SATCOM For Net-Centric Warfare July/August 2014

# MilsatMagazine

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## Security

Artistic rendition of a MILSTAR satellite courtesy of the U.S. Air Force.

# MilsatMagazine

July/August 2014





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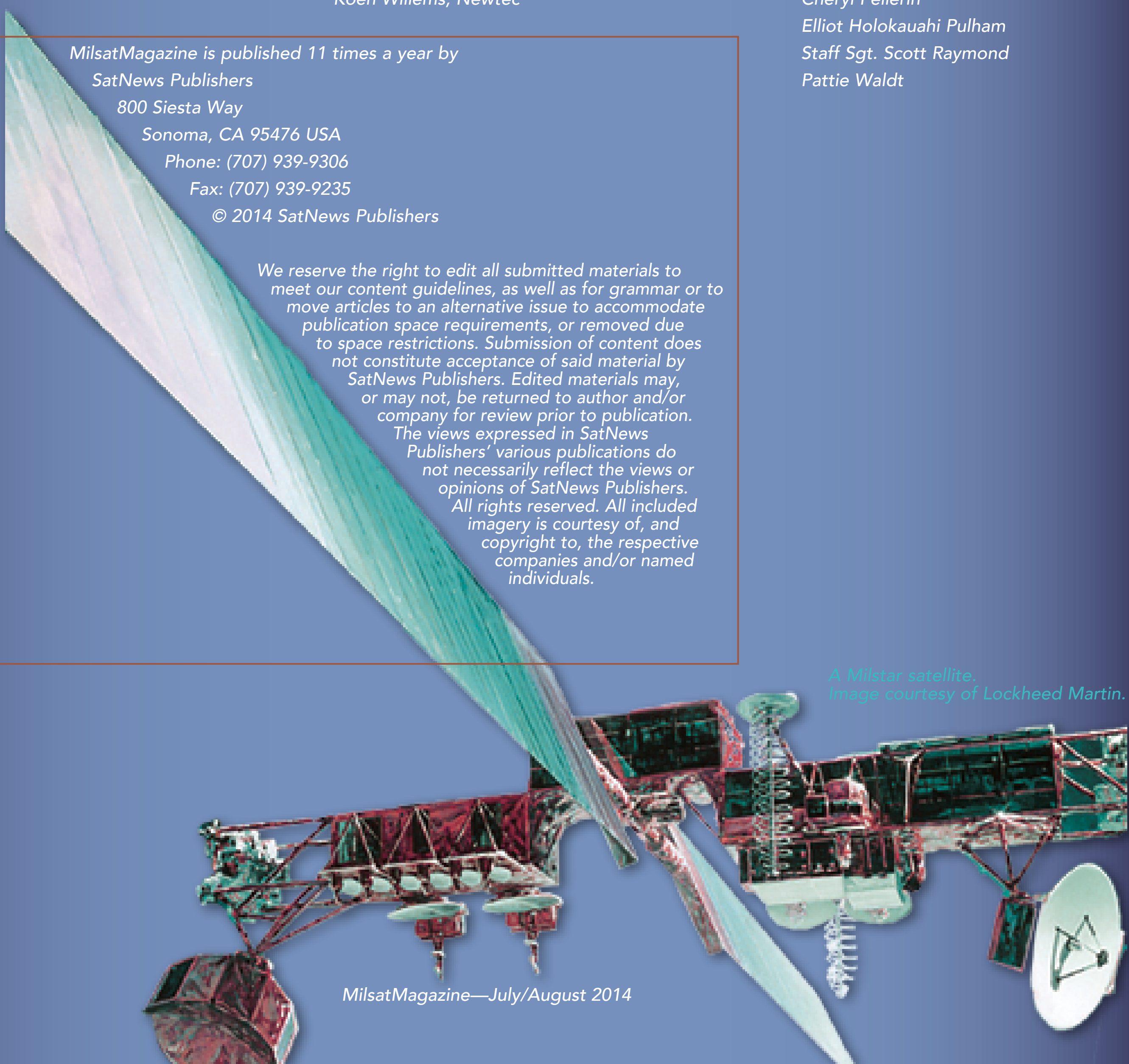

A Milstar satellite.
Image courtesy of Lockheed Martin.

## DISPATCHES



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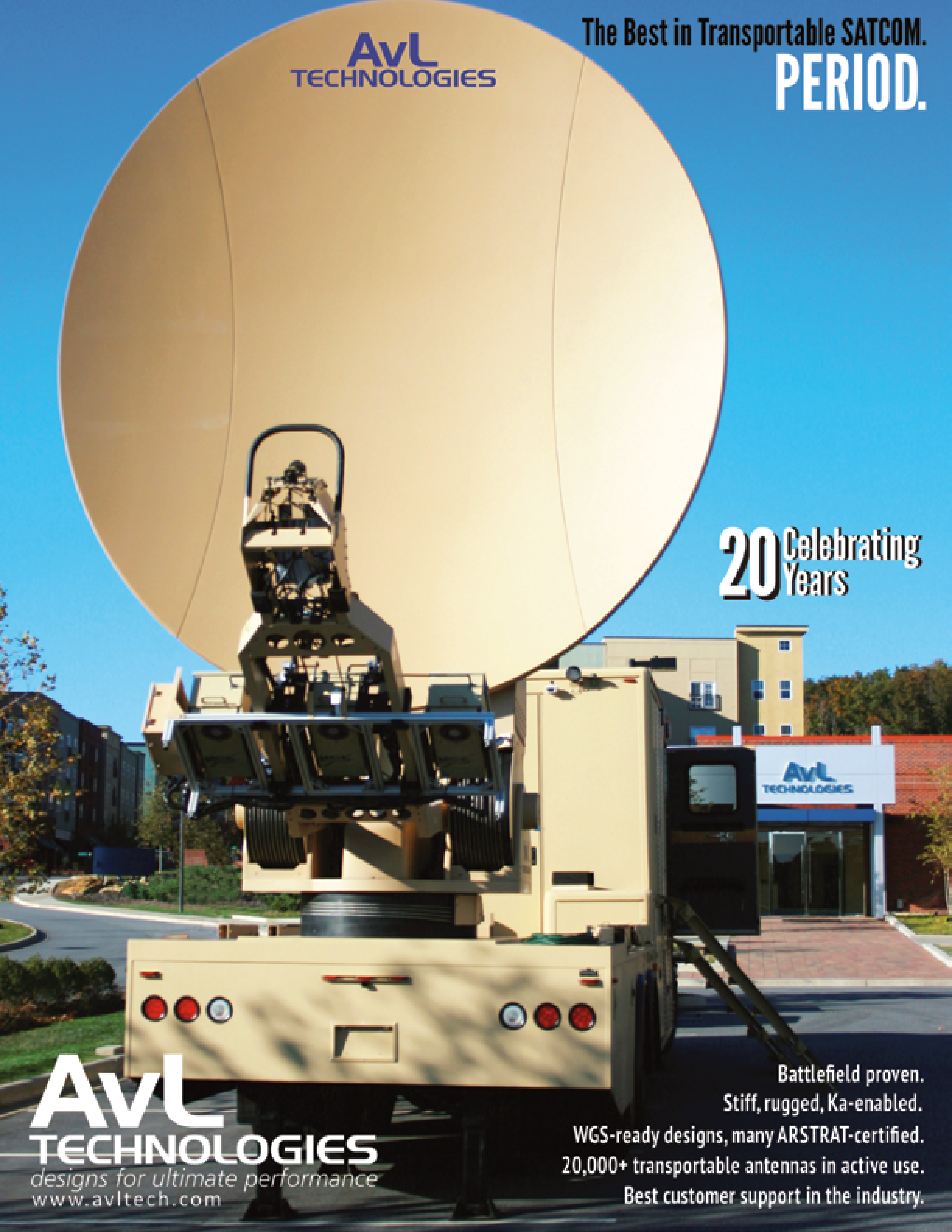
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# DISPATCHES

## DARPA—FIVE NEXGEN TECHNOLOGIES FOR PNT

**It is difficult to imagine the modern world without the Global Positioning System (GPS), which provides real-time positioning, navigation and timing (PNT) data for countless military and civilian uses.**

Thanks in part to early investments that DARPA made to miniaturize GPS technology, GPS today is ubiquitous. It's in cars, boats, planes, trains, smartphones and wristwatches, and has enabled advances as wide-ranging as driverless cars, precision munitions, and automated supply chain management.

As revolutionary as GPS has been, however, it has its limitations. GPS signals cannot be received underground or underwater and can be significantly degraded or unavailable during solar storms.

More worrisome is that adversaries can jam signals. GPS continues to be vital, but its limitations in some environments could make it an Achilles' heel if warfighters rely on it as their sole source of PNT information.

To address this problem, several DARPA programs are exploring innovative technologies and approaches that could eventually provide reliable, highly accurate PNT capabilities when GPS capabilities are degraded or unavailable.

"Position, navigation, and timing are as essential as oxygen for our military operators," said DARPA Director Arati Prabhakar. "Now we are putting new physics, new devices, and new algorithms on the job so our people and our systems can break free of their reliance on GPS."

DARPA's current PNT portfolio includes five programs, focused wholly or in part on PNT-related technology:

- *Adaptable Navigation Systems (ANS) is developing new algorithms and architectures for rapid plug-and-play integration of PNT sensors across multiple platforms, with the intent to reduce development costs and shrink deployment time from months to days. ANS aims to create better inertial measurement devices by using cold-atom interferometry, which measures the relative acceleration and rotation of a cloud of atoms stored within a sensor. The goal is to leverage quantum physical properties to create extremely accurate inertial measurement devices that can operate for long periods without needing external data to determine time and position. Additionally, ANS seeks to exploit non-navigational electromagnetic signals--including commercial satellite, radio and television signals and even lightning strikes--to provide additional points of reference for PNT. In combination, these various sources are much more abundant and have stronger signals than GPS, and so could provide position information in both GPS-denied and GPS-degraded environments.*

- *Microtechnology for Positioning, Navigation, and Timing (Micro-PNT) leverages extreme miniaturization made possible by DARPA-developed micro-electromechanical systems (MEMS) technology. Micro-PNT comprises a portfolio of diverse efforts collectively devoted to develop highly stable and precise chip-scale gyroscopes, clocks and complete integrated timing and inertial measurement devices. DARPA researchers have fabricated a prototype with three gyroscopes, three accelerometers and a highly accurate master clock on a chip that fits easily on the face of a penny. The self-calibrating, high-performance and cost-effective microscale sensors that DARPA is developing could offer tremendous size, weight and power (SWAP) improvements over existing sensors.*

- *Quantum-Assisted Sensing and Readout (QuASAR) intends to make the world's most accurate atomic clocks—which currently reside in laboratories—both robust and portable. QuASAR researchers have developed optical atomic clocks in laboratories with a timing error of less than 1 second in 5 billion years. Making clocks this precise portable could improve upon existing military systems such as GPS, and potentially enable entirely new radar, LIDAR and metrology applications.*

- *The Program in Ultrafast Laser Science and Engineering (PULSE) applies the latest in pulsed laser technology to significantly improve the precision and size of atomic clocks and microwave sources, enabling more accurate time and frequency synchronization over large distances. These capabilities are essential to fully leverage super-accurate atomic clocks, as clocks such as those that QuASAR seeks to build are more precise than our current ability to synchronize between them. If successful, PULSE technology could enable global distribution of time precise enough to take advantage of the world's most accurate optical atomic clocks.*

- *The Spatial, Temporal and Orientation Information in Contested Environments (STOIC) program seeks to develop PNT systems that provide GPS-independent PNT with GPS-level timing in a contested environment. STOIC comprises three primary elements that when integrated have the potential to provide global PNT independent of GPS: long-range robust reference signals, ultra-stable tactical clocks, and multifunctional systems that provide PNT information between multiples users.*

In time, dependence on GPS may be as unimaginable as is the idea today of living without it.

For further information regarding DARPA, please visit their infosite at **http://www.darpa.mil/**

## U.S.A.F.'S 55TH STRATEGIC COMMUNICATIONS SQUADRON—A DISA AWARD

**The men and women of the 55th Strategic Communications Squadron recently learned that their dedication to excellence was about to be acknowledged with the Defense Information Systems Agency's (DISA) top award.**

With 11 categories, each offering a different type of support, the 55th SCS won the Category IX, Defense Satellite Communications System and Wideband Global Satellite Earth Terminal Facility of the Year for 2013. The global award is DISA's top-level award across all services.

Col. Jeffrey Granger, 55th Communications Group commander, said,"They are one of the most focused, organized, compliance driven work centers I've ever encountered. They know their mission, their customers, and their jobs to amazing breadth and depth. This award validates their sustained excellence."

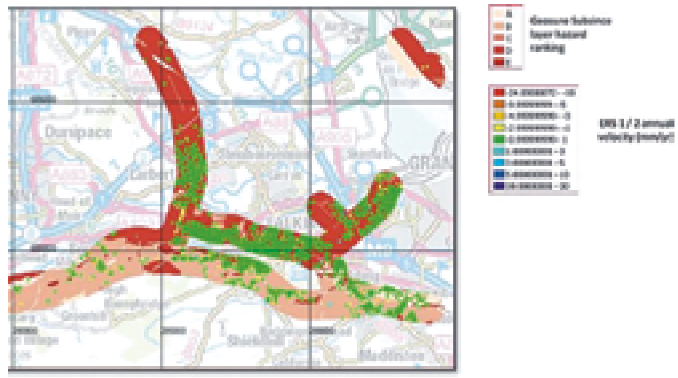
The Offutt Earth Terminal Facility houses two DSCS terminals. These terminals take user data (telephone, computer, etc.), process it and send it to the satellite for reception at another Earth terminal in any area of the Earth the satellite can see.

As it turns out, the DISA Facility of the Year Award Category IX is not the only top-level award the 55th SCS has been awarded for 2013. The 55th SCS also just found out that their High Frequency Global Communication System also won the Outstanding Global Information Grid Facility or Category VIII Global Award for 2013. The High Frequency radio system is a three-site HF communication system at two locations that permits point-to-point and ground-to-air-to-ground communications by voice, continuous wave and data. Three separate sites control, transmit and receive up to 14 four kilowatt solid state radio transmitters, 18 radio receivers and associated equipment.

*Story by David R. Hopper, 55th Wing Public Affairs*

## European Space Agency (ESA)—Trips Won't Be Halted Due To Shifting Land

*Scotland's A85 road in Glen Ogle blocked by two debris flows on August 18, 2004. Royal Air Force and Royal Navy helicopters airlifted some of the 57 occupants to safety from the 20 trapped vehicles. Image courtesy of Live Land.*



*Motion data mapped onto Falkirk area in Scotland. A visualization of the motion data obtained by radar satellite scans mapped onto the geological susceptibility map for the Falkirk area in Scotland. Ground motion is indicated by the small dots (displacement indicated in legend). The thick lines indicate the geological susceptibility for subsidence (A: low potential hazards; E: high potential hazard). Graphic courtesy of Live Land.*

**Subsidence, rockfalls and landslides threaten potentially devastating human and economic consequences across Europe—however, satellites can help.**

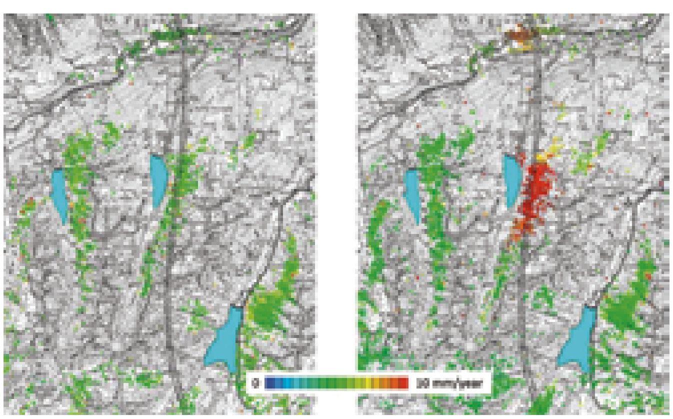
Traditional monitoring, such as photographic mapping to measure changes in the landscape, works well for specific locations, but is labor intensive and costly. Now, ESA has looked at using satellites to watch for hazards across broad areas that could affect road and rail networks.

The outcome is so promising that the resulting monitoring services continue to be developed by the companies involved in the two projects.

The services rely on a triple space alliance of satellite radar images, combined with satnav using satcoms to relay in-situ observations to a central system for analyzing ground motion around road and rail networks.

One promising approach is to use maps produced from radar satellites to identify potentially hazardous slopes, followed by repeat monitoring at ground level.

By taking regular observations, displacements across large areas can be measured with millimeter accuracy. Any sudden changes in motion indicate a potentially high-risk situation and invite closer scrutiny.



*Satellite data reveals small geological movements Subsidence along the Val Nalps in Switzerland. Results on the left are obtained from ERS-1/2 data from 1992 to 2000; the results on the right are from Envisat data from 2004–10. Graphic courtesy of MATIST.*

"There is no single way of solving the problem of monitoring natural hazards," said ESA's Rob Postema, "but these two projects demonstrate how combining techniques results in a powerful toolset for tackling a whole range of geological challenges."

The Live Land study, led by CGI in the UK, looked at how to combine information from satellite radar scans, geology and weather forecasts to come up with risk maps that give enough warning to reduce the disruption and cost associated with landslide and subsidence on selected roads and railways in Scotland.

For example, an area of steep slopes and wet soil that is expecting heavy rainfall is at a higher risk of a landslide—therefore this would be highlighted in the maps.

Similarly, the Matist project, led by Gamma Remote Sensing and Consulting in Switzerland, combined satellite and terrestrial radar information and satnav to follow ground movements in the mountainous regions of Switzerland and Austria, notably covering the dense rail networks and Austria's main road network.

These studies used existing Earth observation (EO) data, but Europe's Sentinel satellites will become a valuable resource once they come online.

Rob Postema added, "In coming years, I expect to see a great many more innovative applications that make use of satellite data and capabilities, such as Earth observation and satellite navigation for keeping a watchful eye on phenomena of ground motion and the associated risks."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The 25W GaN X-Band BUC is perfectly suited for harsh environments such as man-pack terminal deployments. Constructed in a compact cooling enclosure for outdoor operation is the smallest fully integrated unit on the market today.

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## AIR FORCE SPACE COMMAND—BUDGET CUTS = GROWING THREAT TO SPACE OPS

**Until recently, space was a peaceful domain where orbital and flying craft were unprotected, but adversaries now are developing systems designed to counter advantages gained by those using such space capabilities, the commander of Air Force Space Command—General William L. Shelton—said recently.**

The Advanced Extremely High Frequency, or AEHF, system is a joint service satellite communications system that provides survivable, global, secure, protected and jam-resistant communications for high-priority military ground, sea and air assets. Advanced EHF allows the National Security Council and unified combatant commanders to control tactical and strategic forces at all levels of conflict through general nuclear war and supports the attainment of information superiority.

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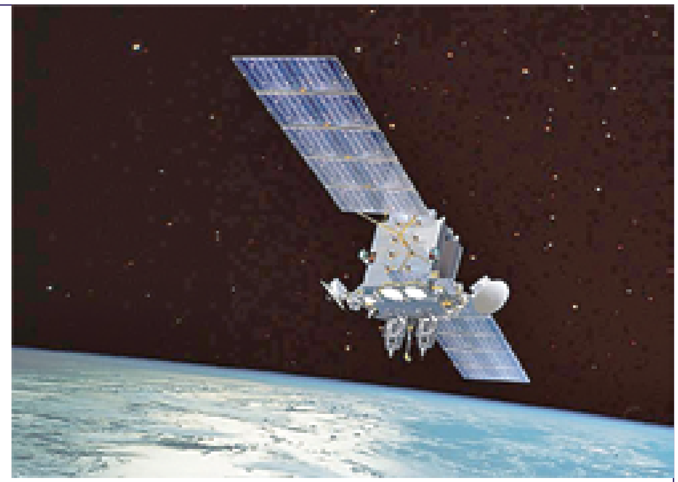
"Our satellites were not built with such threats in mind," Shelton said. There hasn't been a launch failure in 72 consecutive national security launches, he added, and satellites have lasted so much longer than their designed lifespan that the nation accidentally gained overlap between "father and daughter" satellites. "Space largely has been a peaceful sanctuary up to this point," the general said, "and due to the cost of each of these intricate machines, we build just enough capability and build it just in time. We don't really plan for anything but success. "Now," he said, "we have a clear and present danger to contend with that I believe must change our calculus on resiliency."

"Traffic is building in space, as many new entrants have joined the ranks of spacefaring nations and counter-space capabilities are becoming more concerning," Shelton explained. "The Air Force must adapt its satellite constellations in response to such growing threats and elevate its game in space situational awareness," he said. And, the general said, "Air Force Space Command is addressing this challenging space environment in the midst of a decreasing budget outlook.

"Space forces are foundational to every military operation, from humanitarian to major combat operations. It really doesn't matter—space has to be there—continuously deployed in place, providing



*The Advanced Extremely High Frequency, or AEHF, system is a joint service satellite communications system that provides survivable, global, secure, protected and jam-resistant communications for high-priority military ground, sea and air assets. Advanced EHF allows the National Security Council and unified combatant commanders to control tactical and strategic forces at all levels of conflict through general nuclear war and supports the attainment of information superiority.*

*This artistic rendition of AEHF is courtesy of the U.S. Air Force.*

communications, missile warning, navigation, space surveillance and weather services," Shelton said. "Still," he added, "Space Command's share of reductions as part of overall Air Force reductions included a space surveillance asset that saved $6 million per year, an operationally useful sensor redundancy at launch bases that cut another few million dollars per year, and drastic cuts in headquarters contractor support that saved money but has substantially reduced capability.

"All told, we cut close to $1 billion from our annual budget in fiscal year 2013 and [fiscal] 2014 combined," the general said. "The bottom line on our budget situation is this: We made the needed adjustments in fiscal years 2013 and 2014], and [fiscal] 2015 right now looks like it will be feasible," he added. "But the law of the land is still sequestration for [fiscal] 2016 and beyond. Should Congress decide not to grant relief from [the severe budget cuts of] sequestration, I don't know how my command can absorb the mandated reductions."

To elevate the Air Force's game in space situational awareness, Shelton explained his priorities for future satellite constellations as a nexus, aiming for an overlap of required capability, resilience and affordability. To illustrate the idea, he used the Air Force's Advanced Extremely High Frequency, or AEHF, satellite constellation as an example.

"This is the constellation the president would use in existential circumstances for the United States to command and control nuclear forces and to ensure continuity of the United States government," Shelton said. "The required constellation consists of four satellites, just enough for worldwide assured coverage," he added. "If an adversary took out one satellite in the constellation, a geographic hole would open, potentially preventing the president from communicating with forces in that part of the world," the general said. "We're looking at a range of options to make this scenario much less probable—for example, disaggregating our constellations for increased flexibility and survivability.

"The satellite carries strategic and tactical communications packages," Shelton said, explaining disaggregation. "If the payloads were separated onto two or three satellites, he said, they would be much more resilient to a single shot, and each satellite would be less complex, would weigh less and would cost less to launch.

"Air Force Space Command is also considering the following possibilities," Shelton said:

- *Hosting payloads on commercial or other government satellites*
- *Lowering the cost or complexity of getting capability and capacity into space*
- *Leveraging commercial capability such as satellite communications rather than building dedicated military satellites*
- *Exploring partnerships with other nations to share the responsibility of sustaining critical space capabilities*

"We've already done this with our Wideband Global SATCOM Satellite," he added, "and partnered with Australia, the Netherlands, New Zealand, Canada, Denmark and Luxembourg." Shelton said he believes the Air Force needs less complexity and more flexibility in its constellations, and that it will have to make decisions soon on its longer-term approaches.

"Our need date is the mid-2020s for replacements to the current satellite programs of record," he said. "With long budgeting and development timelines, we're looking at decisions in the [fiscal] 2017 program, which works through the Pentagon next year. We're watching carefully as other nations significantly increase their investment in counter-space programs," he continued. "We absolutely must adjust our approach and response, and the time for those decisions is approaching very rapidly."

