industry in technical and commercial roles and is instrumental in developing Marotta's space strategy and securing significant technology content on major platforms. He's been involved in a wide range of launch vehicle and satellite programs, including the Ariane 5 first stage Vulcain Engine, the GOCE (Gravity field and steady-state Ocean Circulation Explorer) satellite, and most recently, the Spacebus Neo and MetOp-SG platforms. Contact Bryan at breid@marotta.com.



A FOCUS ON MAROTTA CONTROLS

Aligning heritage technology with the agility required for new space innovation is an ideal, yet surprisingly unique, strategy for established technology developers. Marotta Controls is one of only a handful of firms that bridge the gap between heritage technology and the new space economy, building on proven, applicable technologies and an agile and responsive culture to enable a new generation of innovators.

While the company's expertise has steadily been built on institutional programs dating back to Apollo, Saturn V and the Lunar Module, Marotta's technology is also part of space programs like Atlas, Delta, Taurus, New Shepard, Falcon 9 and SpaceShip Two.

Marotta's patented valves were used on the Gemini spacecraft and Titan launch vehicle programs to control the fuel and pressurization systems during critical fueling and launch countdown sequences.

The company's solenoid valves were used in Saturn V's environmental control system, cooling electrical equipment required to guide, navigate, and command and control the Saturn launch vehicle from liftoff to Apollo/Saturn vehicle separation.

Marotta was also on board the Space Shuttle, providing technology as part of the program's Solid Rocket Booster (SRB) system, helping the Orbiter escape Earth's gravity using a system designed for recovery and reuse in future missions.

Marotta's résumé ensures intelligent fluid control systems and technologies that are inherently reusable, developed from early design protocols requiring robustness suitable for manned space flight. These factors are vastly improved today, based on advanced simulations and computer models that didn't exist in the early space era.

The result is greater room to incorporate performance and safety margins suited for the rigors of repeat missions, delivered as customized, optimized solutions built for specific performance and reusability requirements.



SMALLSATS... A REVOLUTION IN MILITARY AFFAIRS?

By Russ Matijevich, Vice President, HawkEye 360

Throughout human history, there have been inflection points in military capabilities that fundamentally changed the way warfare was approached.

These inflection points combined technological advances, doctrine updates and organizational changes. Military historians and analysts refer to these occurrences as a "revolution in military affairs" (RMA).

In this article, the focus is on the continuing technological advances in smallsat mission design while noting that to truly benefit from the smallsat RMA, governments and militaries must follow through on the necessary doctrinal updates and organizational changes.

In the late 19th and early 20th centuries, ground warfare was initially transformed by the invention and adoption of the repeating rifle. This weapon advance was made possible by the development of the self-contained cartridge. By World War One, the development and implementation of the machine gun lead to another major advance.

The latest revolution started after Operation Desert Storm in 1991 differs from prior evolutions as the focus was on information. Heralded as the first "space-enabled" war, Desert Storm ushered in the era of using space-based capabilities to make ground, air, and naval forces more effective prosecuting enemy targets.

Taking that thought a step farther, the current renaissance in smallsat design and applications, combined with the ongoing development of smallsat launch capabilities, represent the technological advancements necessary to fuel the next revolution in military affairs within the context of space operations.

Advances in the smallsat industry are significantly lowering the cost and the time required to exploit the ultimate high ground. What has typically required nation-state level resources can now be implemented at far less cost and at a pace previously unobtainable.





This smallsat RMA could also be a forcing function that allows the implementation of current national security space concepts such as resiliency, disaggregation and rapid-reconstitution in ways never before possible in a cost-effective manner.

HawkEye 360 (HE360) is a great example of this premise—the company is privately funded and harnessing the power of the smallsat to perform a service that has, historically, been the domain of the nation state: exploiting the radio frequency (RF) portion of the electromagnetic spectrum.

Similar to the early days of commercial satellite imagery, when high-resolution satellite imagery was chiefly managed by governments, HE360 is developing a system that will extend access to RF signal data and what that means from a “Big Data” analytics perspective to the commercial marketplace.

The way everyone will look at the world and how the world uses data from small satellites is changing. When you combine HawkEye 360's planned offerings with similar ones from companies such as BlackSky, the military will be able to rapidly access combined geospatial products in ways that have been previously unavailable.

MAKING THE RMA POSSIBLE

The traditional satellite constraints of Size, Weight, and Power (SWaP) are of particular importance to the smallsat industry. Historically, the utility of smallsats (including cubesats) was limited by the available spacecraft volume and the power generated by body-mounted solar arrays. However, this is all changing as electronics become smaller and more powerful

and smallsat power generation increases. For HE360, the key technology advances include the following:

MINIATURIZED ELECTRONICS

Perhaps the greatest driver in smallsat design is the continued shrinking of electronics. This miniaturization offers smallsats increased processing power to do new, more complex tasks as well as allows the spacecraft to perform this processing at significantly lower power levels.