Another way the Air Force Space Command is improving its real-time space situational awareness, or SSA, is through a new architecture approved for SSA, Shelton said. The first critical step, he added, is the Joint Space Operations Center Mission System Program, or JMS. "This open-architecture, high-performance computing environment will be a several-orders-of-magnitude improvement over our current system," he said. "And by the way, the last major upgrade to our current system was in 1994.

"JMS will give Air Force Space Command a modern sensor data-processing capability plus a command-and-control environment for all space forces. The command is also making sensor improvements," Shelton said.

"We just awarded the contract for the Space Fence that will be built on Kwajalein Island in the Western Pacific," he added. "This new radar will produce thousands of observations every day, covering almost all orbital inclinations. The Space Fence will be much more sensitive and will be able to track unscheduled events in space, such as threatening satellite maneuvers and rocket body breakups that cause increased orbital debris traffic," Shelton said. "We've shipped a converted space-launch tracking radar to Western Australia to give us much better near-Earth space situational awareness in the Southern Hemisphere," the general added, "and we will send to Australia a DARPA-developed telescope that is currently in New Mexico."

DARPA is the Defense Advanced Research Projects Agency. The agency's C-band mechanical tracking ground-based radar can accurately track up to 200 objects a day and can help identify satellites, their orbits and potential anomalies, according to a fact sheet about the system. When the radar is relocated to Australia, it will be the first Low Earth Orbit (LEO) space surveillance network sensor in the Southern Hemisphere. The new location will give needed southern and eastern hemispheric coverage that will lead to better positional accuracies and predictions. "This very capable telescope will do a great job of deep-space surveillance from that unique vantage point in Western Australia," Shelton said.

Upcoming, the Air Force is scheduled to launch two operational satellites into near-geosynchronous orbit, he added. The satellites are part of the Geosynchronous Space Situational Awareness Program, or GSSAP. The GSSAP satellites will give U.S. Strategic Command space situational awareness data that allows for more accurate tracking and characterization of human-made orbiting objects, according to the Air Force News Service.

"This Neighborhood Watch twosome will help protect our precious assets in geosynchronous orbit," Shelton said, "plus, they will be on the lookout for nefarious capabilities other nations might try to place in that critical orbital regime." The general said the two satellites would provide a lot of knowledge about geo-traffic through the images they produce.

"GSSAP will also demonstrate enhanced maneuverability activities that include rendezvous and proximity operations during the developmental and operational test events shortly after launch," he added.

The 1st Space Operations Squadron at Schriever Air Force Base in Colorado Springs will then have rendezvous and proximity operations in its toolkit to allow GSSAP to maneuver to get the best possible vantage point for collecting images when required, the general added. GSSAP represents a big leap forward in situational awareness at geosynchronous orbit, the general said. "With new data sources and a new system to process the data, later in this decade we will have truly enhanced our ability to monitor activity in space," Shelton said. "And the big payoff [is that] we can transition from a reactive posture in space to becoming much more proactive, predicting space activity and anticipating outcomes."

*Story by Cheryl Pellerin,*
*DoD News,*
*Defense Media Activity*

## HARRIS CORPORATION—MULTI-BAND + MULTI-MISSION SOLUTION FOR TACOPS

**Harris Corporation has received a $15 million order to deliver its latest wideband handheld tactical radio to a Middle Eastern nation.**

Harris is supplying this nation with the RF-7850M handheld, a multi-band, multi-mission radio that provides advanced tactical communication capabilities. The radio offers a new embedded interface that gives users access to a library of applications that provide situational awareness, tactical messaging, file transferring and radio configuration support from a standard web browser. The interface is fully customizable through a software-development kit, simplifying the process of creating and distributing new applications.

The RF-7850M-HH supports the latest wideband and narrowband networking waveforms. Lightweight and highly portable, the radio also is fully interoperable with the Harris Falcon II® and Falcon III® families, which are widely used by NATO and other global military forces.

"The RF-7850M combines the portability of a handheld with much of the functionality and performance of a larger manpack in areas such as range, bandwidth and power output," said Brendan O'Connell, president, International business unit, Harris RF Communications. "The radio provides capabilities for sharing situational awareness feeds and command and control information while on-the-move, allowing commanders to make informed decisions in real time."

For further information, please visit **http://rf.harris.com/capabilities/tactical-radios-networking/rf-7850m-hh.asp**

## WTA—TELEPORT STANDARDS CERTIFICATION

WTA World Teleport Association

**Certificate levels of Platinum, Gold, Silver, or Bronze will be assigned to teleport operators to reflect a clear, objective standard for facilities, technology and operating procedures.**

The World Teleport Association (WTA) announced that, at the request of its customers, it is developing a Teleport Certification Program.

The program aims to serve teleport operators and their customers by creating an objective, transparent, and internationally accepted method for teleport operators to document the quality of their operations for customers and strategic partners.

The program also aims to provide a means for customers to select teleport vendors delivering the price-performance level that is appropriate for their applications. Certification at one of these levels will indicate, at a minimum, that the teleport complies with the standards of that particular level.

The certification standards are being developed by a volunteer committee made up of teleport, satellite and technology executives as well as representatives of end-user customers. As draft standards are determined, they will be posted for comment by the industry on a schedule yet to be determined.

Offering temporary self-certification and multi-year audited circulation, the program will launch upon approval of the standards. WTA will maintain an up-to-date online registry of certified teleports and provide teleport operators with links to their online statement of certification as well as a certification logo for display in their marketing programs.

"Customers bidding a project struggle to understand the quality differences that lie behind estimate from different service providers," said executive director Robert Bell. "There is no objective way for a teleport operator today to demonstrate its quality, without time-consuming and costly site audits. This is a gap that our Certification program will fill, in a transparent way that lets customers select the price-performance their application needs."

For information on how to participate in the committee, or learn more about the certification process, please contact WTA's Membership Director at ***rbarney@worldteleport.org***.

Additional WTA information: ***http://www.worldteleport.org/***.

## HUGHES NETWORK—STEADY WITH THALES DEFENSE & READY ANYWHERE, ANYTIME



**This robust and private network solution can be deployed virtually anywhere, making it ideal for emergency response networks such as FirstNet, the nationwide, interoperable public safety broadband network.**

Hughes Network Systems, LLC, a provider of broadband satellite solutions and services, and Thales Defense & Security, Inc., of aerospace, transportation, defense and security technologies, have announced they have successfully tested a rapidly deployable Long-Term Evolution (LTE) mobile networking solution via satellite.

The solution leverages the powerful combination of Hughes SPACEWAY® 3 and JUPITER™ high-throughput technologies, connecting with the Thales B-14 system-on-wheels. This robust and private network solution can be deployed virtually anywhere, making it ideal for emergency response networks such as FirstNet, the nationwide, interoperable public safety broadband network.

"The key to emergency preparedness and response is ensuring first responders can communicate with each other and with Emergency Operations Centers (EOC) to share information about the disaster and coordinate the response to it—no matter where they are located," said Tony Bardo, Assistant Vice President for Government Solutions at Hughes. "This successful test proves that Hughes satellite technology and systems, combined with Thales LTE deployable system-on-wheels, provides the public safety community with a mobile networking solution that is easy to use, dependable, and enhances capabilities over current narrowband voice radio systems."

Hughes and Thales conducted situational testing operating on the 700MHz public safety spectrum to validate the solution's performance and interoperability with public safety network requirements.

Using readily available smartphones and vehicular modems, first responders are able to easily communicate and share video with each other and EOCs via this local deployable broadband network.

"Cellular and broadband networks see the most congestion right after a catastrophe," said Lewis Johnston, Vice President of Advanced Programs at Thales. "As people scramble to reach loved ones, first responders spring into action, facing the same communication challenges as the general public at a time when the need to communicate between each other and with EOCs is the most critical.

"Our deployable 4G/LTE secured communications solution enables the security, availability and resilience of mission-critical applications to solve this problem, which is vital to the public safety mission."

The test marks Hughes' latest innovation for the public safety community and emergency operators, ensuring secure, reliable connectivity using the latest combined mobile and satellite communications technologies.

Previously, Hughes successfully tested its satellite solutions for Land Mobile Radio (LMR) backhaul for two Cabinet-level agencies and in multiple states, including Louisiana's Department of Public Safety.

Headquartered in Clarksburg, Maryland USA, Thales Defense & Security, Inc. serves military and civilian customers worldwide with a product portfolio that includes communication systems; helmet mounted display and motion tracking technologies; tactical SATCOM terminals; intelligence surveillance and reconnaissance solutions; electronic warfare; combat management systems; advanced sonars; air traffic management solutions; and information security and data protection solutions.

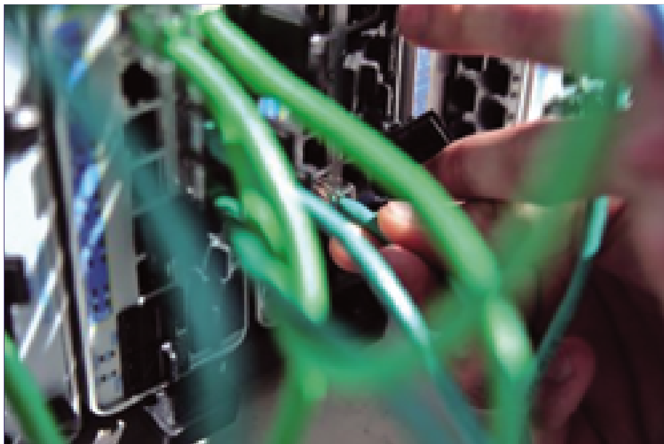
Hughes Network Systems, LLC provides satellite broadband for home and office, delivering network technologies, managed services, and solutions for enterprises and governments around the world.

*http://www.hughesnet.com/*

*http://thalesdsi.com*

# DISPATCHES

## U.S.A.F.—TRAINING FOR WORLDWIDE COMMUNICATIONS SECURITY OPS



*Wires are connected to the Orthogon system that transmitted information wirelessly to a satellite location near MacDill Air Force Base, Florida. The Joint Communications Support Element conducted an exercise to test the unit's readiness for rapid deployment communications operations.*

*U.S. Air Force photo by Tech. Sgt. Brandon Shapiro)*

**Traditionally, the communications career field is viewed as the office to call for over-the-phone support, or to request a technician to work some magic at a workstation.**

However, there is an elite, specially-trained group of communications experts at MacDill AFB who are far from the typical information technology specialists. They train to deploy at a moment's notice to austere environments, establishing secure communications lines.

Two teams from the Joint Communications Support Element on MacDill Air Force Base conducted an exercise at a simulated remote location on July 23, 2014. As one team set-up their equipment on the base's shoreline, another team traveled by boat to a secluded island to test their rapid-deployment capabilities.

Once at the island, the team setup non-classified, classified and other secure lines of communication.

"Basically we're just setting up and testing our Orthogon system, which is pretty much like a big Ethernet cable," said U.S. Marine Corps Sgt. Daniel Bunnell, JCSE radio frequency operator. "Except it's an Ethernet connection in the sky, and we're transmitting information wirelessly."

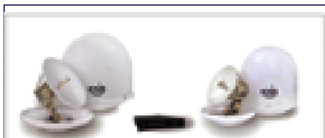
The teams were given less than three hours to transport all the equipment and complete a transmission. They accomplished their goal with nearly an hour left to spare, which proved their readiness to support missions worldwide.

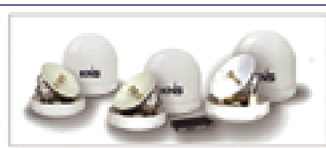
These teams constantly deploy to the U.S. Central Command area of responsibility, U.S. Africa Command and other regions, supporting Operation Enduring Freedom and Horn of Africa.

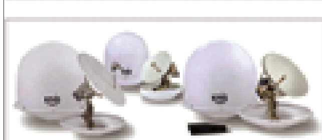
According to the unit's website, "JCSE immediately deploys to provide enroute, early entry, scalable command, control, communications and computers (C4) support to the regional combatant commands, Special Operations Command, and other agencies as directed; on order, provides additional C4 services within 72 hours to support larger Combined Joint Task Force/ Combined Joint Special Operations Task Force headquarters across the full spectrum of operations."

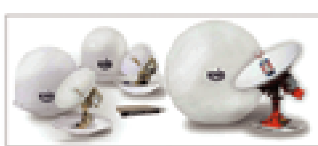
*Story by*
*Senior Airman Michael Ellis,*
*6th Air Mobility Wing Public Affairs*

## KNS—CONTROL IS ALWAYS POSSIBLE









**KNS, Inc. has launched their proprietary web-based software that will allow ships to remotely control and monitor their antennas, regardless of how far the operator is from the Antenna Control Unit (ACU).**

With engineers and captains requiring better management to the status of their antennas, KNS believes that their web interface will enable them to provide improved decision making, and ultimately, increase safety and service.

This new software is, according to the company, easy to use and provides a maximum of 16 different IDs for a single antenna. Each ID requires a separate password, entered on a PC, iOS, Android or mobile phone, to ensure security and controlled access.

Additional features include the ability to have all antenna monitoring information visible on one page.

Incorporated into this page would be errors, sensor voltage and a graph showing the satellite carrier spectrum analyzer.

There is also a dedicated function for saving error data codes, which can be logged by time and by error code.

This information can be stored using the memory bank and can be searched through at a later stage via a specific date or time span.

The software is available immediately via KNS's global distribution channel.

The KNS infosite is available at
**http://www.kns-kr.com/**

## JAXA + Quasi-Zenith Satellite—Natural Disasters Pinpointed To Centimeters

*Quasi-zenith Satellite System (QZSS) watching Japan.*

**An updated disaster prevention and evacuation system is more vital than ever after a devastating mudslide hit Nagiso early in July...**

The Japan Aerospace Exploration Agency is partnering with Japan's Cabinet Office and Internal Affairs and Communications Industry to begin utilizing data from the country's quasi-zenith satellite in order to monitor Earth movement and proactively detect mudslides, reports The Yomiuri Shimbun.

As mobile phones equipped with car navigation or GPS have become widespread, positioning information using satellites is imperative to everyone's lives. To specify a location, signals from at least four satellites must be received. However, in some urban or mountainous areas, positioning signals from four satellites are often hampered by skyscrapers or mountains, and that has often caused significant errors.

The quasi-zenith satellite, Michibiki, can pinpoint movement down to within several centimeters, versus the country's Global Positioning System's (GPS) accuracy, which is down to within ten meters. This means earlier detection of even the slightest slips of Earth—early signs of a mudslide—and earlier evacuation warnings. These evacuation warnings may even be tailored to the cell phone user's location. The full-scale operation is projected to start in 2018.

The QZSS consists of a multiple number of satellites that fly in the orbit passing through the near zenith over Japan. By sharing almost the same positioning signals for transmission with the currently operated GPS, as well as the new GPS which is under development in the U.S., the system enables area and time duration expansion of the positioning service provision in mountainous and urban regions in Japan.

Japan is also considering establishing their own GPS with 10x the accuracy of the current system, with plans to launch a second, third, and fourth quasi-zenith satellite throughout the 2016 and 2017.

# DISPATCHES

## DEPARTMENT OF DEFENSE (DOD), U.S.A.F. SMC—FOURTEEN WILL HOPS TO IT

U.S. Department of Defense

**The U.S. Department of Defense has revealed new U.S. Air Force contracts that find 14 companies involved in the satellite industry, all benefiting to the tune of nearly one-half billion dollars each.**

The companies have been awarded a $494,900,000 maximum firm-fixed-price, indefinite-delivery/indefinite-quantity (IDIQ) contract under the Hosted Payload Solutions (HoPS) program.

The purpose of the multiple awarded HoPS IDIQ contract is to provide a rapid and flexible means for the government to acquire commercial hosting capabilities for government payloads.

The contract is designed to create a pool of qualified vendors to meet the government's needs for various hosted payload missions.

The HoPS IDIQ scope includes procurement of hosted payload missions and procurement of hosted payload studies.

Procurement of hosted payload missions includes a fully-functioning, on-orbit hosted payload space and ground system for government-furnished payloads on commercial platforms.

In addition to the space and ground systems, the HoPS mission will also include related on-orbit support for data transfer from the hosted payload to the government end-user(s).

The HoPS studies include those study activities related to enabling hosted payloads.

This award is the result of a full and open competitive acquisition. The contract has a five-year ordering period from the date of award. Work will be performed predominantly at the contractors' locations mentioned above, and is expected to be completed by January 31, 2029.

A total of 19 firms were solicited and a total of 14 offers were received. This is not a multiyear contract.

Fiscal 2014 research and development funds in the amount of $975,696 are being obligated at time of award.

The Space and Missile Systems Center Contracting Directorate, El Segundo, California, is the contracting activity.

The companies receiving the contracts include:

- *Astrium Services Government, Inc., Rockville, Maryland (FA8814-14-D-0001)*
- *Harris Corp. Government Communications Systems Business Unit, Palm Bay, Florida (FA8814-14-D-0002)*
- *Space Systems/Loral, LLC, Palo Alto, California (FA8814-14-D-0003)*
- *Millennium Engineering & Integration Company, Arlington, Virginia (FA8814-14-D-0004)*


- *Surrey Satellite Technology, Englewood, Colorado (FA8814-14-D-0005)*
- *Orbital Sciences Corp., Dulles, Virginia (FA8814-14-D-0006)*
- *The Boeing Co., El Segundo, California (FA8814-14-D-0007)*
- *Exoterra Resources, Littleton, Colorado (FA8814-14-D-0008)*
- *Lockheed Martin Corp., Littleton, Colorado (FA8814-14-D-0009)*
- *Merging Excellence and Innovation Tech, Inc., Houston, Texas (FA8814-14-D-0010)*
- *ViviSat, LLC, Beltsville, Maryland (FA8814-14-D-0011)*
- *Intelsat General Corp., Bethesda, Maryland (FA8814-14-D-0012)*
- *SES Government Solutions, McLean, Virginia (FA8814-14-D-0013)*
- *Eutelsat America Corp., Washington, District of Columbia (FA8814-14-D-0014)*

## U.S.A.F. + LOCKHEED MARTIN—PLEASE FENCE ME IN WITH IMPROVED TRACKING

**The U.S. Air Force has awarded Lockheed Martin a $914 million contract to improve the way objects are tracked in space and increase the ability to prevent space-based collisions.**

Lockheed Martin's Space Fence solution, an advanced ground-based radar system, will enhance the way the U.S. detects, catalogs and measures more than 200,000 orbiting objects.

With better timeliness and improved surveillance coverage, the system will protect space assets against potential crashes that can intensify the debris problem in space.

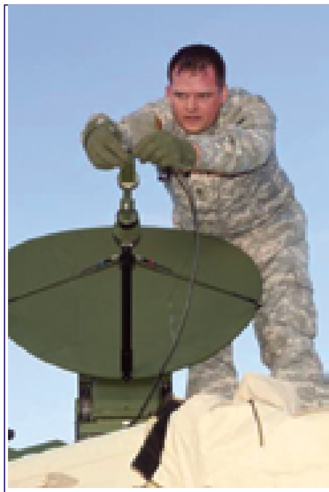
Dale Bennett, executive VP of Lockheed Martin's Mission Systems and Training business, said, "Space Fence will locate and track objects with more precision than ever before to help the Air Force transform space situational awareness from being reactive to predictive."

Lockheed Martin will deliver up to two advanced S-band phased array radars for the Space Fence program. The Space Fence radar system will greatly improve Space Situational Awareness of the existing Space Surveillance Network.

Construction of the new Space Fence system on Kwajalein Atoll in the Marshall Islands is slated to begin in the early 2015 to meet the program's 2018 initial operational capability goal. The total contract value is estimated at greater than $1.5 billion over an eight-year period of performance if all options are exercised.

With more than 400 operational S-band arrays deployed worldwide, Lockheed Martin is a leader in S-band radar development, production, operation and sustainment. The Lockheed Martin-led team includes General Dynamics and AMEC.

## U.S. Army—24-Hour Response Package Is Put To The Test



*Staff Sgt. Jonathan Means sets up a dish antenna for a satellite unit nicknamed the "Cheetah" as part of a communication exercise for the 63rd Theater Aviation Brigade's signal section in Pensacola, Florida. The Cheetah system is an auto-acquiring portable satellite receiver that provides high-speed data communications for Internet and phone connections in remote locations or following a catastrophic event.*

**The Army has a plethora of communication systems. Soldiers with the 63rd Theater Aviation Brigade's signal section recently participated in a multi-state communication exercise in Pensacola, Florida, to ensure that they could connect as many systems as they could in a potential crisis situation.**

In a true test of interoperability, the Kentucky National Guard soldiers flew to Florida, thanks to the Illinois Air National Guard and Kentucky Air Guard's 123rd Airlift Wing, to validate their equipment and skills for Task Force 46, a Michigan National Guard command.

"This exercise showcases the talents of this unit and the quality cooperation of a variety of assets," said Capt. Joseph Fontanez, officer in charge of the Kentucky delegation.

Fontanez said the exercise took into consideration all the logistics of responding to an incident, but it was still primarily an exercise in communicating. The unit's goal was to send a forward command and control element within 24 hours to establish lines of communication between military units and local emergency responders for potential life-saving operations.

"We do this to ensure we are more than capable of filling in the communication needs of the task force and responding to an incident effectively."

According to Task Force 46, the exercise enhanced the abilities of personnel and units to perform operations in support of local agencies and Homeland Defense during a catastrophic event, such as a large-scale chemical, biological or nuclear incident.

A variety of units including aviation, medical, chemical and signal make up the response under the task force's command and are based in Kentucky, Alabama, Florida and Michigan. Michigan is also home to the headquarters element for the Command and Control CBRN-E Response Enterprise Bravo. Each unit had their own roles and objectives to be validated for the exercise, but Fontanez said there was opportunity for more.

As part of a first time test of their "24-hour response package," the Soldiers worked with Kentucky's 123rd Airlift Wing Airmen to pack all the gear and equipment. This included loading two Humvees into a C-130 and then expediting their arrival in Florida.

"We play our part here and the team does a fantastic job, but we certainly tested the limits of our readiness for this exercise," said Staff Sgt. Jonathan Means. "We tried something new and it worked well for us."

*Chief Warrant Officer Scott Goode (front) and Sgt. Joshua Atonovich with the 63rd Theater Aviation Brigade install an antenna to the unit's mobile communication system during a signal exercise in Pensacola, Fla., March 8, 2014. The exercise brought various units of Task Force 46, a Michigan National Guard command, together to validate communication systems and response.*

The Kentucky soldiers also worked to connect back to Frankfort, Kentucky, and finish the circle of communication from home station to field environment. With the added goals and unique equipment footprint, the 63rd was well represented and caught the eyes of others at the exercise.

Maj. Gen. Burton Francisco, Task Force 46 Commander was on hand to oversee the exercise and stressed the importance of exercising communication abilities of the units and how critical communication is for the task force.

"I'm very happy with I have seen so far, the soldiers that are here representing each of their task forces are subject matter experts, each and every one of them," he said. "I was very impressed with what I saw from Staff Sgt. Means and the whole task force aviation team from Kentucky."

The communication exercise is in preparation for the much larger Vibrant Response exercise held each August at Camp Atterbury, Indiana. The unit will participate in other exercises prior to the annual event, but the soldiers said the size of this exercise in Florida was invaluable for them and their jobs.

"These exercises are very beneficial for us in this field because our skills are perishable," said Chief Warrant Officer Scott Goode. "We have to maintain our equipment and remain proficient in all the different radio systems and technologies. This is a great tool for keeping the unit sharp and ready to go at all times."

*Story and photos by Staff Sgt. Scott Raymond, 133rd Mobile Public Affairs Detachment, Kentucky National Guard*

## DARPA—SPACEPLANE WORK COMMENCES

**Three companies have received the nod to outline their visions of DARPA's next-generation spaceplane.**

In an era of declining budgets and adversaries' evolving capabilities, quick, affordable and routine access to space is increasingly critical for both national and economic security. Current satellite launch systems, however, require scheduling years in advance for a handful of available slots. Launches often cost hundreds of millions of dollars each, in large part to the massive amounts of dedicated infrastructure and personnel required.

DARPA created its Experimental Spaceplane (XS-1) program to help overcome these challenges and create a new paradigm for more routine, responsive and affordable space operations. In an important step toward that goal, DARPA has awarded prime contracts for Phase 1 of XS-1 to three companies:

- *The Boeing Company (working with Blue Origin, LLC)*
- *Masten Space Systems (working with XCOR Aerospace)*
- *Northrop Grumman Corporation (working with Virgin Galactic)*

The XS-1 program aims to develop a fully-reusable unmanned vehicle that would provide aircraft-like access to space and deploy small satellites to orbit using expendable upper stages. XS-1 seeks to deploy small satellites faster and more affordably, and develop technology for next-generation hypersonic vehicles.

XS-1 envisions that a reusable first stage would fly to hypersonic speeds at a suborbital altitude. At that point, one or more expendable upper stages would separate and deploy a satellite into Low Earth Orbit (LEO). The reusable first stage would then return to Earth, land and be prepared for the next flight. Modular components, durable thermal protection systems and automatic launch, flight and recovery systems should significantly reduce logistical needs, enabling rapid turnaround between flights.

Key XS-1 technical goals include flying 10 times in 10 days, flying to Mach 10+ at least once and launching a representative small payload to orbit. The program also seeks to reduce the cost of access to space for 3,000- to 5,000-pound payloads to less than $5 million per flight.

DARPA expects the performers to explore alternative technical approaches from the perspectives of feasibility, performance, system design and development cost and operational cost. They must also assess potential suitability for near-term transition opportunities to military, civil and commercial users.

These opportunities include both launching small payloads per the program goals as well as others, such as supporting future hypersonic testing and a future space access aircraft.

## U.S.A.F. + Blue Canyon Technologies—It's All About A CubeSat's Attitude

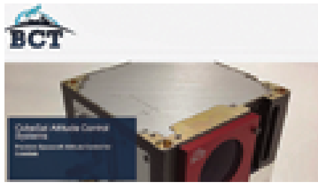
**A new attitude system developed by the U.S. Air Force and a small business offers improved capabilities for small space research satellites.**

The all-in-one unit provides satellite control and orientation capability and is ultimately expected to result in a low-cost platform for missions and rapid launches. The eXact Attitude Control Technology (XACT) is an attitude determination and control system (ADCS), which was developed with funding from the Air Force Small Business Innovation Research (SBIR) program.

With this critical funding, Blue Canyon Technologies (BCT), a small business in Boulder, Colorado, delivered the new system to the Air Force Research Laboratory (AFRL) this year.

The technology has already been integrated into a number of new missions by a wide range of organizations, including Raytheon's SeeMe program, which uses small satellites to give soldiers a birds-eye view of the battlefield, and NASA's INSPIRE student internship program. AFRL is also using the system on upcoming CubeSat missions this fall as part of a university research program mission and on a NASA mission in 2015.

"The key to this product's success has been the timing in creating something that fit the current needs of the market," said George Stafford, BCT's president. "BCT has been fortunate to have the opportunity to work with the




Air Force SBIR program at AFRL. This partnership has provided invaluable support for our company as we have developed this new type of spacecraft attitude control system for CubeSats. Our successful transition from start-up to thriving small business has been in large part due to the opportunity that the SBIR program has provided. We believe that our products our now filling an important need for the Air Force and will hopefully lead to many successful CubeSat missions."

During a SBIR solicitation, the Air Force requested an innovative means for providing an all-in-one, packaged ADCS for miniaturized space research satellites, or CubeSats, to meet research and development experiment-pointing requirements

CubeSat units, 10x10x10 cm cubes, are quickly becoming an ideal platform for hosting a number of new mission applications. Currently CubeSats have limited three-axis stabilization and do not provide adequate maneuverability, or pointing, to meet mission requirements. As a result, programs that could use CubeSats to conduct their mission are forced to acquire rides or purchase larger satellites, which provide better pointing accuracy. Therefore, the Air Force wanted to develop a ADCS capability for the CubeSats that met the goal of a 0.2 degree pointing ability while offering a low-cost platform for new missions and more rapid launch opportunities.

"XACT is relatively inexpensive when compared to the cost for larger satellites," said Capt. Tae Kim, the AFRL engineer who managed the program. "It is easier to find launch opportunities for CubeSats than larger satellites due to their small size and weight; they can piggyback on existing launches."

BCT's objective was to provide a prototype XACT that was half the size of CubeSat unit, which would provide 0.2 degree or better pointing accuracy for a three-unit CubeSat, with a maximum weight of eight kilograms.

The resulting XACT system is a reliable CubeSat ADCS that is compatible with the current miniature satellites for a variety of mission configurations. The XACT's highly integrated architecture leverages a powerful processing core with BCT's micro-Star tracker and micro-Reaction Wheel technologies to enable a new generation of miniaturized spacecraft. XACT features a three-axis stellar attitude determination in a micro-package.

Built-in flexible commands allow for multiple pointing reference frames, including local vertical local horizontal, Earth-fixed, inertial and solar. The system sensors include the star tracker, an inertial measurement unit, a sun sensor, a magnetometer and an optional GPS unit.

Software is also available to support simulation, system integration and customization of ADCS functionality.

This Air Force SBIR project resulted in the development of a line of products by BCT that are in demand in the small satellite spacecraft market. BCT has leveraged this demand into revenue growth of over $750,000 in 2013. The company expects continued growth over the next two years, projecting $2.5 million in 2014 alone, which will allow the company to increase their staff and expand their facilities.

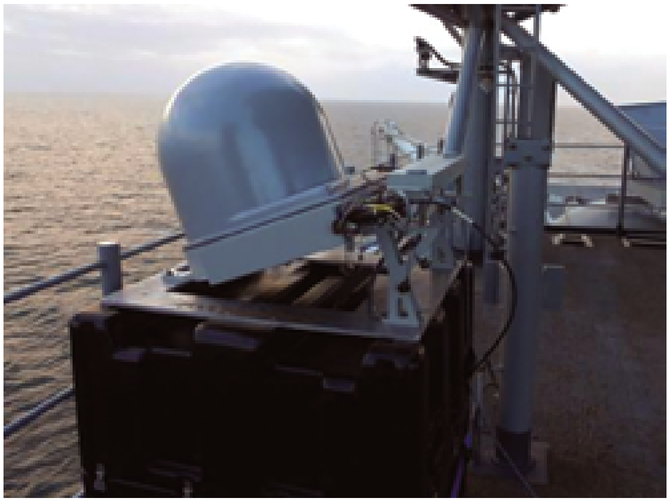
The Air Force's SBIR program was established by Congress in 1982 to fund research and development through small businesses of 500 or fewer employees. It focuses on projects with the potential to develop into a product for defense or commercial markets.

Congress also established the Small Business Technology Transfer (STTR) Program in 1992. It is similar in structure to SBIR and funds cooperative research and development projects with small businesses in partnership with not-for profit research institutions (such as universities) to move research to the marketplace.

For more information about these programs, please visit ***http://www.afsbirsttr.com/***.

The infosite for Blue Canyon Technologies is available at ***http://bluecanyontech.com/***

## Joint Enabling Capabilities Command—In Support Of Chemical Weapon Elimination



*Members of the Joint Communications Support Element, embarked on the MV Cape Ray, are employing a Shipboard Carry-on Satellite System-Joint, or SCOSS-J, (pictured here on a different vessel) to provide critical communication capabilities to other personnel aboard the ship. The SCOSS-J provides on-the-move shipboard connectivity independent of shipboard systems and U.S. Navy networks. Photo provided by JCSE.*

**Two members of the Joint Enabling Capabilities Command's Joint Communications Support Element (JCSE) are currently deployed aboard the MV Cape Ray to participate in the Department of Defense's operation to support the elimination of Syria's chemical weapons.**

Specifically, the JCSE personnel are providing command, control, communications, and computer capabilities throughout the duration of the mission, which is part of an international disarmament effort led by the United Nations and the Organization for the Prohibition of Chemical Weapons.

The MV Cape Ray, a National Defense Reserve Fleet vessel owned by the Department of Transportation's Maritime Administration, was recently equipped with two Field Deployable Hydrolysis Systems (FDHS) which can neutralize bulk amounts of known chemical warfare agents, such as mustard gas, into compounds not usable as weapons.

Upon arriving at the port of Gioia Tauro in southern Italy; the MV Cape Ray will load about 700 metric tons of Syria's chemical warfare agents on board and then head into international waters, where the materials will be neutralized by the FDHS. The process will create about 1.5 million gallons of waste which will be housed in containers aboard the MV Cape Ray until operations are complete, at which point they will be transported to a commercial waste treatment facility for disposal.

While JCSE's communications are prioritized for mission command and control functions first, their capabilities are available to anyone aboard the MV Cape Ray with a mission requirement.

JCSE maintains three active-duty squadrons and one U.S. Army Reserve squadron (1st, 2nd, 3rd and 4th Joint Communications Squadrons (JCS), respectively) and two Air National Guard units (224th and 290th Joint Communications Support Squadrons) which provide rapidly deployable, mission-tailored communications capabilities worldwide.

"JCSE brings full spectrum, high bandwidth communications in a small footprint," explained U.S. Air Force Lt. Col. Chance Geray, the 1JCS Commander, whose squadron is participating in this mission. "For the Cape Ray, our support includes secure and unclassified data, voice, radio and video teleconferencing capabilities enabling globally integrated mission command using joint, coalition and civil communications networks."

Specifically, JCSE is employing a maritime communications package called the Shipboard Carry-on Satellite System-Joint, or SCOSS-J. This is a mobile system designed to provide on-the-move shipboard connectivity independent of shipboard systems and U.S. Navy networks. Specifically, the SCOSS-J is an antenna that augments one of JCSE's most heavily deployed communications packages—the Initial Entry Package—for maritime environments. The SCOSS-J is capable of providing continuous coverage and connectivity with the Department of Defense Wideband Global Satellite System as well as commercial satellite communications systems.

"Ships have limited bandwidth and often provide less than 1MB of shared throughput; or the rate of data delivered successfully," said Geray. "The SCOSS-J is a high bandwidth antenna system designed for high bandwidth maritime communications without interfering with, or being interrupted by, other shipboard electronic or radio frequency systems."

Before deploying for any mission, JCSE personnel complete a total communicator training program which familiarizes members with data, voice, radio and satellite communications on multiple networks. Each member is also trained to operate and maintain all aspects of the employed communications equipment which enables them to operate as a team or individually, if required. However, JCSE worked closely with mission partners as the Cape Ray was outfitted for this mission and conducted final sea trials, to identify any distinct requirements.

"Since each operation is different, we try to prepare for unique mission requirements as much as possible," said Geray. "For the Cape Ray, this included advanced coordination for their coalition network requirements, extra all weather demands, shipboard safety training and most importantly, additional nuclear, biological and chemical training."

The JCSE communicators will be fully employed throughout each phase of this operation as they provide mission-tailored communications expertise to this significant international effort.

*Story by Whitney Katz,*
*Joint Enabling Capabilities Command*

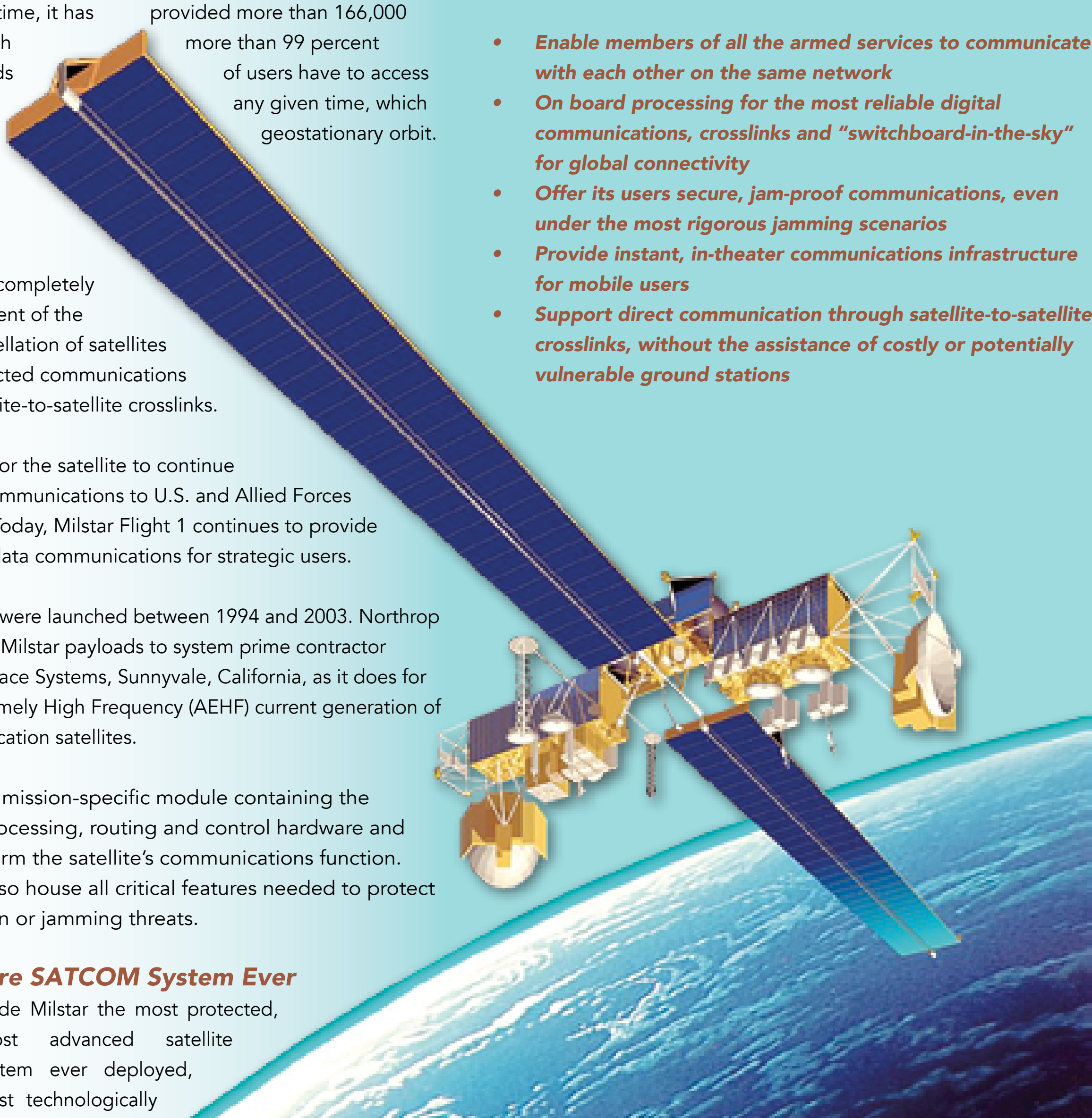
# THE AMAZING MILSTAR CONSTELLATION—20 YEARS OF SERVICE

*By Peggy Paul, Program Manager, Protected Military Satellite Communications, Orbital Operations, Northrop Grumman Aerospace Systems*

**The first Milstar protected communications satellite, launched 20 years ago on February 7, 1994, gave U.S. national and defense leaders a new capability: Assured communications day or night, without detection or interception under any level of military conflict.**

Now the satellite, with a Northrop Grumman-designed and -built low data rate (LDR) payload, has achieved an unprecedented 20 years of successful on-orbit operations, or double its design life. The LDR payload is the operational heart of Milstar Flight 1, featuring autonomous processing, routing and network management capabilities.

In the payload's lifetime, it has provided more than 166,000 hours of service, with more than 99 percent availability. Hundreds of users have to access the system at any given time, which operates in geostationary orbit.



The Milstar Flight 1 payload is still fully mission-capable, a completely integrated component of the MILSATCOM constellation of satellites that provides protected communications worldwide via satellite-to-satellite crosslinks.

The expectation is for the satellite to continue providing secure communications to U.S. and Allied Forces for years to come. Today, Milstar Flight 1 continues to provide assured voice and data communications for strategic users.

Six Milstar satellites were launched between 1994 and 2003. Northrop Grumman provided Milstar payloads to system prime contractor Lockheed Martin Space Systems, Sunnyvale, California, as it does for the Advanced Extremely High Frequency (AEHF) current generation of protected communication satellites.

The payload is the mission-specific module containing the complete set of processing, routing and control hardware and software that perform the satellite's communications function. Milstar payloads also house all critical features needed to protect against interception or jamming threats.

### *The Most Secure SATCOM System Ever*

These payloads made Milstar the most protected, secure and most advanced satellite communication system ever deployed, as well as the most technologically adaptable satellite system for the needs of its users. As the communication functions are configurable in digital and software-based processors, the national command has been able to configure the communication resources according to need. In addition, during these 20 years, new versions of the processor software have been updated to deliver enhanced capabilities without the need to design and build new satellites.

The LDR payload distinguished itself through several groundbreaking achievements. In addition to its autonomous processing, routing and network management capabilities, the payload offered military users several other important "firsts." This was the first satellite payload to:

- ***Enable members of all the armed services to communicate with each other on the same network***
- ***On board processing for the most reliable digital communications, crosslinks and "switchboard-in-the-sky" for global connectivity***
- ***Offer its users secure, jam-proof communications, even under the most rigorous jamming scenarios***
- ***Provide instant, in-theater communications infrastructure for mobile users***
- ***Support direct communication through satellite-to-satellite crosslinks, without the assistance of costly or potentially vulnerable ground stations***

## Evolution To AEHF

Starting with Block 1 satellites, or those with LDR capabilities, Milstar was originally intended to provide strategic capabilities. An evolution in capabilities enhancement began when the Milstar program expanded communications to the tactical realm with the advance to medium data rates (MDR) in Block 2.

Milstar MDR payloads meant that troops on the move could remain in communication at the regimental level—without having to stop and set up a line-of-sight antenna to communicate among various units. Under Milstar Block 1, the military had secure voice communications. With the advent of Block 2, troops could send large data files by satellite for the first time.

The introduction of AEHF payloads moves communications one step farther with extended data rates. To show the dramatic improvements made possible by this evolution in protected MILSATCOM, the U.S. Air Force cites these examples:

- *A 1.1-megabyte air tasking order takes 1.02 hours to transmit over Milstar I; only 5.7 seconds over Milstar II; and 1.07 seconds over AEHF.*
- *For imagery, the Air Force says it takes 22.2 hours, almost a full day, to transmit 24 megabytes from an annotated 8 x 10 photograph over Milstar I. Milstar II reduces this time to 2.07 minutes for the same imagery, and it takes only 23.6 seconds with AEHF.*

Milstar Flight 1 was the dawning of a vision for protected MILSATCOM that was initiated some 30 years ago. Today, five Milstar satellites and three AEHF satellites are delivering an unprecedented level of immunity to jamming, interference and detection that gives our military forces an advantage no other nation possesses.

The eight satellites are cross-linked into a constellation the Air Force aptly describes as a "ring of protection" around the Earth for secure and assured communications for military users operating in a broad set of mission areas. Milstar Flight 1 set the tone for performance and flexibility that will characterize the ring of protection long into the future.


**About the author**

*Peggy Paul is responsible for the on-orbit support of the reconfigurable MILSATCOM communication network of satellite payloads that provides warfighters and the National Command Authority with worldwide protected communications. Ms. Paul is synonymous with Milstar's success. She started her career with TRW as a member of the System Engineering technical staff, where she led development of the Milstar Flight 1 payload verification. She became program manager for Milstar Flights 5 and 6 payloads, where she was responsible for delivery, activation and incorporation of those payloads into the Milstar network. Most recently, she returned to the MILSATCOM programs as Program Manager with responsibility for the launch, activation and integration of the AEHF payloads as well as the on-orbit support of Milstar and AEHF payloads.*


## A Peek At The Payloads

The Northrop Grumman-built Milstar LDR payload receives uplink user signals on nine EHF receive antenna beams. The uplink signals are demodulated and routed to destinations assigned by the onboard computers, which mark the world's first "bandwidth on demand" satellite communications. Data are also received via crosslinks from other Milstar satellites in the constellation. Received user data may be routed either to onboard destinations, to one of five downlink antennas, or to the crosslinks for connections through other Milstar satellites that form a "closed ring" enabling secure, Milstar communications from point to point anywhere on Earth.

The SHF downlink subsystem modulates and transmits the signal through the downlink antennas. A UHF subsystem provides interoperable UHF communications and a fleet broadcast channel. Milstar supports communications to man-transportable terminals.

| | LDR (Milstar I) | LDR and MDR (Milstar II) |
|---|---|---|
| Frequency | EHF (44 GHz) uplink;<br>SHF (20 GHz) downlink | EHF (44 GHz) uplink;<br>SHF (20 GHz) downlink |
| Data Rates | 75-2400 bps | 75-2400 bps (LDR); 4.8 kbps-1.544 Mbps (MDR) |
| System Security | Terminal-to-terminal COMSEC<br>TRANSEC-governed frequency hopping | Terminal-to-terminal COMSEC<br>TRANSEC-governed frequency hopping |
| Interoperability | Common modulation modes and protocols | Common modulation modes and protocols |
| Channel Capacity | 192 (100 at 2400 bps) | 192 (100 at 2400 bps) LDR; 32 MDR |
| Antenna Coverage | 1 uplink, 1 downlink (earth coverage)<br>5 uplink agile antennas<br>1 downlink agile antenna<br>2 up/downlink narrow spots<br>1 up/downlink wide spot | LDR: 1 uplink, 1 downlink (earth coverage)<br>5 uplink agile antennas<br>1 downlink agile antenna<br>2 up/downlink narrow spots<br>1 up/downlink wide spot<br>MDR: 2 uplink nulling spots,<br>2 coincidental downlink spots,<br>6 up/downlink spots<br>(distributed user coverage) |
| UHF Services | 4 AFSATCOM IIR channels (earth coverage)<br>1 Fleet Broadcast channel (earth coverage) | 4 AFSATCOM IIR channels (earth coverage)<br>1 Fleet Broadcast channel (earth coverage) |
| Crosslinks | 2 per satellite (1 each direction)<br>Compatible with LDR requirements | 2 per satellite (1 each direction)<br>Compatible with LDR and MDR requirements |

*Milstar payload performance features*

## Medium Data Rate (MDR) Payload

For the Milstar medium data rate (MDR) payloads that fly aboard Flights 4, 5 and 6, Northrop Grumman Space Technology supplies two types of antennas and the digital processing subsystem. MDR's data rates—as high as 1.55 megabits per second (MBPS)—accommodate voice and data, imagery and targeting intelligence at the 1.55 mbps rate on each of 32 uplink channels. This capability greatly increases the capacity of the Milstar system and supports new missions, such as high-capacity links between Navy shore stations and ships at sea.

*A Milstar payload undergoes integration and tests at Northrop Grumman's facilities in Redondo Beach, California. Photo is courtesy of Northrop Grumman.*

*Milstar I and II*

*The first two Milstar satellites are referred to as Milstar I. They employ a low data rate (LDR) payload that transmits secure data at a maximum of 2400 bits per second.*

*Flights 3 through 6 collectively are called Milstar II. Milstar II satellites carry LDR and medium data rate (MDR) payloads.*

*Northrop Grumman is the LDR payload integrator and also provided the MDR antennas and digital processing subsystem to Boeing Satellite Systems, the MDR payload integrating contractor; Lockheed Martin is the Milstar prime contractor.*

*Connectivity among Milstar satellites is established via space-to-space crosslinks in the 60GHz band. Crosslinking allows user communication networks to extend around the globe, without retransmission through intermediate ground stations.*

The MDR payload's Northrop Grumman-developed nulling antennas are capable, without any instruction from a ground station, of detecting and then countering enemy signal-jamming. This revolutionary capability was developed for Milstar II, with each MDR payload carrying two nulling antennas. The nulling antennas are well suited to Army coverage requirements, where many troops may occupy a relatively small theater of operations near the enemy. The Army, therefore needs coverage with protection against close-in jamming.