Every single processing component, from incredibly powerful Application Specific Integrated Circuits (ASIC) to reprogrammable ARM processors and Field Programmable Gate Arrays (FPGA), are enabling smallsats to perform at the level of full-sized satellites—but at a fraction of the required power. Taken in total, the availability of high-power processing to smallsat design is staggering.

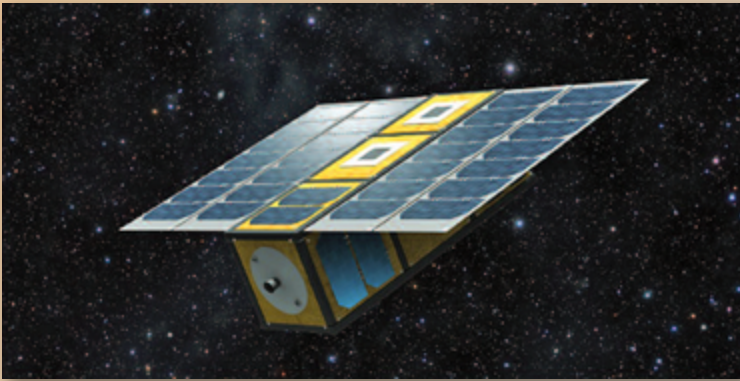
HE360, in partnership with GomSpace, is benefiting from these advancements by combining commercially available RF System on a Chip (SOC) technology with reprogrammable FPGAs to be the foundation of our smallsat's payload.

A KEY ENABLER

One of the challenges facing smallsat designers is developing a propulsion system that is on par with those found on larger spacecraft. For HawkEye 360, the propulsion solution was just as important as the microelectronics going into our software-defined radios, and was a key decision point for the firm

in selecting Deep Space Industries (DSI) and their partner, UTIAS Space Flight Laboratory, as the prime spacecraft supplier.

Their DSI Comet-1™ electrothermal micropropulsion system provides HawkEye 360 with the necessary thrust and stored delta to support station keeping requirements throughout a three-year design life. Enough margin is available to extend beyond three years and still deorbit HE360 satellites if necessary for debris mitigation compliance. It also helped that the Comet-1™ uses water as the propellant—that greatly simplifies ground processing and launch procedures for smallsats.



Artistic impression of the Deep Space Industries' Comet-1™ micropropulsion system. Image courtesy of DSI.

LAUNCH

Possibly the most substantial contributor to the smallsat RMA is the developing smallsat launch industry. The current practice of ride-shares to orbit is great for initial demonstrations and for those missions that don't require specific orbit architectures to optimize performance.

However, to fully realize the RMA that smallsats will bring, a cost-effective, dedicated ride to space is crucial. The launch industry is answering that need.

From Spaceflight's Sherpa to Vulcan's StratoLaunch capability, there is much activity within the smallsat launch industry that promises enhanced and cost-effective access to orbit for smallsats. At HE360, this development is being closely watched. The potential to use these emerging launch-on-demand systems that provide a dedicated ride to orbit at the ride-share price point is obviously quite significant.

OPEN STANDARD SDR

The other key enabling technology for the company is the advancement in open-standard software-defined radios (SDR). GNU Radio is the foundation being used by the company as an incredibly capable RF receiver payload.

HE360 code is being used with advanced Field Programmable Gate Arrays (FPGA), which will allow signal detection, characterization and geolocation capabilities throughout the spacecraft's three-year design lifetime to be updated when required.

A REVOLUTION IN SITUATIONAL AWARENESS

The real value that HE360 will bring to the market is distilling RF spectrum utilization data into actionable information and then using that information to build knowledge products tailored to address our customers' difficult problems.

Our challenges of Big Data require bold approaches to automation and machine learning. Over time, the plan is to advance HE360 system satellites to become increasingly autonomous.

The goal is to ultimately have a robust machine learning capability that will, for example, allow the system to predict future behavior to the point of autonomously tipping/cueing commercial satellite imagery or receiving similar tip-off information from the imaging systems.

In the end, the anticipation is an integrated machine-to-machine system that facilitates a new level of situational awareness in the transportation, maritime, and wireless communications (both terrestrial and satellite) markets.

A DIFFERENT VIEW OF THE WORLD

Previously mentioned have been the parallels between the commercial satellite imagery industry and the plans for HawkEye 360, but there's also an intersection point between the two: geospatial information.

Thanks to the growth and availability of remote sensing systems and their data, the geospatial industry is thriving and evolving beyond only images of objects. Activity Based Information (ABI)—looking at why something is happening in addition to where it's happening—is driving new methodologies for observing activity on Earth.