Six smaller Northrop Grumman-built MDR antennas produce spot beams and 1.55mbps data rates without the nulling. These are called distributed user coverage antennas (DUCAs) and are best matched to the dispersed, global-type requirements of the Navy, which operates ships and shore stations around the world. Navy vessels and bases tend to be removed from the front and the threat of close-in jamming is much less likely.

## Milstar II's Digital Processing—Key To The MDR Payload

Milstar II satellites (*see the info box, top of the next column*) will benefit from a Northrop Grumman-developed digital processing subsystem that delivers data 640 times faster than Milstar I payloads, while capitalizing on dramatic advances in microelectronics and manufacturing processes to lower payload costs, weight, and part counts. The result is a system well adapted to fast-moving tactical military uses, as well as one that preserves Milstar's core communications requirements for worldwide, antijam, scintillation-resistant services with low probability of interception.

The digital processing subsystem, combined with the RF subsystem built by Boeing Satellite Systems, constitutes the medium data rate (MDR) payload electronics package. Boeing integrates the MDR payload for Milstar prime contractor Lockheed Martin. MDR services will provide U.S. military forces with on-demand availability of interactive voice, video, and data links at rates up to 1.544 megabits per second. That's more than 50 times faster than the 28.8-kilobit-per-second modem used with many personal computers.

The MDR payload is tailored to meet the needs of third world threats and regional conflicts. Flexible onboard processing instantly reconfigures networks to suit evolving command and control requirements.

The use of EHF frequencies and highly directional nulling antennas reduce the probability of jamming and intercept. Lightweight portable terminals on land, sea, and in the air can be easily moved during tactical operations.

Quickly changing battlefield conditions and spontaneous requirements for interservice connectivity demand Milstar's highly sophisticated onboard network configuration capabilities.

Each MDR payload has eight antennas, each independently steerable and operating at extremely high frequencies (EHF). Terminal users may communicate with other users within the same antenna beam or with users located in other MDR antenna beams from any of the Milstar II satellites. The on-orbit digital router establishes and maintains links within and among beams and responds to users' changing and differing bandwidth requirements.

From each uplink beam the MDR payload processes the communication data, sorting and routing them to the proper downlink beams. If a data destination is found to lie outside the areas covered by a satellite's antenna beams, the payload routes the message via crosslink antenna to another satellite for downlinking. In addition to sorting and routing messages, the digital processing subsystem performs other key functions such as demodulation of the EHF signal, authenticating and granting user access, and dynamically configuring payload resources (antennas, receivers, processors, etc.) to establish networks and provide bandwidth on demand.

To perform these complex functions, the MDR digital processing subsystem relies on 14 custom application-specific integrated circuits and 397 large-scale integrated (LSI) circuits, all fabricated in CMOS technology. This figure represents a decrease of 37 percent from the 630 custom LSI circuits required for each LDR payload.

## Fast, Flexible, MDR Flight Software

The software that controls MDR payload resources, like the processors it runs on, delivers higher performance at reduced cost than its flight-proven counterpart in the LDR payload.

The software is responsible for managing all MDR payload resources (uplink, downlink, and crosslink) employed for user communication. The software acts as a "switchboard in space," dynamically changing the routing path of communications data, based upon user requests.

In addition the software performs all the multi-satellite coordination with other Milstar satellites to support worldwide communications without resorting to intermediate ground links.

The ability to improve performance and functionality while lowering development risk and reducing cost stems largely from two key factors. One is the selection of the Milstar Advanced Processor (MAP) as the MDR resource controller. MAP is a high-performance, general-purpose computer, developed for the Milstar program and used in other capacities on Milstar spacecraft. The other risk- and cost-reduction factor is the extensive reuse of LDR processing design and software code, which shortened development time dramatically.

In addition, Milstar requirements and external interfaces were already well defined by the time MDR development began. Although software in the MDR and LDR payloads provides similar functionality, the MDR software incorporates a number of important system improvements. MDR software:

» ***Employs a centralized database architecture. This means that database information about users is not duplicated on multiple satellites. Instead, service operations are coordinated by a single satellite with full service information. Centralizing this function simplifies multi-satellite coordination and lowers the amount of crosslink traffic devoted to system administration "overhead."***
» ***Adds a new "fencing" capability. Fencing ensures that designated user groups in the three military services can procure access to allotted satellite resources. In times of crisis, fencing guarantees these user groups Milstar availability.***
» ***Increases system flexibility. The software is both configurable and uploadable from the ground. This feature provides the ability to add software patches and improvements "on the fly," or to replace the software with an updated version.***
» ***Supports LDR-aided acquisition of the MDR payload. This feature permits LDR users to log onto the MDR payload.***

## Savings In Time, Weight + Power

Payload engineers took advantage of advances in microelectronics technology to pack more processing power into smaller digital units, or "configured items," as the boxes are called. For example, the MDR digital processing subsystem requires only two configured items to perform demodulation and routing functions. The LDR payload management subsystem (PMS) required four configured items to perform the same two functions. Overall, the MDR's digital subsystem weighs about 40 percent less than its equivalent configured units on the LDR PMS. The MDR units consume only half the power of their LDR counterparts.

The MDR design also paid off in savings of time and manpower. The integration and acceptance of the MDR digital processing subsystem took less than three months, about half the time required to complete the same tasks for the LDR PMS. In addition, the size of the crew needed for integration and test was reduced by one-fourth. Add the savings in support personnel and the manpower required for integration and acceptance testing was cut in half.

## MDR Digital Processing Demonstrates Continuous Milstar Improvements

The MDR payload boosts Milstar performance by giving forces in the field the wideband services they need for high-speed communications and dynamic network configuration. The payload also demonstrates the Milstar program's ongoing progress in providing greater performance from electronic payload units that weigh less, consume less power, and require fewer people to build and test. All of which is necessary to meet the U.S. military evolving communications needs in the post-Cold War world.

## *Milstar MDR Nulling Antennas: Ensuring Secure Tactical Military Communications*

The medium data rate (MDR) payload of Milstar II satellites (see box below) — delivering data to field terminals at T1 rates of 1.544 megabits per second, or more than 25 times the speed of a 56 kilobit-per-second computer modem — will make possible secure, real-time transmission of voice, image and data among tactical users. Northrop Grumman-developed adaptive nulling antennas on each MDR payload protect Milstar MDR communications against electronic jamming by enemy forces. Each "nuller" is a fully autonomous antenna system that continuously maximizes user signals while minimizing jammer signals.

### *The MDR Antenna Suite*

The MDR payload's antenna suite is designed to meet the diverse needs of Milstar users. The Army, for example, deploys large numbers of troops in a relatively small theater of operations, where the bulk of communications is in theater. Therefore, the Army needs to cover a small geographic area with one or two payload antennas. The Navy, by contrast, operates ships on every ocean and has shore stations around the world. The Navy needs as many antennas as possible covering the portion of Earth visible from the satellite.

Close-in jamming (where jammer and friendly terminals are both located within a single antenna beam) is a serious threat to the Army, which tends to operate near the front, close to enemy jammers. The Navy often operates from bases and carriers some distance from the front, where the jammers are often out of beam.

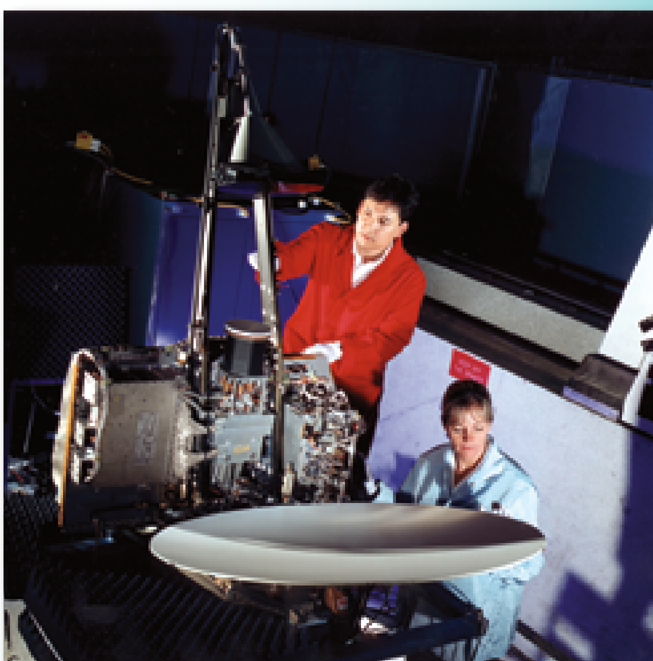
Two nulling antennas onboard each MDR payload are capable of negating the effects of both in-beam and out-of-beam jammers. In addition, the MDR payload carries six smaller antennas that produce spot beams without nulling. These are called Distributed User Coverage Antennas (DUCAs). Generally speaking, the nulling antennas are best matched to theater-type requirements, while DUCAs better match those of dispersed global users such as the Navy.

### *Adaptive Nulling: How The Nulling Antenna Works*

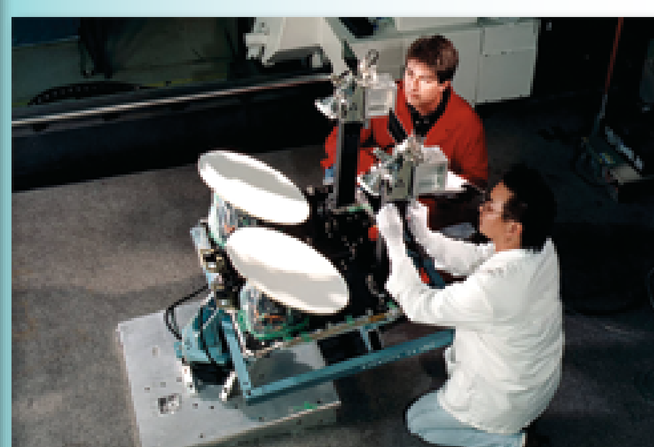
Milstar satellites and ground terminals employ a spread-spectrum approach in which the signal hops in pseudo-random fashion from frequency to frequency within an assigned bandwidth. User terminals communicate with the satellite using a secure frequency hopping pattern shared by the terminal and the satellite.

In the absence of jammers, user signals received by the nulling antenna fall within an expected distribution of frequencies. When a jammer terminal begins operating within the satellite's spot beam coverage area, its radiated power does not follow the satellite's frequency-hopping pattern. As a result, anomalies appear in the nuller's power distribution curve, revealing the presence of jamming signals.

The antenna takes immediate steps to eliminate these unwanted signals. It calculates appropriate signal-weighting factors for the power received at each antenna feed to determine the position of the jammer and produces a null in that direction.



*Technicians adjust a nulling antenna for a Milstar protected communications payload.*
*Photo is courtesy of Northrop Grumman.*



*Northrop Grumman employees conduct tests of Milstar's dual use coverage antennas.*
*Photo is courtesy of Northrop Grumman.*

Nulling: Key To MDR Performance

The MDR nulling antenna consists of four major components:

- *Multibeam reflector and feeds. The MDR nuller produces 13 essentially non-overlapping narrow spot beams. Its design is based on a 40-inch offset-Cassegrain reflector, which illuminates a 13-element feed array. Each antenna is gimbaled and can be independently steered to any position on the visible Earth.*
- *Beamformer. A millimeter-wave beamformer provides sum and sample signals to a radio frequency combiner, which establishes the received radiation pattern. The pattern, of course, includes nulls that block out jammer signals.*
- *Correlator. The correlator constantly monitors each of the 13 EHF feed inputs, determines whether a jammer is present, and then computes baseband error weightings.*
- *Digital processor. Error signals produced by the correlator are passed to the processor. The processor updates the beamformer weights to drive the errors toward zero. As error weightings coming from the correlator are progressively reduced, the beamformer shapes a null in the antenna pattern in the direction of the jammer.*

Northrop Grumman also developed the algorithm for the nulling antenna processor. The Northrop Grumman-patented algorithm determines the weight updates from the correlator error signals. The algorithm's performance, along with the speed of the processor, is essential to the nulling antenna's ability to counter jammers.

## *Nulling: Key To MDR Performance*

The complex signal-processing algorithms required for adaptive nulling have existed for some time. Only in recent years, however, have advances in microelectronics enabled engineers to design a fully autonomous nulling antenna system light enough and compact enough to fly aboard a spacecraft.

Northrop Grumman delivered the first flight nulling antenna to MDR payload integrating contractor, Boeing Satellite Systems, in October of 1996.

The MDR nulling antennas do far more than simply receive RF signals. Each antenna is a complete feedback control system designed to continuously maximize desired signals while processing out jamming signals. With nulling antennas in operation, the Milstar MDR payload can push data rates to 1.544 megabits per second. Or, by switching to lower data rates, it can receive signals from small, low-power ground terminals. Or the antenna can operate at some intermediate combination of data rate and terminal power, all without sacrificing anti-jam performance.

**LDR Payload Technical Specifications**

Data Rates: 75 to 2,400 bits per second (bps)

Operational Frequencies
- EHF Uplink (44.5 GHz, 2 GHz bandwidth)
- SHF Downlink (20.7 GHz, 1 GHz bandwidth)

Interoperability: Common modulation modes and protocols

Channel Capacity: 192 (108 available for general communication)

EHF/SHF Antennas

| Uplink Antennas | Downlink Antennas |
|---|---|
| 5 EHF Agile Beams | 1 SHF Agile Beam |
| 1 EHF Earth Coverage | 1 SHF Earth Coverage |
| 2 Narrow Spots | 2 Narrow Spots |
| 1 Wide Spot | 1 Wide Spot |

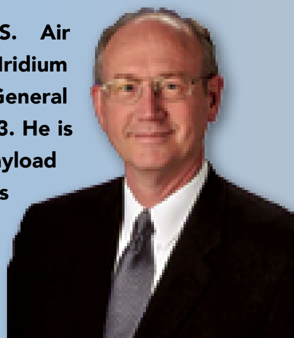
UHF Services
- 4 AFSATCOM IIR channels (earth coverage; 75 bps, transmit and receive)
- 1 Fleet Broadcast channel (earth coverage; 1,200 bps, transmit only)

Crossbanding Capabilities
- Uplink EHF to Downlink SHF (Standard operations for Milstar terminals)
- Uplink UHF to Downlink UHF (AFSATCOM Terminals)
- Uplink EHF to Downlink UHF (Fleet Broadcast Mode)

*Editor's note: The preceding information is courtesy of Northrop Grumman.*

# COMMAND CENTER: DAVID A. ANHALT
# VICE PRESIDENT + GENERAL MANAGER, IRIDIUM PRIME$^{SM}$

**Colonel David Anhalt (U.S. Air Force, retired), joined Iridium as Vice President and General Manager of Iridium PRIME$^{SM}$ in 2013. He is a recognized leader in the hosted payload industry and will spearhead business development for Iridium PRIME, focusing on customer acquisition and technology partnerships.**



Prior to his position at Iridium, he was the initial Vice Chairman of the Hosted Payload Alliance and is the organization's current Secretary. He served as Vice President of U.S. Government Solutions at Space Systems/Loral (SSL), where he directed a portfolio of national security space sector initiatives promoting new technology and product offerings. In addition to his vice presidential duties, Mr. Anhalt served as SSL's capture manager, chief architect, and company spokesman for its pursuit of the United States Air Force Hosted Payload Solutions Contract, which provides fully integrated space and ground communication solutions for government end users, delivering hosted payload data to them in the process.

Before SSL, he spent seven years at Orbital Sciences Corporation, where he conceived, captured and managed the Commercially Hosted Infrared Payload (CHIRP) flight test demonstration. CHIRP launched in 2011 to evaluate modern wide-field-of-view staring sensors for missile warning. The CHIRP program is the largest unsolicited proposal ever awarded by the Air Force Space and Missile Systems Center on a sole source basis.

Mr. Anhalt was especially well positioned to work with the Air Force, having served in the military branch for 28 years and graduated from its Test Pilot School. He has played key roles in a broad array of USAF research and development, test operations and program management responsibilities in both the air and space sectors.

Mr. Anhalt earned a Bachelor's of Science degree in electrical engineering from the U.S. Air Force Academy. He holds Master's degrees in Aerospace and Mechanical Sciences (Princeton University), Digital Design and Control Theory (University of Idaho) and International Relations (Queen's University, Ontario, Canada). He is an Associate Fellow in the American Institution of Aeronautics and Astronautics.

### *MilsatMagazine (MSM)*

*Colonel Anhalt, what inspired you to pursue a career in the satellite industry following your military service and what specifically drew you to Iridium Communications?*

### *Dave Anhalt*

For the past 10 years, following my career in the U.S. Air Force, I've benefited by working at two of the finest satellite manufacturing companies in the world—Orbital Sciences Corporation and Space Systems/Loral—pursuing ways of leveraging commercial space goods and services to meet U.S. government requirements, including hosting government capabilities on commercial spacecraft.

While at Orbital, we collaborated with satellite owner/operator SES and sensor payload manufacturer SAIC to integrate and fly the Commercially Hosted Infrared Payload (CHIRP) on a commercial telecommunications satellite to evaluate modern wide-field-of-view staring sensors for missile warning. CHIRP was the U.S. government's first experiment hosting a military payload on a foreign-owned commercial spacecraft.


*CHIRP is installed on the SES-2 communications satellite, demonstrating military paylaods can be hosted on commercial satellites without interference concerns. Image of the SES-2 satellites is courtesy of Orbital Sciences Corp.*

Later, while I served at SSL, the U.S. Air Force made the bold decision to institutionalize their approach for procuring fully functioning commercial on orbit hosted payload systems, integrated ground systems, and interfaces to deliver payload data to government end users. Applying lessons learned from CHIRP's successful debut and mindful of the U.S. government's urgent need to purchase more affordable and resilient solutions for their space mission, I worked closely with SSL's partners to develop efficient, cost effective concepts for hosting payloads on commercial spacecraft to meet mission objectives for both U.S. civil government and national security customers.

I was attracted to Iridium to spearhead Iridium PRIME, the world's first commercial payload accommodation service. My focus is on building partnerships for the Iridium PRIME enterprise and directing business development.


**MSM**
*Would you please tell us more about Iridium PRIME?*

**Dave Anhalt**
Iridium has a successful history with hosted payloads. The company was a founding member of the Hosted Payload Alliance in 2011 and successfully sold all of the capacity for hosting payloads on Iridium NEXT to Aireon and Harris. Building on that momentum and experience, and recognizing the growing market potential in hosted payloads, Iridium created Iridium PRIME.

Iridium PRIME is a first-of-its-kind turnkey space payload solution that allows customers to leverage the capability and cost advantages of the Iridium NEXT constellation. Iridium PRIME will be built on the foundation of Iridium's unique constellation of 66 cross-linked LEO satellite system that covers 100 percent of the globe. An additional 66 Iridium PRIME satellites can orbit in concert with the 66 operational Iridium NEXT satellites. Each polar orbiting LEO Iridium PRIME satellite will fly over every part of the planet.

**MSM**
*What kind of opportunities does Iridium PRIME provide to MAG (Military, Aerospace and Government)?*

**Dave Anhalt**
In the past, government payload customers have been slower to adopt new technologies and approaches, especially during budget downturns. However, they've been evaluating hosted payloads for several years now and speak positively about leveraging the highly competitive commercial satellite bus market and hosting payloads on commercial platforms.

Iridium PRIME gives MAG the opportunity to launch missions when ready—they no longer have to wait for an operator to launch a new satellite to host their mission or rush into making a decision on a payload before they're ready. MAG can now plan and launch payloads on their own timelines. Additionally, the customer doesn't have to deploy any ground system to get their data in near real-time, nor do they need a satellite operations center to maintain the satellite on orbit—all that is done by the Iridium infrastructure and operations team.

Iridium PRIME also affords customers the opportunity to launch their missions in a more cost effective way—instead of designing, building and launching a satellite on their own, their payload can hitch a ride on one of our Iridium PRIME satellites for a much more affordable price. Our initial analysis shows that payload customers can save approximately 50 percent getting their payloads to space on Iridium PRIME.

**MSM**
*What are the technical capabilities of the Iridium PRIME bus and what kind of applications are you envisioning for this kind of hosted payload?*

**Dave Anhalt**
The Iridium PRIME bus can accommodate up to 215kg of payload and will offer 650 watts of power to hosted payloads. The bus is designed for continuous access to at least 1mbps of data rate with up to 17mbps available on a surge basis.

To date, we've seen strong interest from more than three dozen parties within various industries including commercial, civil and defense segments in exploring Iridium PRIME for hosting payloads. We envision payloads ranging from space situational awareness and Earth observation to advanced broadband services, asset tracking, space weather forecasting and scientific and climate monitoring applications.

**MSM**

*What about smallsats and CubeSats? Those are certainly gaining in popularity—how does Iridium PRIME compare to those options?*

**Dave Anhalt**

Satellites are challenging and wildly complex systems to build and manage. If a company or agency is looking to launch its own small satellites or CubeSats, it will still need to cross many technical and regulatory barriers. Small satellites and CubeSats typically have rather short lifespans. They often don't have maneuvering capabilities. After its mission is complete, it remains in the LEO plane and runs the risk of colliding with other communications systems and creating even more debris. In many cases, it is much more sustainable to use hosted payloads instead of building and launching smallsats every few years. The Iridium PRIME platform is designed for a 12.5 year lifetime, though performance may extend beyond that, as we have seen with the Iridium Block 1 satellites

Furthermore, there is a significant investment required to build and launch these satellites—hosted payloads are often the most cost efficient option for getting a mission to space, and with Iridium PRIME, we manage all of the operations so that the customer can focus on the payload and meeting mission objectives.

**MSM**

*What kind of impact do you think Iridium PRIME will have on the satellite industry, overall?*

**Dave Anhalt**

Iridium PRIME is truly unprecedented, and I think it will have a great impact on the MAG and satellite industries. We've created a completely new business model within the satellite industry. With the advent of Iridium PRIME, hosted payloads are no longer secondary payloads—instead, we're able to work directly with the hosted payload clients to launch and support a satellite (or constellation of satellites) that's correct for them. Coupled with the ability to set their own timelines and "launch when ready," Iridium PRIME is making access to space easier and more affordable for the commercial, civil and defense industries.

**MSM**

*Having served as a command officer in the U.S.A.F. (and our thanks), how has such experience assisted you in dealing with the government acquisition and contract entities that govern project procurements? What can be done to smooth this process out to prevent waste of resources, from the financial to the equipment, such as satellites?*

**Dave Anhalt**

I am grateful for the chance to apply my experience and education learned in the military as an R&D officer, flight test engineer, and program manager. I have great respect for the intended rigor of the military's acquisition processes and the constitutional requirement to spend dollars consistent with Congressional appropriations.

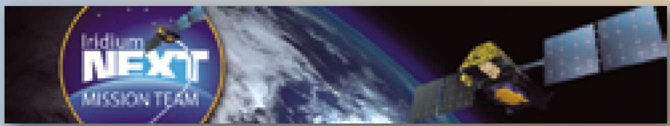
Having said that, I am awestruck by the speed at which capital is deployed in the commercial sector according to the discipline of ROI mathematics. I believe that the military advantage of the United States can be accelerated by artfully leveraging commercial services to procure capabilities that heretofore would have been acquired as materiel solutions using the painfully slow Defense Acquisition Management System.

**MSM**

*Other areas of importance for the continued health of our industry include the support of STEM programs to ensure a rich talent pool from which to hire the professionals of the future who will be needed to drive crucially needed projects. Does Iridium support any such programs in middle and high schools as well as on college campuses?*

**Dave Anhalt**

Iridium recognizes the importance in encouraging students in STEM programs and created the Iridium NEXT Mission Team Scholarship program along with our Iridium NEXT Mission Team partners three years ago. This program is one of the largest and most significant scholarships in the aerospace industry. The endowment is part of Iridium's vision for the future by seeking out and rewarding the most promising aerospace engineers.




This year, the fund awarded $50,000 in scholarships to students who have demonstrated high standards of academic excellence in STEM with a focus on aerospace studies to complete their college education. Iridium also runs a summer internship program and currently has three college students working in our engineering and operations departments.

**MSM**

*What role can Iridium play in assisting MAG players, such as Air Force Space Command, to understand the importance of working with commercial entities to develop additional resources from satellite manufacturing, launches, and on orbit C2?*

**Dave Anhalt**

I would say to my comrades at Air Force Space Command that companies in the commercial space sector thrive on innovation to grow their business. For the most part, the financing for these innovations comes from sources other than the US Government. Therefore, it should be a cost avoidance imperative for the US Government to deliberately leverage commercial capabilities that meet the government's requirements or can be modified to meet government requirements for less than buying dedicated military solutions.

In order to achieve this new balance in an architecturally sound way, I would encourage my comrades at Air Force Space Command to disaggregate their requirements so the aspects of their mission that can take advantage of the economic order quantity of commercial production lines and commercial services can be handled separately from non commercial aspects of the mission involving unique military payloads technologies.

Hosted payloads are a good example of this sort of business approach. The commercial sector already builds, operates and launches more satellites in LEO and GEO than the U.S. military. If the U.S. Government furnishes the unique military payload they can leverage the highly competitive satellite bus market and significant commercial investments already being made in space and network infrastructure. The commercial sector can provide the integrated space and ground system network services for payload command and data handling. The commercial sector can manage the interfaces that deliver payload data to the end user. Cleaving the facets of any mission into a commercial service component and mission payload component can result in savings that the Government can invest developing and maintaining the intellectual capital needed for unique government capabilities.

### MSM

*Iridium is a major player in the ever expanding world of MILSATCOM—what makes Iridium a "differentiator" from others in the industry?*

### Dave Anhalt

Speaking from a network standpoint, Iridium has many differentiators. Our network, comprised of 66 interlinked LEO satellites, is the only satellite constellation that provides truly global coverage, even in polar regions. The government has employees and soldiers located in remote regions throughout the world that rely on Iridium to provide the connectivity needed to support them everywhere. The government has recognized Iridium's strengths from the beginning and last year renewed its $400 million satellite air time contract with us, as well as the contract for support and maintenance of their dedicated secure gateway.

However, the element that really makes Iridium different is our brand of innovation. At Iridium, we strive to bring connectivity to people in unique ways and have announced a number of innovations over the past year that highlight that. This year we introduced Iridium GO!, the small portable "satellite hotspot" that creates a satellite backed Wi-Fi zone anywhere on the planet, dramatically extending voice and data coverage for smartphones and tablets when out of cellular range.
Furthermore, we've brought Iridium Burst to market, the first one-to-many global data broadcast service that enables government/military entities (as well as enterprises) to send data to an unlimited number of devices anywhere on Earth, whether inside buildings, in vehicle or in aircraft. This is especially beneficial to military organizations that need to communicate in a timely, reliable and survivable manner to manage troops and resources or to send out alert messages to ground troops in combat zones or people threatened by natural disasters.

Iridium PRIME also puts us clearly ahead of the pack. No other satellite provider has a turnkey, launch-when-ready hosted payload solution. As I outlined above, this solution will have great impact on MAG's ability to fly missions in space whenever they're ready.

### MSM

*Our world is becoming a far more dangerous place and, in spite of the exigent circumstances that confront our militaries, budgets are being slashed by politicians who have never served under the phrasing of "sequestration." How can Iridium assist in ensuring MILSATCOM technologies and warfighter needs remain at the forefront of project consideration, working to reduce government costs all the while ensuring a profitability factor for the company?*

### Dave Anhalt

Given our long history serving the U.S. Government's needs for mobile communications anywhere on the globe, warfighter needs for MILSATCOM remain at the forefront of our project consideration.

For instance, we're participating in the U.S. Army's Network Integration Evaluation (NIE), which is held twice a year to get soldier feedback on improvements to network systems and radios. We're presenting a Position Location Information (PLI)-based blue force tracking device that relies on Iridium connectivity. The device known as the Enhanced Mobile Satellite System (EMSS) Beacon manufactured by NAL Research serves as a critical communications lifeline to every soldier on the battlefield. Our longstanding relationship with the U.S. Department of Defense makes the integration of this device extremely cost effective since it takes advantage of the unlimited airtime available to DoD users under our current contract's service terms.

Overall, we're always looking for new and innovative ways to apply our global system and technologies for new and economical applications that benefit the warfighter—be it through enabling greater access, via different channels, developing new hardware like Iridium GO! or services like Iridium Burst.

### MSM

*With a nod to your military and commercial career, you have managed to be involved with numerous priority projects. Looking back on your career so far, what missions or programs bring a true sense of satisfaction to you?*

### Dave Anhalt

The missions and programs that bring into service brand new capabilities and business approaches are by far the most challenging and rewarding. The Commercially Hosted Infrared Payload (CHIRP) program validated the value proposition of hosting military sensor instruments on commercial telecommunication satellites. Launched in 2012 on an SES communication satellite manufactured at Orbital Sciences Corporation, CHIRP tested the performance of a wide field-of-view infrared sensor built by SAIC for missile launch warning.

Such programs don't happen by walking through the front door; CHIRP came about as the largest unsolicited proposal ever awarded on a firm-fixed-price basis by the Space and Missile Systems Center (SMC). CHIRP achieved all of its assigned objectives for less than 15 percent of the cost of a dedicated mission.

CHIRP's success has led to SMC procuring multiple IDIQ contracts for Hosted Payload Services. Soon SMC and the rest of the US Government can routinely use this new contract and business approach to achieve affordable and resilient solutions made possible by purposefully leveraging the strength of America's commercial space sector.

For further information regarding Iridium PRIME, please visit:
**http://www.iridium.com/About/IndustryLeadership/Iridium-PRIME.aspx**

# AT A FEVER PITCH: SPECTRAL EFFICIENCY ENHANCEMENTS

*By Karl Fuchs, Senior Contributor*

**It is a fact of life for those in the satellite industry that satellite transponder space is a precious commodity. Even the introduction of the new high throughput satellite (HTS) constellations will not change this reality.**

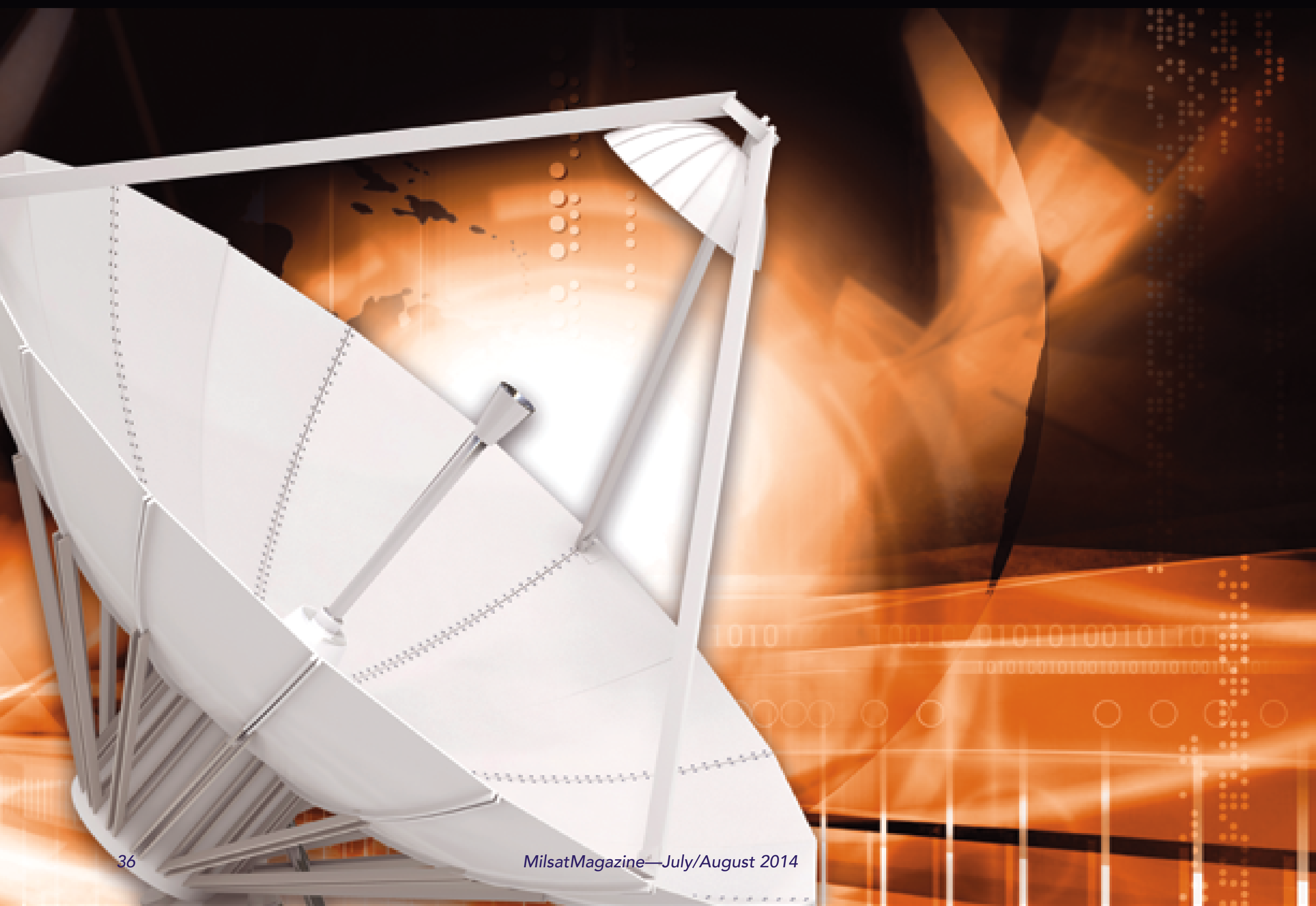
As such, the spectral efficiency of satellite transmission equipment is of paramount concern. At its basic form, spectral efficiency refers to the rate of information that can be conveyed over a given bandwidth—this can also be called bandwidth efficiency.

The quest for greater spectral efficiency has driven virtually all development since the beginning of satellite communications. This is particularly true for digital communications.

Spectral efficiency enhancements began in the 1960s with the development of forward error correction (FEC) codes and the advent of high order modulation techniques. The intervening decades have brought newer, more powerful FECs, which have brought us remarkably close to the Shannon limit, which is the maximum rate at which data can be sent without error.

Demodulators have become more capable, offering higher order modulations at lower Eb/N0s. However these approaches have their limits and antenna size, available power and other link budget constraints limit usable MODCODs.

A great increase in spectral efficiency came with the introduction of Time Divisional Multiple Access (TDMA) systems. TDMA allows multiple users to transmit on the same frequency at different times, allowing network designers to take advantage of the statistical nature of bursty traffic. For the first time with TDMA, the precious satellite resource could be shared across multiple users. No longer would



single channel per carrier (SCPC) circuits, dedicated to one user, need to be provisioned.

The move to TDMA allows a network designer to build a network typically using 40 percent less bandwidth than a traditional SCPC network. While the statistical nature of traffic engineering leads to bandwidth savings, the necessary overhead of a TDMA system was a bit of a price to pay but more than worthwhile.

The true challenge in developing a TDMA system is the ability to provide the network characteristics, primarily low jitter to allow for high-quality voice and video calls as well as to provide mechanisms to ensure sufficient network resources for high-priority applications while still maintaining spectral efficiency. Early TDMA systems suffered when trying to support real-time applications such as Voice over Internet Protocol (VoIP) and IP video. The systems simply were not agile enough to keep the jitter low across the network.

Greater processing power has allowed for systems which can reallocate bandwidth on the order of milliseconds. Application aware systems are able to preempt low-priority data in favor of high-priority or flash override traffic.

The next important advancement in spectral efficiency came with the introduction of adaptive coding and modulation (ACM). The most common ACM implementation is found in the DVB-S2 standard, which was ratified in 2005 and quickly adopted by industry for two-way communications on the outbound channel. ACM allows a satellite engineer to develop a link budget based not on worst case rain fade but, rather, allows the use of higher order modulations during clear sky conditions.

Today's advancements in spectral efficiency are focused on the inbound channels. The same basic ACM concept is employed, but due to the complexities of TDMA, the implementation is much more intricate. Just as in DVB-S2, a receiver must communicate then receive Eb/No back to the transmitter so the appropriate transmit modulation and coding can be determined. However, as mentioned above, the key to a TDMA system is the ability to deliver the network characteristics needed to support VoIP and video and be application aware to support multilevel precedence and preemption (MLPP) traffic.

The integration of Adaptive TDMA (A-TDMA) return channels, feature-rich quality of service and de-queuing mechanisms presented a great challenge during development. An A-TDMA network must be able to maintain fairness as a network adjusts to atmospheric conditions ranging from clear sky through widespread rain fade to hub side rain fade.

Future spectral efficiencies will be realized with the adoption of the new HTS satellites. The power and antenna gain-to-noise-temperature (G/T) available on these new satellites will enable higher order modulations than could be obtained on a terminal of a given aperture. The homogenous equivalent isotropically radiated power (EIRP) distribution of the spot beams helps mitigate the need to build in margin for the edge of beam remotes.

Some of the new HTS satellites will be using Ka-band, which has challenges with rain fade. The rain fade problem makes the ACM on the outbound and inbound more important than ever. The occurrence of hub side rain fade can be so pronounced in Ka-band that geographically redundant hubs are often required.

Further off in the future is the prospect of using Low Earth Orbit (LEO) satellites for two-way communications. Currently, there are LEO constellations for voice traffic. However, a number of providers, some of whom are not currently in the satellite industry, have expressed interest in developing their own LEO data services. The power and data rates available on these LEO constellations are yet to be seen, but they certainly have an advantage, given their much lower orbits.

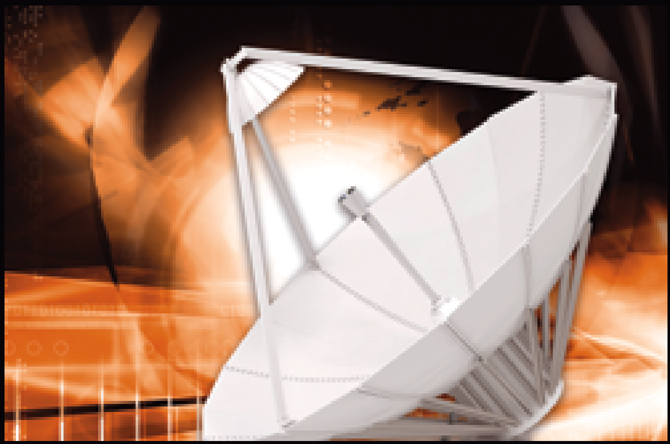
Spectral efficiency enhancements continue at a fever pitch. Designers are working to improve the roll-off of waveforms to decrease the required guard band; improve signal cancellation techniques, which allows one carrier to reside under another, have gained popularity; mathematicians are working on better FEC. Developments in spectral efficiencies will continue for as long as satellite bandwidth is expensive.

***About the author***

*Karl Fuchs is vice president of technology for iDirect Government Technologies (iGT). He joined iGT in 2004 as the director of sales engineering, just as the satellite-based IP communications company was expanding its very small aperture satellite (VSAT) market presence into the federal government and international Internet Protocol (IP) networking world. He now works as the vice president of technology.*

*With more than 20 years of experience in technology and the federal government, Fuchs leads iGT's team of federal systems engineers and serves as chief architect for new product integration.*

*Prior to joining iGT, Fuchs was director of systems engineering at Nortel Networks, where he oversaw the Verizon account team of systems engineers, leading the design of IP, frame relay, asynchronous transfer mode (ATM) and dense wavelength division multiplexing (DWDM) networks. Before joining Nortel, he designed IP and ATM networks for Sprint and the federal government. Fuchs holds a Bachelor of Science degree in electrical engineering from George Mason University, Fairfax, Virginia, and an MBA from Averett University, Danville, Virginia.*



# THE HPA CORNER: DESIGNING A DEFENSIVE ARCHITECTURE

*By Wendy Lewis, Director of Communications, Space Systems/Loral (SSL)*

**At the May 22nd Hosted Payload Alliance board meeting, which was held in conjunction with the Space Symposium in Colorado Springs, Colorado, Mr. Doug Loverro, Deputy Assistant Secretary of Defense for Space Policy, discussed the next-generation architecture for the Department of Defense. He told the group that over the next few months, government agencies are developing the strategy for this new architecture, which must integrate Air, Land, Sea and Cyber resources in a way that cannot be contested.**

He explained that in the past, when American technology dominated the world, and budgets were unlimited, we were able to take an approach to our space environment which did not have to consider other conventional threats. In today's world, where the threats from adversaries are increasing and space is more highly contested than ever, Mr. Loverro suggested that a more defense-minded approach was logically needed. He referred to this as an historical moment when we need to move from an offense-dominated regime to a defense-dominant regime.

In an offense-dominant regime, where large, highly sophisticated assets that might take billions of dollars and a decade to develop and build dominate the architecture, an adversary on the offensive has an advantage—he can cripple such an architecture with far less effort than it took to build it. A defense-dominant regime flips that on its head. It is designed so that no single target would have the potential to cripple national security, and that the actions an adversary would need to take become far more taxing than the capability he seeks to deny.

While hosted payloads are not the complete solution for a defense-dominated architecture, it is clear that they could play an important role.

**This month's question for HPA members**:
***From your perspective, as members of the Hosted Payload Alliance, how can hosted payloads on commercial satellites be woven into the fabric of a new architecture? Mr. Loverro encouraged industry to contribute to the dialog to help determine "what is the right architecture." What ideas would you throw into the ring?***

"Hosted payloads can be an integral part of the new architecture, complementing missions that support communications, situational awareness, air traffic control, and Earth sensing. Inmarsat and Intelsat have demonstrated that existing payloads are transparent to the ground systems of WGS, UHF, and others. Commercial satellites in geosynchronous orbit can be used for neighborhood watch, as well as missile warning as part of CHIRPs.

"Protected waveform technology is being demonstrated today that will enable tactical protected communications at a fraction of the cost of EHF tactical capabilities. Hosted payloads can be quickly reconstituted, and they are disaggregated, other key enablers to compatibility with the new architecture. Hosted payloads can also be managed independently from the satellite operator and can provide the appropriate security. Finally, from and economics perspective, shared launches and shared satellites enable substantially lower prices, and can also be sold as a service to maintain steady consistent budgets during acquisition spikes."—***Jim Simpson, President, Boeing Satellite Systems International, Inc.***

"As is often said, space is a congested, competitive, and contested operating environment. A resilient mission architecture requires diversification of capabilities among multiple platforms to help mitigate risks presented by natural hazardous conditions, the growing number of satellites, orbital debris, unintentional and intentional interference, and the continuing development of counter-space weapon systems.

"Hosted payloads on commercial satellites can, and should be, a crucial element of each architecture because they offer proven economics based on shared spacecraft and launch costs, shorter cycle times with low schedule risks, and allow for regular and timely insertion of technology. A resilient architecture based on dispersed capabilities can be used to distribute vital resources and help preserve critical capabilities in the face of adversity."—***Rich Pang, Senior Director, Hosted Payloads, SES Government Solutions***

"The 'correct architecture' for hosted payloads is one that enables the convergence of commercial and military communication channels. The DoD should incorporate comsatcom as a foundational element of the military's communication system, rather than treating commercial bandwidth as a temporary urgent purchase. Instead, make comsatcom a program acquisition and treat it as an avenue for enhancing the long term resilience and sustainability of U.S. military advantage.

"The DoD should also purchase comsatcom on a multi-year basis to achieve cost effective prices and motivate innovation on the part of commercial suppliers who can then rely upon long term business relationships with the U.S. Government.

"Additionally, in concert with the commercial sector, deliberately develop information assurance appliances that can be integrated onboard commercial satellites to securely pass hosted payload command and mission data through commercial channels to national security users."—***Dave Anhalt, Vice President and General Manager, Iridium PRIME***

"Hosted payloads could be part of an evolved architecture that is highly robust, more resilient and flexible enough to eliminate vulnerabilities to low-cost or easy-to-develop threats.

"Budgetary constraints won't allow the fielding of numerous SATCOM systems to deal with the full range of threats. So the solution is a system with certain capabilities: Satellite crosslinks (i.e., no in-theater gateways, no fiber dependencies, unknown disbursed CONUS ground satellite operations and gateway capabilities), space processing (i.e., anti-jam features) and distribution of nodes.

"This particular architecture would result in an overall less expensive capability as fewer systems (space, ground and terminals) will need to be deployed and maintained over their life cycle."—***Tim Frei, Vice President, Communication Systems, Northrop Grumman Aerospace Systems***

"The HoPS ID/IQ will be an excellent mechanism to query industry on the "art of the possible" when it comes to commercial hosting opportunities. The contract will facilitate government visibility into firm commercial launch plans as well as those 'on the drawing board.'

"Mission architects can then expand AOA's (Analysis of Alternatives) to evaluate options for each individual sensor, potentially resulting in more timely, cost effective access to space. Taking the opposite angle, government communication of missions deemed appropriate for commercial hosting will undoubtedly result in a plethora of ideas from the commercial space community."—***Janet Nickloy, Chair of the Hosted Payload Alliance***

"The new architecture demands resiliency, disaggregation, reliability, and robustness and the use of commercially hosted government payloads must be included into the architectural framework. In doing so, not only will the above demands be met, but the fiscal challenges of protecting the nation can continue to be achieved.

"Hosted payloads are not a new construct for the U.S. Government and its allies. There have been numerous hosted payloads on government systems, civil missions and commercial platform over the years. Leveraging the commercial marketplace as a means to achieve assured access to space in a rapid cadence will create the network that the architecture demands."—***Gerry Jansson, Business Development Director, Intelsat General***

***About the Hosted Payload Alliance (HPA)***

*Established in 2011, The Hosted Payload Alliance (HPA) is a satellite industry alliance whose purpose is to increase awareness of the benefits of hosted government payloads on commercial satellites. The HPA seeks to bring together government and industry in an open dialogue to identify and promote the benefits of hosted payloads. The HPA:*

- *Serves as a bridge between government and private industry to foster open communication between potential users and providers of hosted payload capabilities*
- *Builds awareness of the benefits to be realized from hosted payloads on commercial satellites*
- *Provides a forum for discussions, ranging from policy to specific missions, related to acquisition and operation of hosted payloads*
- *Acts as a source of subject-matter expertise to educate stakeholders in industry and government.*

# THE U.S. GOVERNMENT'S BUDGET CUTS ARE INFLICTING DISTRESS ON NATIONAL SECURITY + THE SPACE BASE

*By Elliot Holokauahi Pulham, Chief Executive Officer, Space Foundation*

**One of the more disturbing bits of data in Space Foundatin's** *The Space Report 2014* **concerns the continued slashing of federal space budgets by the United States. For the first time since the Space Foundation began tracking this data, global government spending on space declined in 2013—and with most other countries either maintaining or increasing their space spending, the global decline can be laid entirely at the feet of the U.S. government.**

This has huge negative implications for the vanishing U.S. space industrial base, U.S. national security and U.S. economic vitality and competitiveness. Of all the places where the feds could be trimming a little fat, it would be hard to pick one that is more harmful to the country overall. If you accept the idea that the best way to work ourselves out of this decade-long economic funk is to grow the economy, then space (and aero) is the one place we should be investing heavily to get the U.S. economy moving again.

The data, for the record: Overall, the global space economy grew by 4 percent in 2013, reaching a record $314.17 billion. Most of this growth was in the commercial sector, where the commercial space products sector grew from $114.55 billion in 2012 to $122.58 billion in 2013, and where the commercial infrastructure sector grew from $112.30 billion in 2012 to $117.49 billion in 2013.


The 4 percent growth rate was slower than in recent years, where the growth rate has ranged between 6 and 7 percent. This drag reflects a global 1.7 percent decline in government space spending, driven entirely by a 9.4 percent cut in U.S. government space spending. While the U.S. was cutting its investment in space by nearly 10 percent, outside of the United States government space spending increased by 10.1 percent.

For a country that prides itself in being a leader in all things space, this should be setting off loud alarm bells. If this is not the tipping point that sends the U.S. space industrial base into a death spiral, you can certainly see it from here. In a country that has all but gone hysterical over its dependence on Russia for rocket engines and astronaut transport to and from the ISS, a ten percent decline in investment while competitors are making a ten percent increase in investment should simply be unacceptable.