Combining varied data sources allows the geospatial analyst to infer additional insights beyond just the static snapshot of the scene. HE360 RF data builds on that concept and will allow ABI to be taken a step further by creating contextualized activity based information (CABI).

For example, suppose a customer has a commercial satellite image of various ships in a specific sea line of communication (SLOC). This static image brings to mind several questions:

1. *Who are the ships?*
2. *What are they doing?*
3. *Are they supposed to be there?*

The static image, depending on resolution and amount of cloud cover, may allow answers to some of these questions. HawkEye 360's data analytics can provide those answers... and then some.

The firm's Maritime Domain Awareness line of analytic products is designed to determine a ship's identity and self-reported location from its Automatic Identification System (AIS) broadcast.

This ability is differentiated from other commercial sources of AIS data by also providing an independent geolocation of the AIS broadcast itself to verify that the ship is at the location it is reporting. This is important because a nefarious actor can easily spoof their reported location.

HE360's on-going airborne test program already demonstrated that the company can independently detect the transmitter's spoofed location and independently determine its true location.

Suppose that the AIS-identified ship is listed on the military's watch list, and the ship's captain turns off its AIS thinking they will be able to hide from detection. HE360's planned system is addressing this very real hypothetical scenario.

In addition to AIS, the HE360 system can collect and geolocate other sources of RF data from a ship, such as its navigation radar or satellite communications. This information will be used in combination with AIS, if it's available, to dynamically observe the ship's heading, speed, and course, thus allowing one to deduce the nature of its activity and provide the missing context to that original satellite image.

Also planned by HE360 is to provide a tip-off message to the company's commercial space imaging partners in order for them to provide a current image of the suspect ship. HE360's watch center would then take that updated image, combine that image with the RF track data, and then produce an actionable knowledge product that the military can use and share with all coalition partners—without restriction.

A BRIGHT FUTURE

At HawkEye 360, the future is exciting and the company thrives on solving big problems in collaboration with industry and government partners. The development of the Pathfinder Cluster mission of three smallsats to LEO, scheduled for Q4 of 2017, is well underway.

Each spacecraft in the Pathfinder Cluster has been designed to have SDRs running our proprietary software. The Pathfinder Cluster will demonstrate and differentiate HE360's capabilities to the marketplace and prepare the firm for the planned, operational constellation deployment of six three-ship clusters (for a total of 18 operational, plus three Pathfinder Cluster spacecraft on orbit) in the next few years.

From the successful airborne demonstrations this year to the planned Pathfinder next year, HE360 is moving forward at a rapid pace to bring commercial RF sensing from space to market and to help change the way the world is viewed

www.he360.com

deepspaceindustries.com



THE IMPORTANCE OF SPACE THROUGH THE TRANSITION

By Elliot Holokauahi Pulham, Chief Executive Officer, Space Foundation

With the 2016 elections only a couple of weeks away, a lot of time, energy and focus in Washington, D.C., space circles is on "the transition"—the hand-off of the executive branch from the Obama administration to a new team—Democrat or Republican.

Much of this focus will be on engineering the non-perturbation, to the extent possible, of current, funded and planned government space programs. Changes of administration frequently wreak havoc on current programs, with billions of dollars of work and/or hardware often discarded in order to put new "thumbprints" on the NASA, NOAA or Department of Defense programs of record, and often, on US space policy itself.

This is a terrible waste, as the Space Foundation pointed out in vast and sobering detail in our 2012 report, **PIONEERING: Sustaining U.S. Leadership in Space**. The teams at NASA, NOAA, OMB, OSTP, the Pentagon and elsewhere in government are absolutely correct to be preparing now to mitigate potential negative impacts of changing administrations to U.S. government space programs and policies.



However, there are a couple of larger reasons to be concerned about space and how it fares through this election cycle. The first is the critical importance of space to the US economy. The second is the importance of space to US leadership in the world.

SPACE IN THE ECONOMY

The Space Foundation is well known for producing the essential economic data on our industry. Our annual **The Space Report** is the authoritative guide to global space activity, and provides tremendous insight into an industry, which we conservatively measured at about \$323 billion in 2015. As impressive as that number is, it really doesn't scratch the surface of the impact of space in the economy -- where space products, services and infrastructure have moved beyond simply being an enabler,

and today form the crucial backbone upon which the economy runs.

This is a crucial point, and the reason why transition teams and the new administration must get space programs and policy right. Without space, most of America's economy could come to a grinding, punishing, cruel halt. Every financial institution in the US—whether it knows this or not—relies upon the precision timing signals of GPS satellites to operate their internal computer networks, enable those networks to "talk" to other financial institutions and networks and even to enable credit card transactions and ATM transactions.