The United States is budget-cutting itself out of options. If the nation is going to do that, it should do so in full understanding of the impacts.

Unfortunately, the country's recent track record in this regard has been less than stellar. If you consider the current flap over the RD-180 engine, you can easily understand the political thinking that drove a decision to invest in Russian rocket scientists rather than U.S. rocket scientists.

*But the potential consequences were clearly not all equally balanced.*

One of the potential consequences was a loss of U.S. industrial capacity to produce rocket engines, which should have been deemed an unacceptable risk, and mitigated with research and development funding which would have kept U.S. rocket scientists actively engaged in developing the tools, technologies and manufacturing capability needed to "turn on" the production of American-made engines, virtually on demand.

Another risk was clearly the "major disagreement with Russia" scenario that has, indeed, come to pass. Again, a trickle of funding to keep American capabilities "warm" would have been wise. The nation's current scramble for options need not have looked like this, if elected officials had simply exercised a little prudence in protecting a critical national technical capability.

Similarly the gap between the space shuttle retirement and new capabilities—be they governmental or commercial—need not have become such a black hole for the U.S. to fall in. But while headline-weary politicians were anxious, after the loss of Columbia, to bring the shuttle program to a close, they were not equally anxious about national means for launching humans to space.

NASA should have been given more money, much sooner, in order to have the next generation astronaut transportation system ready to go when the shuttle retired. Instead, America opted for flat budgets and cheap solutions and is now faced with the bellicose suggestion that we use trampolines to send astronauts to the ISS.

All of this is not to take advantage of 20/20 hindsight to say "I told you so." Rather, it is to suggest that the consequences of America's past lack of vision serve as an object lesson in the critical need for foresight at this juncture. Cutting the already woefully underfunded national space enterprise by ten percent is the wrong answer.

Cutting the U.S. government space budget from $45.56 billion (2012) to $41.26 billion does almost nothing to help balance a U.S. federal budget of $3.9 trillion. It simply assures that NASA, the U.S. Air Force, NOAA and others are less capable, and the U.S. industrial base is more fragile, than Americans should be willing to accept.

This counsel is not new or particularly original. The Commission on the Future of the United States Aerospace Industry (2002), two "Augustine Commissions" (The Advisory Committee on the Future of the United States Space Program, 1990 and Review of United States Human Space Flight Plans Committee, 2009), the Aldridge Commission (President's Commission on Implementation of United States Space Exploration Policy, 2004), among many others, have sounded the alarm on declining budgets and U.S. space capabilities.

Two additional Augustine reports, *Rising Above the Gathering Storm* (2005) and *Rising Above the Gathering Storm-Revisited* (2010) were brutally honest in their assessment of the decline in federally funded research and development, and its impact upon our workforce, industrial base and international economic and technologic competitiveness.

The *View From Here* is that current and planned cuts to U.S. government space budgets do almost nothing to save taxpayer dollars, while further injuring the space industrial base (jobs and manufacturing capabilities lost), national security and technical and economic competitiveness. Strong political leadership is needed to reverse these troubling trends.

***Editors note***

*This article is courtesy of Space Foundation's Space Watch newsletter and Elliot Pullham's column, The View From Here. For further information regarding both, please visit http://www.spacefoundation.org/*

***About the author***

*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 chairman of the Hawaii Aerospace Advisory Committee, a former Air Force Civic Leader and advisor to the Chief of Staff and Secretary of the Air Force and a recipient of the U.S. Air Force Distinguished Public Service Medal. He serves on the editorial board of New Space Journal.*

# IN-DEPTH: THE INTELSAT GENERAL PROCESS FOR THE USE OF COMMERCIAL ASSETS TO HOST FUTURE COMMUNICATIONS SYSTEMS

*By Gerry Jansson, Director, Space Segment Development , Intelsat General Corporation*

**The Global War on Terror, program overruns, and increasing demand for new capabilities has placed an ever increasing strain on National Space Assets, from communications satellites to Earth and space observing systems. This strain has also created an opportunity. With the goal of increasing the number and capability of space based payloads at reduced costs compared to dedicated systems the concept of "Hosted Payloads" [1] has recently been attracting the attention of both Government and Industry as an example of how the government can do things differently and focus on capabilities, not systems.**

The Hosted Payload concept infers that a commercial satellite is used as a platform on which a secondary payload gains access to space by sharing the costs of the bus, the launch, and the insurance. This paper describes the Hosted Payload vision and strategy, and the specific requirements for access to space. It describes the commercial best practices and technical systems trade offs in size, weight and power (SWaP) for deploying a hosted payload onboard an Intelsat satellite.

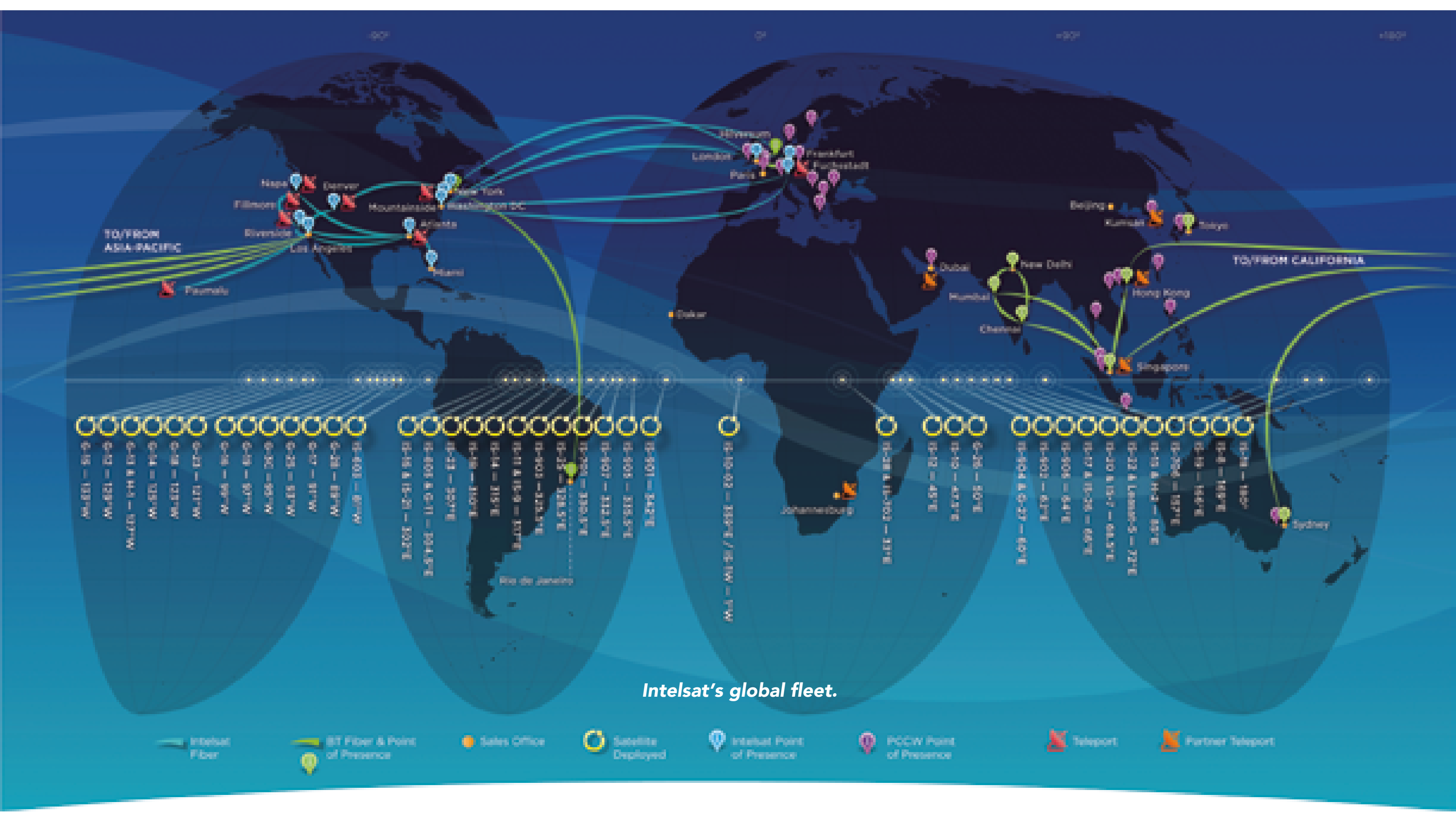
## Hosted Payloads—Their Historic Background + Capabilities

Intelsat has provided services to the US Government for more than four decades. Currently, Government's approach to working with satellite operators does not take full advantage of the operators' knowledge, expertise, capabilities & assets.

Novel and new approaches are available which could strengthen the government/industry relationships. These new approaches could provide flexible and cost effective customized capabilities for government customers. A Hosted Payload program could help define and accelerate the government's objectives.

Hosted Payloads on Intelsat spacecraft have proven to be successful in the past. These include UHF, L- and C-band payloads on: Intelsat-22 (hosting the JP2008 PHASE 5 ADF Indian Ocean UHF Capacity), MARISAT, the predecessor to Navy FLTSATCOM program and INMARSAT, and the US Federal Aviation Administration L-band (GCCS) Payload which was launched on Intelsat's Galaxy 15 spacecraft in 2005.

Intelsat's global satellite fleet is shown in *Figure 1* below, which creates interest in expanding our hosted offering into the world of remote sensing, Earth & space observation and scientific applications,




*Intelsat's global fleet.*

MILSATCOM, which includes tactical protected communications. Intelsat defines Hosted Payloads simply as "*mission specific customer payloads on commercial spacecraft.*" Advantages of these payloads are that they are timely, economical and responsive. Their designs can be matched to a specific governmental need while supplementing purpose built government assets.

The sharing of a spacecraft platform and the "ride" into geostationary orbit potentially distributes both the risks and the capabilities of dedicated systems. Hosted Payloads position the satellite operator community to be a more effective provider of space capabilities to the government. This is achieved by augmenting government space acquisition with rapid, cost effective space access.

## Legacy Of US Government Dedicated Payloads "Hosted" On Intelsat Spacecraft

A model for the Hosted Payload system is the UHF hosted payload on board Intelsat's IS-22 spacecraft at 72 degrees East. The UHF-band payload is dedicated to the ADF mission and is hosted on a commercial satellite whose commercial mission is primarily C/Ku-band services. Intelsat General operates the ADF payload under a long term commercial agreement.

Another model for hosted payloads is the FAA Geostationary Communication and Control System ("GCCS") L-band payload currently in-orbit on the Intelsat Galaxy-15 satellite at 133 degrees West. The L-band payload is dedicated to the FAA mission and is hosted on a commercial satellite whose commercial mission is primarily C-band video service. Galaxy-15 was launched in September of 2005. *Figure 3* below depicts the Galaxy-15 spacecraft with, and without,the GCCS payload.

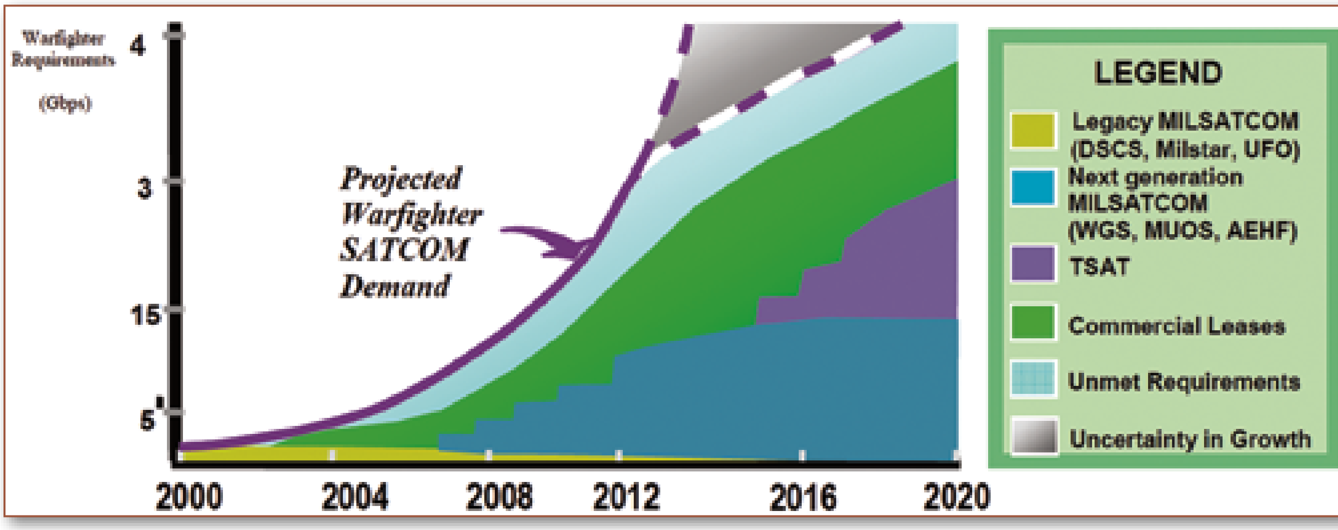



*Figure 2. Warfighter Requirements*
*Image is courtesy of DISA*

As an example of a demand to which Hosted Payloads provide possible solutions, the U.S. warfighter's communications needs are presented in *Figure 2* above, whereby commercial leases, unmet requirements and growth uncertainty outpace MILSATCOM systems. Similar situations exist in other application areas.

Another model for the Hosted Payload system was the "IP Router in Space" (IRIS) payload, which was built under a DoD Joint Capability Technology Demonstration ("JCTD"). IRIS included a dedicated payload, including an IP Router, onboard the Intelsat IS-14 spacecraft, which was launched in November 2009 to 45 degrees West. IRIS demonstrated the operational capabilities of IP Routing in Space for warfighters in developing a concept of operations (CONOPS) for IP space based communications. The IRIS architecture and coverage areas that were in existence during the payloads' operation are shown in *Figure 4* on the following page.

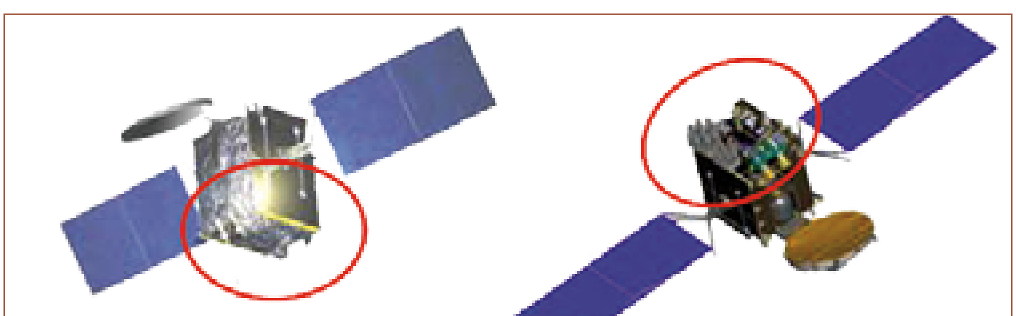


*Figure 3. Galaxy-15 with, and without, GCCS.*


*Figure 4. IRIS Architecture + Coverage.*

## *Hosted Payloads: The Advantages*

As the world's largest commercial fixed satellite services operator, Intelsat typically procures two to three spacecraft per year. Each satellite is designed for an operational life of 15 years. Intelsat's spacecraft have many commercial customers who depend upon the timely delivery of satellite capacity. Delaying procurement and/or launches could result in an erosion of the customer base and cause unacceptable contention on existing resources across the global fleet. Intelsat plans its fleet deployment based on a rigorous analysis of the business requirements associated with each current satellite orbital location. The ability to maintain a healthy satellite fleet and provision replacement satellites in a timely and cost efficient manner is the core of Intelsat's 50 years of success as a satellite operator. As such, the ability of Intelsat to host a payload is driven by the following points:

**Shared Operations**: Hosted payloads take advantage of the Intelsat satellite operations capability. Hosted payloads share the satellite bus with the commercial payload; the satellite is flown and monitored by Intelsat throughout its life. The hosted payload customer leverages Intelsat's substantial primary and back up space operations infrastructure to fly the host spacecraft. The hosted payload customer may select the option to control and manage its payload independently. In this option, Intelsat's visibility can be limited, at the customer's request, to the interface between the payload and the host spacecraft bus.

**Access to Space**: Hosted payloads take advantage of Intelsat's orbital slot allocations. Over the last five decades, Intelsat has been granted the authority to operate at more than 60 geosynchronous orbital locations around the Earth. Matched with Intelsat's fleet replacement program, the large number of allocations offers geographic coverage. Intelsat's customers also leverage 50 years of regulatory influence.

**Risk Reduction/Demonstration**: Hosted payloads offer the government a powerful method to reduce or mitigate risks associated with program funding, launch delays, and operational issues. This can be accomplished by augmenting planned government systems and by providing a platform for the development of CONOPS prior to full operational capability of those systems.

**Shared Development and Launch**: Hosted Payloads take advantage of an existing commercial satellite's design, development, and launch cycle. The hosted payload customer leverages Intelsat's substantial technical infrastructure in the design/build/launch cycle, resulting in significant cost savings relative to typical governmental space acquisition programs.

**Control Options**: Hosted Payloads offer government customers various levels of payload command and control either through the Intelsat Telemetry and Command (T&C) ground facilities, or directly from a government facility possibly using an encrypted link.

**Enhanced Security**: Examples of standard commercial security include: NSA approved command encryption, RF security carriers; high power command transmissions; dedicated antenna on every satellite for commanding and telemetry monitoring; redundant antennas and systems within each ground facility; redundancy between ground sites to allow for a complete site outage; and perimeter and other physical security that includes camera surveillance, guards, and authorized person access only. In addition, Intelsat has backup operations centers (for satellite operations and customer communications services) in Metro Washington, DC, and Metro Los Angeles, California, offering geographic diversity. Telemetry and Telecommand sites are connected to the prime and backup Control Centers via redundant, diversely routed communication links, for accommodation of FIPS-140 traffic, and segregation of customer equipment and technical data.

## *Hosted Payloads: Technical Issues*

### *System Trades*

The system trades objective is to provide system capability into geosynchronous orbit. The selection of the commercial satellite mission's orbital role and configuration may influence the delivery schedule to space, cost of integration and launch or salient performance parameters of the hosted payload.

Intelsat has significant flight history with numerous spacecraft bus manufacturers. However, detailed accommodation analysis is necessary to assess the impacts of incorporating payloads. In hosting specific customer payloads, system level trades are conducted in key areas. These include interactions with the commercial (primary) payload, field of views, cooling (thermal), accommodation, proximity of electronics and concept of operations.

Additionally, the physical dimensions, (SWaP), thermal dissipations (conductive and radiative) and DC power draw are considered. The commercial payload's configuration and mission are also evaluated to assess impact to the hosted sensor payloads. The commercial mission can then be merged with the hosted payload to address mission interactions, stability, operations, maneuver life, and opportunity costs. The intention is to maximize both the commercial mission to allow for continuity of service whilst enabling the hosted payload mission.

Commercial spacecraft bus employs modular designs, thereby allowing the spacecraft manufacturers to support a varied set of mission requirements. These bus have been designed with the best commercial practices and procedures utilized in their fabrication which allows for rapid and repeatable architectures. As missions change, the bus design does not require redesign or requalification.

As the spacecraft operator, Intelsat reviews the requirements needed to host the payload. This review is done with the selected spacecraft bus supplier, as Intelsat believes that the spacecraft bus supplier has the appropriate tools and skill sets necessary to determine the feasibility of accommodation. Part of Intelsat's trade space is to maximize the commercial mission while enabling the hosted payload mission.

Key areas the commercial bus supplies must address are utilization of side wall and Earth view (AKA—Earth deck) mountings to accommodate antennas and the sensor payload; payload component mounting real estate which employs either conduction or radiative cooling techniques for payload thermal dissipations; electrical power; jitter or pointing accuracy.

***Accommodation***

Hosted payloads needing Earth views warrant accommodation onto the Earth deck. These areas have traditionally been used for communication payload antennas. Unlike large East / West deployed commercial antennas, Earth facing payloads need to take advantage of the mounting area on the Earth deck. This is driven by various trades, namely heat dissipation, continuous Earth views and a stable environment. This stable environment is compared to the East / West mounting areas.

In integrating the payload, the spacecraft supplier must also assess the proximity to the payload's electronic boxes. This allows for easier access during integration onto the spacecraft and a mounting area that allows for thermal dissipation.

To ease integration late in the spacecraft's build, the payload may be integrated onto extension panels. This allows for delivery flexibility (partial or sequenced) of the payloads. Furthermore, the use of simulators can further extend the needed time for integration.

This may not be the preferred approach but with careful planning, the programmatic risk can be managed. *Figures 5a*, *5b* and *5c*, next column, top, provide a sample of notional commercial configurations of the Earth deck onto which a hosted payload can be accommodated. In the configurations shown, extension panels can be seen rising up from the Earth deck along the north / south panels.

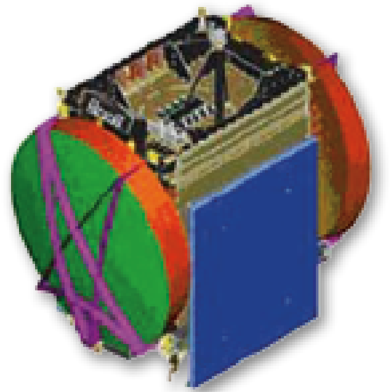


*Figure 5a.*

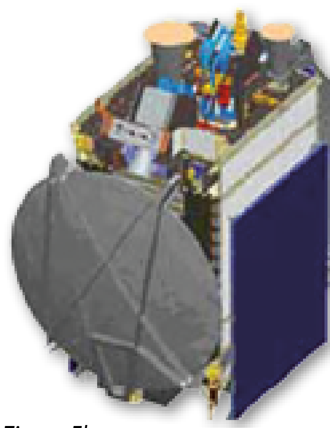


*Figure 5b.*

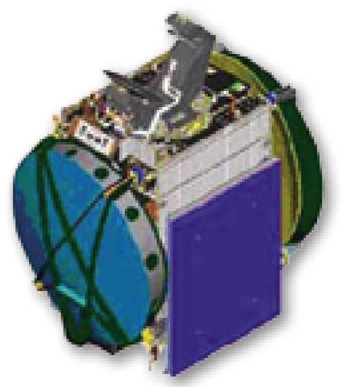


*Figure 5c*

*Figures 5a, 5b + 5c: Notional Commercial Mission Configuration*

Part of the accommodation trade addresses the payload data stream requirements. A critical piece of the data stream requirements is the need to encrypt the data collected onboard prior to transmission. Encryption capability will either be delivered as part of the hosted payload or as part of the T&C subsystem. To minimize SWaP and hardware cost associated with the payload's data streams, connectivity via the commercial transponders is suggested. This alleviates the need to obtain additional regulatory filings for frequencies not currently allocated to the host spacecraft. Additionally, it minimizes the resources needed by the hosted payload thus, reducing the overall cost to orbit.

Using the commercial transponders allows for various data rates that can be transmitted to or from existing customer sites or through Intelsat's ground network for distribution. Intelsat currently operates an extensive global data distribution network which can support the required bandwidth to gather and distribute data globally. *Figures 6a*, *6b*, *6c*, and *6d* on the following page illustrate notional payloads interfaced onto Earth decks with commercial mission antennas deployed from the spacecraft's east and west side walls.

***Telemetry + Command***

The hosted payload may require connection via a payload interface unit for appropriate power conversions, telemetry and command interfaces. Commands are sent to the payload using the onboard command system. Telemetry is received via the onboard telemetry system. The T&C subsystem that controls the payload is the same subsystem that controls the commercial payload.