Imagine the impact to the economy if all those capabilities went away.

Virtually every major transportation system, from ships at sea and airplanes in the sky, to FedEx and UPS drivers on the ground, depends upon space assets to identify, locate, plan, track and execute the movement of goods and services ranging from Petromax tankers filled with oil, to an Amazon.com delivery of a ball point pen.

Imagine the impact to the US economy if our transportation systems all ground to a halt.

Emergency services, from the rescue of distressed ships at sea, to the dispatch of local paramedics and other first responders, rely heavily on space -- not just for geolocation, but for real time communication, satellite imagery and the transmission of crucial medical data.

This is especially true in the case of large scale weather events and other environmental disasters, where land-based communications are often wiped out as part of the event, and roads and avenues of escape cut off, and data on current and forecast weather often makes the difference between life and death.

Even the commonplace becomes problematic without space. Most people don't realize it, but, even when you pull into a gas station to put fuel in your vehicle, two or three space transactions are taking place: a contact to your financial institution, a contact with the financial institution of the gas station and a contact to the fuel provider so they'll know when to send a tanker truck to replenish supplies at the service station.

Hell, most people can't even make a dinner reservation without space! They'll find a nearby restaurant using a satellite-enabled app on their smart phone, make a reservation either via a computer network or phone network



that relies upon satellites and then navigate to their dining destination using the small satellite ground station (GPS receiver) built into their smartphone or built into the dash of their car.

Of course, this doesn't even begin to speak to the vast amounts of space technology embedded everywhere. Back to our fueling example, automobiles are really just terrestrial spaceships, chock full of space technology. Your anti-lock braking system, your collision avoidance and back-up radars, the accelerometers that deploy your airbags, fire protection firewalls, the metallurgy of high compression engines, cabin air filtration... all of this comes from space research and development (to say nothing of your satellite navigation or satellite radio systems on board).

The examples are countless, and, suffice to say that when America gets up to go to work, it gets up and goes to work with space. The potential impact to the US economy, of an ill formed or misinformed decision during the transition to a new administration, could be catastrophic.

This is why the US needs strong space leadership and strong space advocacy during the upcoming transition. Not just to preserve the NASA or NOAA programs of record, not just to ensure continued U.S. access to space for all purposes and uses, not just to ensure that US national security space programs are second to none—although, of course, all those things matter profoundly. Space policy and programs go deep to the heart of the American way of life.

They are that important.

SPACE & US LEADERSHIP IN THE WORLD

I am a great believer in leadership by example, and in success via attraction rather than promotion. In this regard, US leadership in the world has been significantly shaped by space programs over the past five decades. In the early years, defined by the launch of Sputnik by the Soviet Union, and by the US response, leadership in space and the attendant attraction of friends and allies was a bipolar affair. Today, with a vast increase in the number of spacefaring nations and the evolution of significant transnational, commercial actors in space, the global picture is more complex than ever.

Most nations continue to look to the US to provide leadership in space, and it is in American interests that they do so. While many actors in many parts of the world have developed exquisite space capabilities that compete with America's own, it is still true that no other country enjoys the complete range of capabilities that the US does.

This, however, is not a given. While Russia now competes mainly on price, rather than technical merit or innovation, Europe, China, India, Japan and others have evolved into formidable partners—or, competitors, if the US allows its policies to drift toward isolationism. In particular, Europe and China have evolved tremendous capabilities.

Although the US occasionally proves adept at partnering with Europe to mutual benefit (and, about as frequently, proves inept), America has an incredibly long way to go toward maturing its space relationships with China. Both are huge players and both have earned the kind of stature in space that allows them to compete with the US for leadership in many ways. India and Japan are emerging members of the club.

As it does affect American leadership in the world, the US needs to take considered, thoughtful, positive steps in shaping space security and space diplomacy throughout the transition process. Of course, every country wants to be able to deal with the rest of the world from a position of strength, and it is America's right, as it is the right of every nation, to do so. National security space programs are important, but not enough. A strategy for improving dialogue and engagement with the rest of the spacefaring world is also essential.

Space has not really become an issue, thus far, in the presidential campaigns—which is probably okay from the lightning-rod-avoidance perspective. Space seems never to be a hot-button issue in US politics, for a couple of reasons. First, compared to the massive amounts of the federal budget that other activities gobble up, and the huge social and economic issues facing the US, space is just a very small, almost nuisance-level detail for these campaigns. Second, it is almost an article of faith with the American people that the US will have a strong space program—however ill-defined that may be. Americans largely just assume the government will get space right.

The stakes are much too high for such assumptions. The View From Here is that the viability and resiliency of the US economy, and America's continued leadership in the world, are at stake. *Throughout the transition to a new government, space is no less important than that.*

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 US 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: <http://www.spacefoundation.org/>