*Figure 6a.*

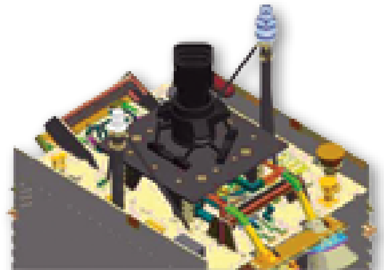


*Figure 6b.*

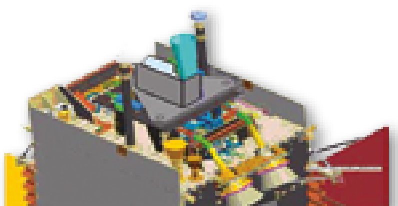


*Figure 6c.*

*Figure 6d.*

*Figures 6a, 6b, 6c + 6d: Notional Hosted Sensor Payloads.*

The Satellite Control Center (SCC) monitors the health and status of the commercial mission and the hosted payload to ensure safe and continual operations over their respective mission life. Under this umbrella, there are numerous structures for hosting. These range from 'pure' hosted payloads where the entire payload is turned over to the customer for remote commanding from a customer facility (with Intelsat focusing on 'flying' the spacecraft), to options for Intelsat to provide ongoing command and control of the payload for the customer. In the latter case, commanding may be done either by establishing a contact protocol with Intelsat's Satellite Operations Center (SOC), Intelsat General's government dedicated Secure Operations Center (ISOC), or through an established terrestrial Virtual Private Network (VPN) using the SOC's infrastructure. This latter example is the agreed methodology selected that supports the ADF hosted UHF payload onboard IS-22.

***Electrical Power Subsystem***

Hosted payloads can be accommodated to operate at either beginning of life (BOL) or throughout the spacecraft's end of life (EOL). Operation at BOL is when the spacecraft produces more power than required to meet the commercial payloads needs (aka power margin). The payload operating within the spacecraft's design limits during BOL ensures stability and predictable temperature ranges while retaining equipment reliability levels.

The commercial mission needs can alter with time, due to customer changes. This may drive coverage area repointing and link performance parameters associated with the graceful degradation of the solar arrays. As the spacecraft begins its transition toward EOL, operation of the hosted payload beyond BOL may require refinements in managing

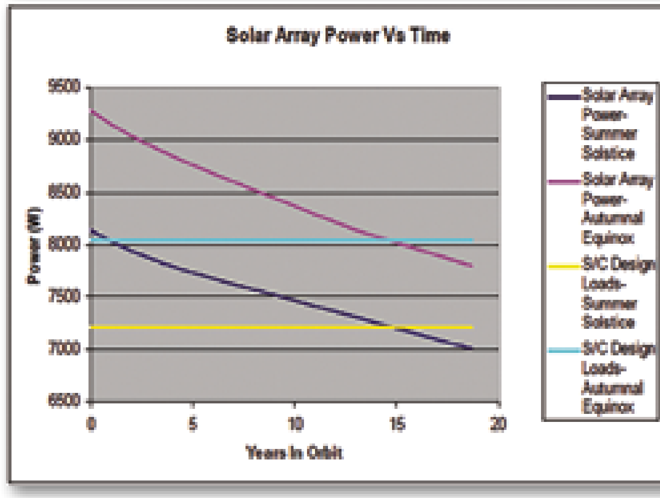



*Figure 7. Typical Available Solar Array Power Vs. Time + Season.*

the power use of the commercial mission. Operation during this time period ultimately leads to a cross over point where excess power margin decreases thus ending the BOL operation.

However, by incorporating the hosted payload into the baseline design of the electrical power subsystem can ensure operation until EOL of the spacecraft. This is accomplished by exercising the modularity of the electrical power subsystem during the spacecraft design thereby, upsizing the subsystem to insure power and thermal margin throughout the spacecraft's operational life. *Figure 7* above provides typical available solar array power curves to support both a hosted payload and commercial mission over time. The BOL operational duration is prior to the crossover point. Furthermore, the required commercial mission power demands are also shown. The area between these curves identifies the available BOL power margin and its availability duration (typically years).

***Thermal Considerations***

In concert with the power needed for the hosted payload, the thermal accommodations are equally important. A communications spacecraft can generate upwards of 15kW of DC power and will need to dissipate approximately half. The integration of a hosted payload must address the effects of this heat. Conductive and radiate heat paths can influence the payload's environment. In order to maintain operational stability, predictable temperature ranges, and equipment reliability levels commercial spacecraft are designed to dissipate heat in an efficient and effective manner.

The spacecraft's Earth deck is thermally coupled to the north and south payload panels. This is done with the use of embedded heat pipe networks, face sheet doublers or local surface mount heat pipes that connect to the payload and aid in its heat transfer. Heat dissipation panels are covered on the outside with optical solar reflectors (OSRs), have built in heat pipe networks which are sandwiched within aluminum honeycomb and aluminum face sheets to for heat dissipation.

The thermal coupling of the north and south panels to the Earth deck can produce additional heat sources that will influence the hosted payload's environment. If it is necessary to isolate the payload from external sources, the sensor payload will need to provide its own thermal control system. The use of cryo coolers, local radiators coated with OSRs or embedded heat pipe networks can aid in thermal dissipation. The effects are a more stable payload platform with isolation from the bus and its local environments. A mission specific thermal analysis assesses the thermal margin within which the payload will operate. The results of this analysis can influence the payload's thermal / mechanical design.

### *Pointing Accuracy, Control, and Jitter*

A concern with hosting a sensor payload is the stability of the spacecraft. Stability mitigations can include better attitude knowledge and control, compensation for excessive motion either on the spacecraft (via an Earth pointing optical bench) or within the sensor (*i.e.,* dynamic image stabilization). As such, the traditional error budgets used to calculate the commercial payload beam pointing accuracy is inadequate. This inadequacy is dominated by the relatively short term (duration) that a sensor captures its information as compared to pointing of a commercial antenna using a wide footprint or coverage area.

The typical pointing accuracy of a commercial communications spacecraft is ±0.1 degrees (333 arc seconds). This pointing accuracy is a combination of long term, short term, seasonal and diurnal errors. For a 15 year mission, each has its respective place. As remote payloads are more sensitive to the short term and diurnal effects, long term and season influences can be treated as separate issues. As mentioned above, it is necessary to mitigate the short duration effects. Better attitude knowledge can be provided to the sensor from the commercial bus via constant gyro updates or directly by way of star trackers. Star trackers can either be integral to the sensor payload or part of the commercial bus attitude control subsystem. The stabilization data can then be used to mitigate the jitter imposed upon the sensor. Short term effects (or jitter) results from bus subsystems (*e.g.,* Solar array flexure (due to solar winds and thermal transients) and the attitude control system (sensor noise, and momentum wheel vibration). Sensor payloads can require up to two orders of magnitude more stability. Taking these effects into account, commercial geostationary spacecraft can be stable especially when an Earth pointing optical bench or sensor dynamic image stabilization is employed.

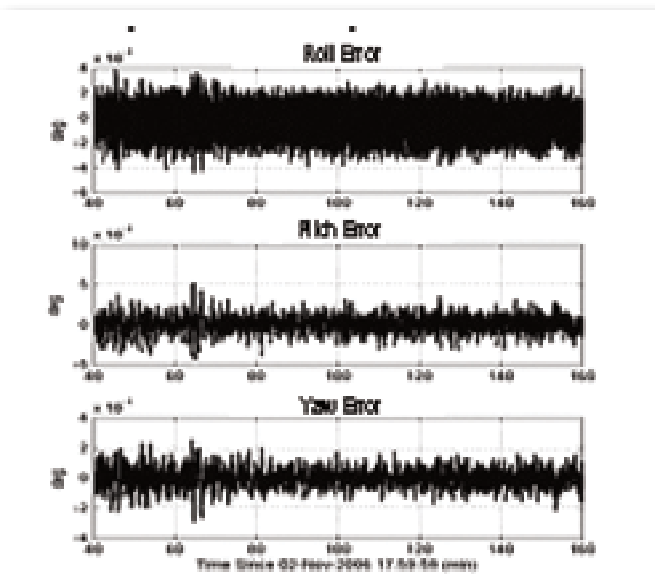



*Figure 8. On-Orbit Data For Pointing Stability.*
*Figure is courtesy Orbital Science Corporation.*

- For Payload Sensor Integration Time = 2 Seconds

| ACS Measure of Performance | STAR-2.2M Performance |
|---|---|
| Attitude Control | 16 Arc-Sec (3σ) |
| Attitude Knowledge | 16 Arc-Sec (3σ) |
| Low Frequency Jitter ( 0.1 – 0.5 Hz ) | 0.93 Arc-Sec (3σ) or 1.86 Arc-Sec (3σ) peak-to-peak |
| High Frequency Jitter ( > 0.5 Hz ) | 0.55 Arc-Sec (3σ) or 1.1 Arc-Sec (3σ) peak-to-peak |

- For Payload Sensor Integration Time = 0.5 Seconds

| ACS Measure of Performance | STAR-2.2M Performance |
|---|---|
| Attitude Control | 16 Arc-Sec (3σ) |
| Attitude Knowledge | 16 Arc-Sec (3σ) |
| Low Frequency Jitter ( 0.4 – 2.0 Hz ) | 0.55 Arc-Sec (3σ) or 1.1 Arc-Sec (3σ) peak-to-peak |
| High Frequency Jitter ( > 2.0 Hz ) | 0.2 Arc-Sec (3σ) or 0.4 Arc-Sec (3σ) peak-to-peak |

*Figure 9. Predicted Pointing Stability.*
*Figure courtesy of Orbital Science Corporation.*

On-orbit stability has been measured on a limited number of commercial spacecraft. The use of star trackers has provided the data for an assessment of the bus' stability. One such supplier's on-orbit measured results are detailed in *Figure 8* and *Figure 9,* to the left and above.

### *Size, Weight and Power*

SWaP of a hosted payload, the associated thermal resources and integration scope require evaluation and study. The use of heritage hardware and /or flight proven technology for the hosted payload design minimizes both technical and programmatic risk. The strategy in identifying candidate orbital roles include: determining replacement needs; growth; timing; spacecraft sizing; consolidation of roles (by collapsing multiple orbital roles from 2 to 1); offload traffic (as part of the consolidation process); and identify in-orbit sparing. These assessments determine the "size" of each candidate spacecraft. For each orbital role the spacecraft size is coarsely defined as small, medium or large. Each spacecraft size is relative to the commercial payload's DC power requirements. A small spacecraft has a payload

DC power of less than or equal to 5kW; a medium spacecraft has a payload DC power between 5kW and 9kW; and a large spacecraft has a payload DC power greater than or equal to 9kW.

Each candidate orbital location is available for a hosted payload. As the commercial mission solidifies along with hosted payload opportunities, the spacecraft size can better be assessed. As stated above, role consolidations, role replacements and even potential anomalies (unforeseen operational or mission failures), will greatly influence the spacecraft size assumptions.

### *Timeline For Integration*

Candidate orbital locations and their associated order dates and launch dates are based upon the commercial payload replacement needed to ensure continued operations. However, as opportunities present themselves, dates are subject to change. As an example, in support of interest for a hosted payload within a specific orbital arc, replacement spacecraft can be considered for acceleration.

Acceleration could advance the order date by as many as two years. In contrast, a delay in spacecraft order dates and launch dates are not necessarily considered. The need for the spacecraft is driven by the orbital maneuver life of the satellite in-orbit and the continued commercial operations from the respective orbital locations.

The identification of candidate orbital location(s) needs to be decided early. Upon selection, regulatory coordination may be necessary along with an assessment of the spacecraft's size. This takes into account the size envisioned for the commercial mission and any "upsizing" that may be required to accommodate the hosted payload.

If upsizing is not required or wanted, the hosted payload may need to be sized to fit within the available bus capability (BOL). Once accommodated, the Hosted Payload is included in the spacecraft requirements documentation.

This documentation is what industry will use to propose a solution for the spacecraft configuration. Through this process, the hosted payload becomes integral to the program. *Figure 10* below depicts an indicative schedule whereby the hosted payload is integrated into program events. As such, all interfaces are established and spacecraft assembly, integration and test are developed with the hosted payload inclusive. Pre Launch, Launch and In-orbit testing are carried out on the payload for performance verification and validation prior to start of service.

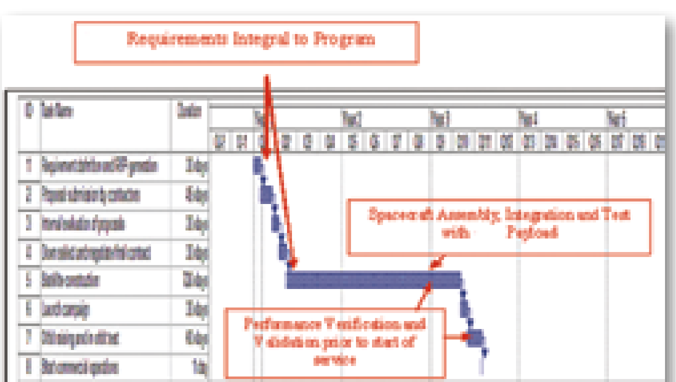



*Figure 10. Indicative Timeline.*

## *Hosted Payload: Program Structure*

Intelsat General acts as the prime contractor for all procurement and leases tied to the described architecture. Intelsat General contracts for the manufacture and integration of hosted payload (either as GFE, CFE, or directed source) and an affiliate of Intelsat General, Intelsat Ltd, would procure the "host" spacecraft on which the payload will operate. The chosen spacecraft manufacturer is then responsible for the overall schedule, to include the delivery, integration and test of the payload.

As part of Intelsat's analysis on hosting a payload, IGC independently verifies that the payload supplier can deliver their system for integration to meet the spacecraft deployment required by Intelsat's commercial mission. Additionally, Intelsat Ltd. procures the required integration and launch services to place the spacecraft into geosynchronous orbit.

The success of payload hosting is supported by Intelsat's policy of in plant monitoring of development, assembly, integration and test of the spacecraft it procures. The approach began during the latter part of the Intelsat III Program (circa 1970's) and has continued since then for the construction of 90+ spacecraft. In the process, Intelsat has developed a close and mutually respectful relationship with each of the major spacecraft manufacturers.

Though its efforts and active on site program participation, Intelsat has realized a highly successful in-orbit record. Intelsat has unparalleled experience and expertise in all areas of satellite engineering and operations, an established ground network infrastructure, launch vehicle program management service, launch and early orbit phase (LEOP) management, in-orbit testing (IOT), satellite communications quality of service (QoS) monitoring, satellite operations services, and satellite insurance support services.

*Figure 11. Notional Deployed Satellite with sensor payload (installed on Earth Deck).*

As part of Intelsat's standard management plan, all of the company's spacecraft manufacturing suppliers accept resident Intelsat Program Managers (IPMs) with each satellite build. These IPMs are highly qualified engineers with an average of more than 12 years of experience in satellite design, acquisition, and program management. Due to the close physical proximity of our staff, we have developed strong relationships with our suppliers in every functional area. Additionally, we have tasked our spacecraft and payload supplier teams with providing a detailed look at how they would integrate a hosted payload solution using commercial best practices while preserving schedule and controlling costs.

Intelsat's commercial spacecraft supplier base offers significant economies and speed of deployment, compared to traditional governmental programs. IGC weighs the experience and technical offerings of potential suppliers for the commercial payload, spacecraft bus, and hosted payload integration capabilities. As such, IGC can establish a team of industry experts to manufacture, integrate, deploy and operate a hosted payload in-orbit. The lessons learned by IGC and our suppliers over dozens of satellite programs has been incorporated into the standard practice and procedures, thereby providing technical and schedule credibility. The interface definitions, roles and responsibilities, and quality assurance practices are well defined between Intelsat and its suppliers.

## Hosted Payloads: Financial Considerations

The business case for a commercial mission spacecraft to host a customer specific payload mission needs to be carefully analyzed. Hosted payload pricing is complex and includes many factors: the hosted payload itself, this can be government furnished and/or funded; integration costs of the payload onto the host spacecraft; shared use of the spacecraft's common systems and the launch vehicle; capitalized program costs during the spacecraft's construction period; TT&C and ground infrastructure, as required by the hosted payload customer; financing costs; insurance, launch plus one year of in-orbit operations; on ground operations over the service life of the payload; custom options requested by the hosted payload customer; and a reasonable return on the investment commensurate with risk.

Other factors that influence the business assessment of the hosted payload opportunity include: volume and term of the customer's commitment; furnished or funded payload; up front deposits paid during the spacecraft construction period versus payments over the service term; market factors and impacts on orbital maneuver life or other performances.

The value of hosted payloads is seen with key economic drivers when compared to a dedicated spacecraft supplying the same payload capability. They include: 1) The sharing of costs with the spacecraft common systems and launch vehicle. 2) Typical payload/spacecraft construction periods of 36 months yielding 2+ years of early start of service. 3) Provision of commercial best practices utilizing professional project management practices. 4) Flexible payment plans to match customers' funding profile (*e.g.*, upfront, all lease, upfront followed by lease).

Within the commercial geosynchronous communication satellite industry, there already exists a fundamental unit of measure of value, the single (36MHz) transponder. Any commercial venture which proposes to use real estate on a communication satellite must at the very least, use this metric in evaluating hosted payload opportunities. *Figure 12* depicts a notional trade between commercial apertures / transponders whereby a commercial payload is replaced by a hosted payload. Any proposed opportunity which does not at least maintain or exceed ROI parameters is essentially a non starter from a conventional investment / business case standpoint.

For additional information regarding IGC, please visit
***http://www.intelsatgeneral.com***

***About Intelsat General Corporation***

*Intelsat General Corporation (IGC) is a wholly owned subsidiary of Intelsat Corporation (Intelsat), the world's largest commercial Fixed Satellite Services (FSS) operator. Currently, Intelsat owns and operates more than 50 geosynchronous spacecraft; additionally, Intelsat operates another 12 satellites for companies such as DIRECTV and EchoStar.*

*Intelsat is the largest provider of commercial satellite services to the U.S. Government and its allies. As a testament to Intelsat's dedication to, and focus on, the Government market, Intelsat General Corp. (IGC) was created in March of 2003. The mission of the company is to provide a range of sustainable, cost effective, secure satellite based solutions to Governments (US and Allied), NATO and other Military and Commercial entities worldwide.*

*IGC, a U.S. corporation, includes a dedicated team of satellite professionals, experienced in every facet of the satellite industry, including satellite design, payload accommodation, network design, transmission engineering, program management, cost benefit analysis, and Government contracting.*

***Acknowledgements***

*The author would like to acknowledge: Orbital Science Corporation for supplying notional spacecraft configurations.*

***About the author***

*Mr. Gerard (Gerry) Jansson Director, Space Segment Development, has more than 25 years' experience in research, development and deployment of advanced communication technology, ranging from passive hardware design through systems architecture to mission support. This includes over 35 commercial spacecraft in which Mr. Jansson contributed to their mission's success. While at Lockheed Martin AstroSpace (previously RCA, GE and Martin Marietta), Mr. Jansson developed communication payloads for commercial satellites, including low cost, high performance payload components for satellite systems. During his tenure years at Orion Network Systems, Gerry moved into satellite operations and was responsible for the payload operations of the in-orbit fleet. During this time Mr. Jansson also transmuted the next generation Orion mission needs into spacecraft requirements. Since joining Intelsat in 1997, Mr. Jansson has supported proposal evaluations, negotiations, monitoring and operations of Intelsat's fleets. Mr. Jansson was also responsible for the technical contract and their content utilized in the procurement of Intelsat spacecraft. Gerry currently serves at INTELSAT General Corporation in Business Development to space systems and hosted payloads for governmental customers.*

## In Example: The GCCS WAAS Hosted Payload On Galaxy 15

*By Dr. Bryan L. Benedict, Product Line Manager, Hosted Payloads, Intelsat General Corporation*

The Wide Area Augmentation System (WAAS) uses a system of dozens of ground stations in various CONUS locations to provide necessary augmentations to the GPS standard positioning navigation signal.

A network of precisely surveyed ground Reference Stations are strategically positioned across the country including Alaska, Hawaii, and Puerto Rico to collect GPS satellite data. Using this information, a WAAS Message is developed at the Master Station to correct signal errors. These correction messages are then broadcast from Ground Uplink Stations through commercial GEO communication satellites to receivers onboard aircraft using the same frequency as GPS.

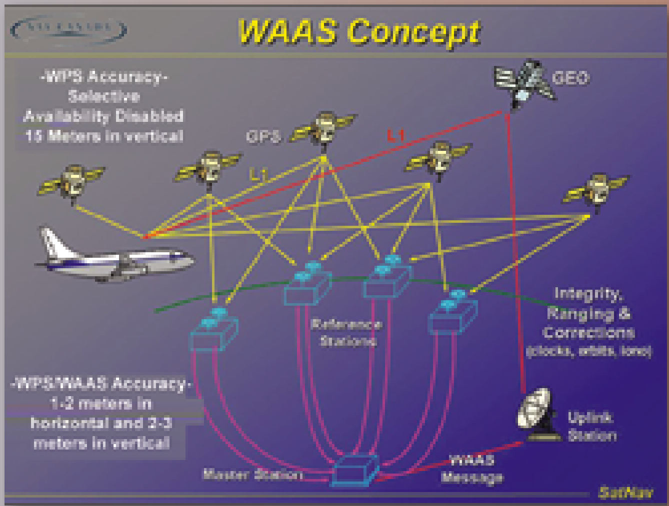
WAAS is designed to provide the additional accuracy, availability, and integrity necessary to enable users to rely on GPS for all phases of flight, from en route through GNSS Landing System (GLS) approach for all qualified airports within the WAAS coverage area. With the Wide Area Augmentation System (WAAS), accuracies of 1-2 meters in horizontal and 2-3 meters in vertical are consistently achieved.

In order to adequately cover the United States and to provide on-orbit redundancy in case of satellite failure, it is desirable to have at least two operational WAAS space payloads on separate platforms.

Lockheed Martin Transportation and Security Solutions was placed under contract by the FAA to be the prime contractor for providing GCCS-WAAS services. The payload provides users with Satellite Based Augmentation Signal (SBAS) navigation waveforms at the GPS L1 and L5 frequencies. The Navigational Payload operates in bent pipe mode and simultaneously translates two C-band uplinks signals into two L-band downlink channels.

In 2003, Lockheed Martin contracted with Intelsat (then PanAmSat) and Telesat for hosting of L1/L5 GCCS WAAS navigation payloads on Galaxy 15 (PRN 125 at 133W) and Anik-F1R (PRN 138 at 107.3W) respectively. Lockheed Martin owned the payload and was responsible for FCC frequency licenses and ITU coordination.

These space payloads provide leased services under the FAA's Geostationary Satellite Communications Control Segment (GCCS) contract with Lockheed Martin for WAAS geostationary satellite leased services, who was contracted to provide up to three satellites through the year 2016.



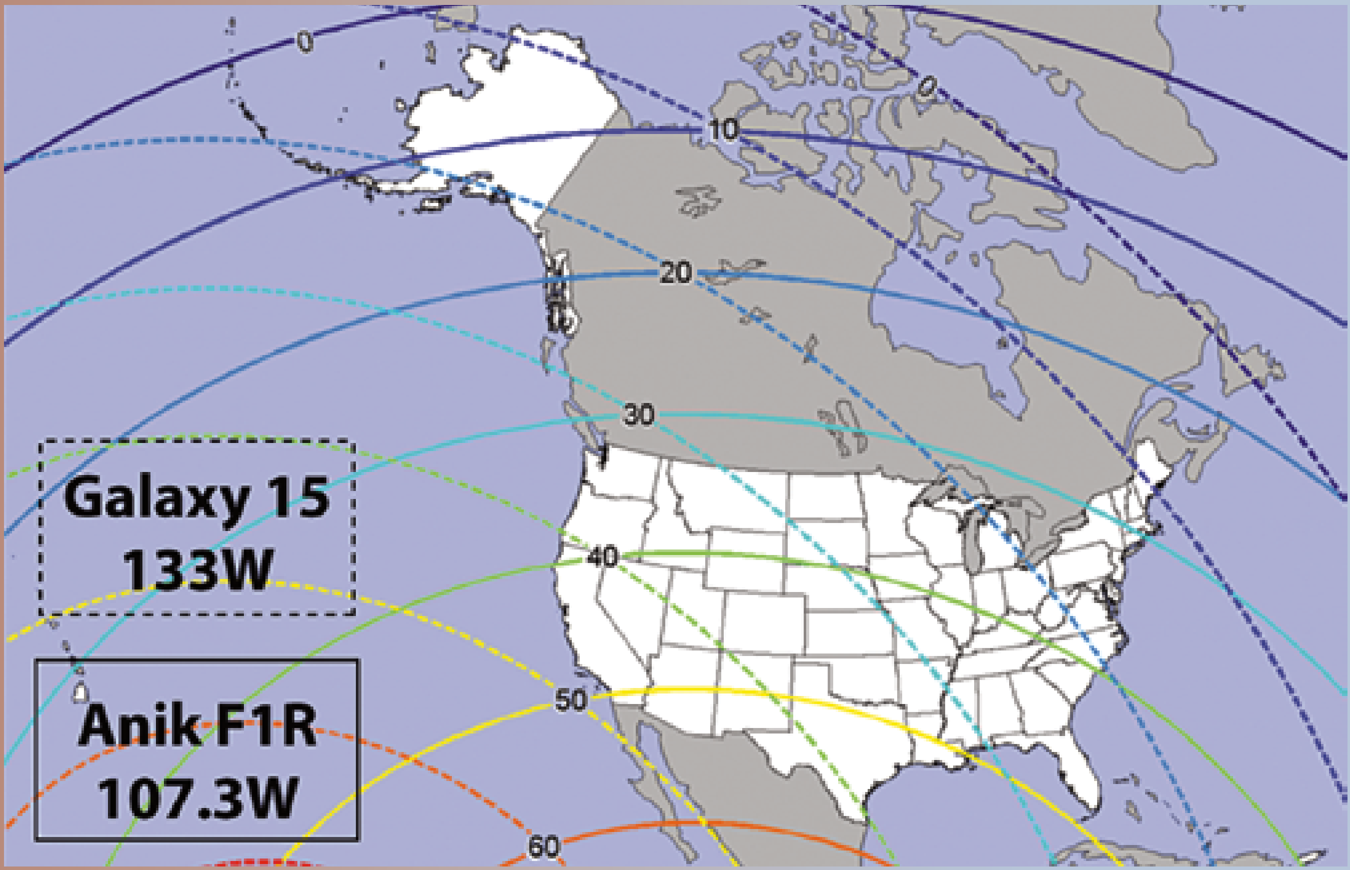

The Lockheed Martin contract with Intelsat actually included two elements. The first element was hosting of a redundant L-band WAAS transponder system on Galaxy-15 (including integration, testing, program oversight, and so on), followed by ten years of operations following service commencement. The second element was placement of a Ground Uplink Station (GUS) located in Intelsat's Napa, California, teleport. Lockheed Martin also owns the hardware installed at the GUS in Napa.

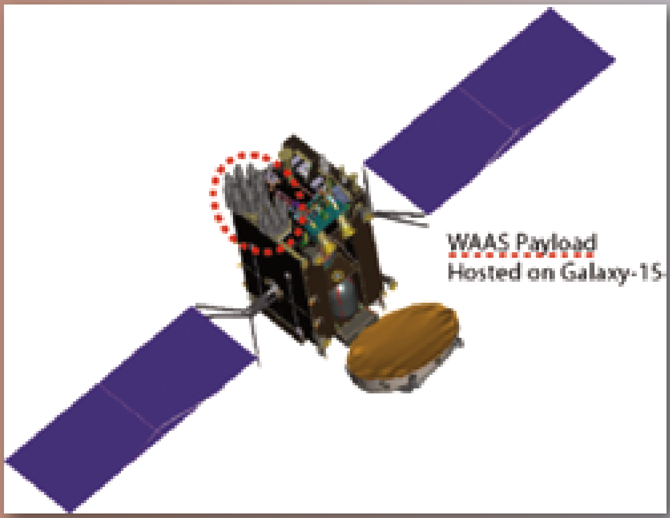
Key to the FAA WAAS program is coverage over Alaska, where GPS and WAAS is used extensively by commercial and civil air traffic. It is difficult to maintain a lock on the WAAS signal where the above horizon elevation from the airplane to the WAAS satellite is less than 10 degrees.

The solid contours illustrated on the next page illustrate elevation angles (above horizon from aircraft) from Anik-F1R, the dashed lines illustrate elevation to Galaxy-15. Consequently, Galaxy-15 is required to provide WASS availability to Alaska. Ideally the WAAS space platforms would be located in the vicinity of 123-125W, where coverage is optimized for both Alaska and to Nova Scotia (see coverage map).

Intelsat's WAAS payload was hosted on an Orbital Science StarBus 2.2 platform. The hosted payload added about 60kg to the launch mass and required about 300W of platform power. This hosted payload was added to a spacecraft already in production and launched within two years of contracting with Lockheed Martin.

Critical to the success of this program was the fact that Intelsat had contracted multiple spacecraft from the same manufacturer with space on the nadir deck. Additionally, Orbital Science was extremely flexible in accepting changes to the spacecraft already in production.

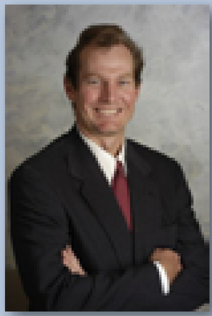



Galaxy 15 was launched in 2005 and, following certification, began transmitting the WAAS signal. This payload now provides the capability for the development of more standardized precision approaches, missed approaches, and departure guidance for approximately 4,100 ends of runways and hundreds heliport/helipads in the National Air System (NAS).

WAAS also provides the capability for increased accuracy in position reporting, allowing for more uniform and high quality worldwide Air Traffic Management (ATM).

***About the author***



*Dr. Bryan L. Benedict serves as the Product Line Manager for Hosted Payloads at Intelsat General Corporation. He has worked extensively within both the DoD and U.S. Civil Agencies to socialize the advantages of hosting imaging payloads on commercial spacecraft...*

*Additionally, Dr. Benedict has been a key driver in the commercial industry for the use of space robotics for both recovery and life extension of geosynchronous satellites. Prior to his current position Dr. Benedict served as the Director of Engineering for Satellite Acquisitions for PanAmSat.*

*Dr. Benedict started his career as a chemical engineer in the petroleum industry, inventing and patenting several catalysts still used for stabilization of jet fuels. Dr. Benedict earned his Ph.D. from the University of Wisconsin in 1986, where he conducted research on the stabilization of "high energy" materials within crystalline lattices.*

*Dr. Benedict has been awarded a number of patents throughout his career, the latest for delivery of microsatellites to orbit piggybacking on the nadir deck of geosynchronous communication satellites.*

# THE SAVING GRACE OF COPAS-SARSAT

Two Galileo Initial Operational Capability (IOC) satellites will soon be launched from Kourou, French Guiana (July/August 2014). While most people are aware that Galileo will provide a new SatNav system, it will also offer a new breakthrough Search and Rescue (SAR) capability.

This article explains how the European Union's Galileo satellite constellation, now in its early launch phase, Russia's GLONASS equivalent and the U.S. military's next generation GPS constellation will dramatically improve the speed and delivery of Search and Rescue services around the world, resulting in a safer environment for us all.

## Galileo European Program

Galileo is a global navigation satellite system (GNSS) currently being built by the European Union (EU) and European Space Agency (ESA). Whereas GPS was initiated by the U.S. military, Galileo is intended to be solely a civil system.

As a new phase of system deployment is entered, the European Community has taken over the leadership of the program from the European Space Agency (ESA). In other words, the program has now moved from a scientific phase to the commercial/operational phase.

The GIOVE-A and GIOVE-B experimental satellites for this program were launched in 2005 and 2008, respectively. These two satellites tested crucial Galileo technologies and also secured the Galileo frequencies within the International Telecommunications Union (ITU).

The next pair of Galileo satellites are set for an August 21st launch via a Soyuz launch vehicle, to liftoff from French Guiana, courtesy of Arianespace. These Galileo Initial Operational Capability (IOC) satellites will initiate the operational phase of the Galileo project.

By end of 2014, two additional IOC satellites will be launched, followed by two further satellites being launch in early 2015.
Aboard the Galileo constellation's MEOSAR nexgen satellite will be a Search and Rescue payload—new SAR radio transponders will be carried as part of the payload. Additionally, a SatNav payload will provide Public Regulated Services (PRS) and Open Services (OS).

## The Early Services

With a total of ten satellites in operation, four from the In-Orbit Validation (IOV) and six from the Initial Operational Capability (IOC) programs, eight of which carry a SAR payload, Galileo will take another step forward and start offering early services by the end of this year or early 2015. These first early services will be:

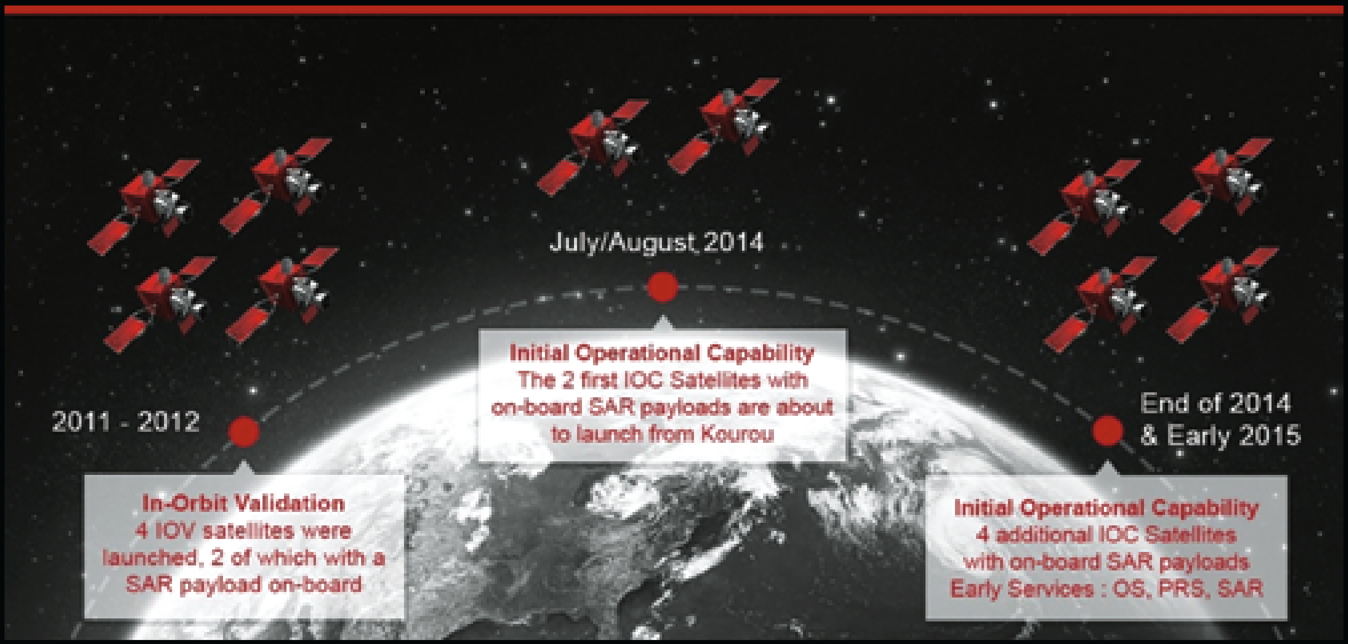
## Search + Rescue

*The Galileo system is critical to the upgrade of the COSPAS-SARSAT international search and rescue program which has saved nearly 37,000 lives since its inception in 1982.*

*How will Galileo dramatically improve Search and Rescue? Galileo will include a number of breakthrough innovations such as:*

» *SAR Payload: Next gen SAR technology on board Galileo satellites will reduce the detection times of COSPAS-SARSAT distress beacons from hours/minutes to seconds, thereby expediting recovery and saving more lives.*

» *Return Link Service : A new feature of the Galileo SAR system is its ability to send messages back to beacon users confirming that their distress signal has been received.*



## SatNav

- *Open Service (OS) : Galileo's freely accessible service for positioning, navigation and timing. It will be fully interoperable with GPS & Glonass and will be used for many mass market applications, such as in-car navigation and location based mobile services.*
- *Early Public Regulated Service (PRS) : The PRS will be an encrypted service limited to government authorized users. It is designed for greater robustness and increased availability. The signal will be resistant to unintentional interference, malicious jamming, spoofing and false interception/re broadcast (meaconing).*

### Search + Rescue Ecosystem—COSPAS-SARSAT

COSPAS-SARSAT is the free, International Search and Rescue system that transmits a position to locate victims rapidly. Wherever an accident takes place, whether on a boat, in a plane or in the mountains, rescue teams are always confronted by the same problem: how can they locate potential victims quickly, and accurately. COSPAS–SARSAT assists in locating distress sites and plays an important role in rescuing lives.

During the 1970s, the U.S., Canada, the USSR and France decided to establish a global system to gather information and to identify emergency operational situations. Called COSPAS-SARSAT, this system greatly improved the efficiency of rescue operations and also allowed for permanent (passive or automatic) localization of distress beacons, *i.e.*, without human intervention. Relayed by satellite, analyzed by control centers on the ground, the COSPAS-SARSAT system distress signals allow for the detection and accurate location of the beacon's position and for the appropriate rescue authorities to be quickly alerted.

**Various distress beacons are available for the COSPAS-SARSAT sytem.**

COSPAS-SARSAT provides, free of charge, distress alert and location information to search and rescue authorities anywhere in the world for maritime, aviation and land users in distress. Where other technologies are out of range, COSPAS-SARSAT can locate people in danger. Thanks to the system, nearly six people are rescued every day. A 406MHz beacon—certified by the COSPAS-SARSAT organization—does not require any monthly subscription fee.

By sending an automatic or manual signal to search and rescue teams via the COSPAS-SARSAT system, distress beacons streamline the rescue chain and increase the victims' chances of survival. To date, more than 35,000 lives have been saved, thanks to the distress beacons that operate with the COSPAS-SARSAT, satellite aided, Search and Rescue system.

The objective of the COSPAS-SARSAT system is to eliminate the "search" in search and rescue by; reducing the time required to detect a distress; and streamlining the process for SAR services. As of this writing, the COSPAS SARSAT system has six Low Earth Orbit (LEO) Search and Rescue (LEOSAR) Satellites and six Geostationary Earth Orbit Search and Rescue Satellites (GEOSAR).

Currently, more than 1.4 million 406MHz distress beacons are registered with COSPAS-SARSAT. These beacons are operated by boat owners, aircraft operators and outdoor enthusiasts.

As many as 45 minutes is required for a beacon to be located by COSPAS-SARSAT—with Medium Earth Orbit Search (MEO) and Rescue (MEOSAR) Satellite technology such as Galileo, the detection time will be reduced to seconds.

To learn more about the SAR ecosystem, McMurdo Group offers webinars to provide education and awareness to the SAR community. Past webinars on both COSPAS-SARSAT and MEOSAR may be accessed by visiting **http://www.mcmurdogroup.com/webinars/.**

In the domain of Search & Rescue, the MEOSAR system represents a technological revolution that is quite similar to the impact GPS had in the world of radio navigation in 1995.

MEOSAR brings several improvements to COSPAS-SARSAT including:

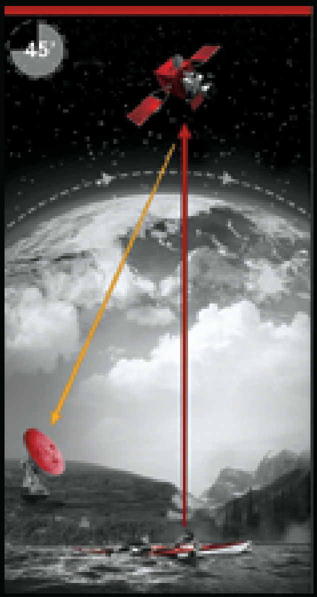
- *A constellation of approximately 72 MEOSAR satellites (vs. 6 GEOSAR and 6 LEOSAR satellites with COSPAS-SARSAT today). This will provide worldwide coverage every second of every day. From anywhere in the world, a distress beacon signal can now be captured nearly instantaneously.*
- *When a distress radio beacon transmits its first signal (and then continues to transmit distress signals regularly for 24 to 48 hours minimum), the signal is received by at least three MEOSAR satellites which locate the beacon within a few seconds (compared to up to 45 minutes or more with traditional LEOSAR and GEOSAR satellites).*

- *The signal is relayed to multiple antennas on satellite ground stations or Local User Terminals (LUTs) on Earth where time-difference-of-arrival and frequency-difference-of-arrival positioning techniques can more accurately calculate beacon locations. Essentially, the MEOSAR system works according to the same principle as the GPS tracking system, but in reverse.*

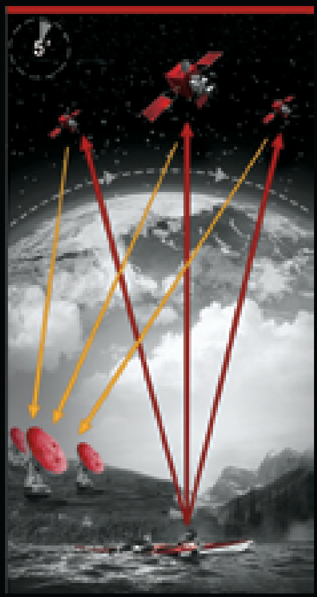
- *The MEOSAR system's objective is to locate beacons within 100 meters, 95 percent of the time, and within five minutes—even for beacons that are not equipped with a GPS receiver.*

- *The part of the MEOSAR system carried by Galileo satellites will have a Return Link Service, which will allow rescue coordination centers to send acknowledgment and feedback to the beacon user, indicating that help is on the way.*

All MEOSAR simulations and initial results have demonstrated that this system will bring considerable improvements to COSPAS-SARSAT. Currently under testing and evaluation, the MEOSAR program will start the operational phase in 2015 and will reach full capacity prior to 2020.




*COSPAS-SARSAT as of today.*



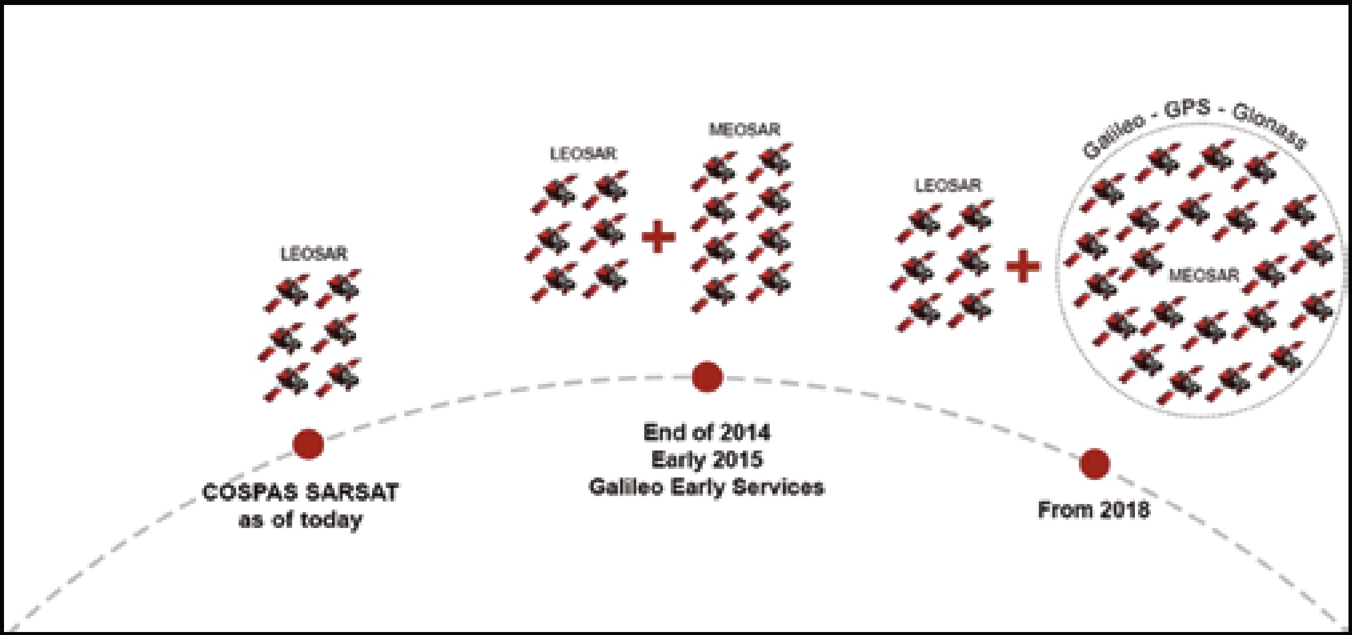

*COSPAS-SARSAT with MEOSAR Starting at the end of 2014 / early 2015*

## MEOSAR Key Benefits

- *Better Accuracy, Timeliness and Reliability*
- *Global coverage and improved position calculation due to number and orbit patterns of satellites (more location data points)*
- *Near Instantaneous Beacon Signal Relay*
- *Faster response times—average 10 times faster*
- *Close to 100 percent Availability*

## Revolutionizing The SAR World

Global Satellite coverage will take five minutes with MEOSAR, compared to 45 minutes with the current COSPAS-SARSAT system.



| | COSPAS-SARSAT<br><br>LEOSAR and GEOSAR | COSPAS-SARSAT<br><br>MEOSAR NEXT GEN. SAR SATELLITES | COSPAS-SARSAT<br><br>MEOSAR + 2ND GENERATION OF BEACON |
|---|---|---|---|
| Description | The current system contains 12 satellites<br><br>6 LEOSAR and 6 GEOSAR | Currently in D&E Phase<br>17 MEOSAR satellites installed<br>72 satellites planned for 2020 | Currently in D&E Phase<br>72 satellites planned to be in orbit by 2020<br>2nd generation beacons available from 2018 -2019 |
| Numbers of satellites | 12 satellites | From end of 2014, 8 Galileo satellites will enable a new era of early MEOSAR service | With 72 new medium orbit satellites to be launched and operational from 2020 (28 of which will be Galileo satellites). This upgrade will offer a much better location accuracy and detection time |
| Beacon Localisation Performance | 406MHz Beacon without GPS (GNSS)<br>o Typical 5km radius precision<br>o 45min average detection time<br>406MHz Beacon with GPS (GNSS)<br>o +/- 60m radius (0.03 square mile area)<br>o New updates every 20 minutes<br>o Under 30 minutes to respond if within GEO footprint. | Determine independent beacon location within 5km, 95 percent of the time within 30 seconds of beacon activation<br><br>1km, 95 percent of the time within 5 minutes of beacon activation<br><br>100m, 95 percent of the time within 30 minutes of beacon activation | First burst transmission timeliness 3 seconds<br><br>Determine independent beacon location within 100m, 95 percent of the time within 5 minutes of beacon activation |
| Return Link Service | | | Return Link Service confirms to person in distress that their alert message was received and their location identified |
| Optional features of the 2nd generation of beacons | | | Cancellation of false alerts |

## About The McMurdo Group

With the acquisition of Techno-Sciences, Inc. (TSi), McMurdo Group becomes the world's first provider of a single vendor, end-to-end COSPAS-SARSAT ecosystem—from distress beacons to satellite ground station infrastructure to mission control and rescue coordination center software.

The McMurdo Group brings together 140 years of combined experience by consolidating proven search and rescue brands (McMurdo for maritime and personal distress beacons, Kannad for maritime and aviation beacons, Sarbe for military beacons, and TSI for COSPAS-SARSAT and MEOSAR infrastructure) into their comprehensive portfolio of products that save time, costs and lives. McMurdo Group also provides a number of Maritime Domain Awareness (MDA) solutions for fleet management, coastal surveillance and intrusion detection.

As a lead player in the COSPAS-SARSAT satellite aided search and rescue chain), McMurdo Group's vision to provide a single vendor, end-to-end, COSPAS- SARSAT ecosystem became a reality with the firm's acquisition of TSI. TSI completes the McMurdo Group SAR portfolio with product innovations, technological advancements and industry expertise from

COSPAS-SARSAT's inception to the most recent advances in MEOSAR, the nexgen COSPAS-SARSAT system.

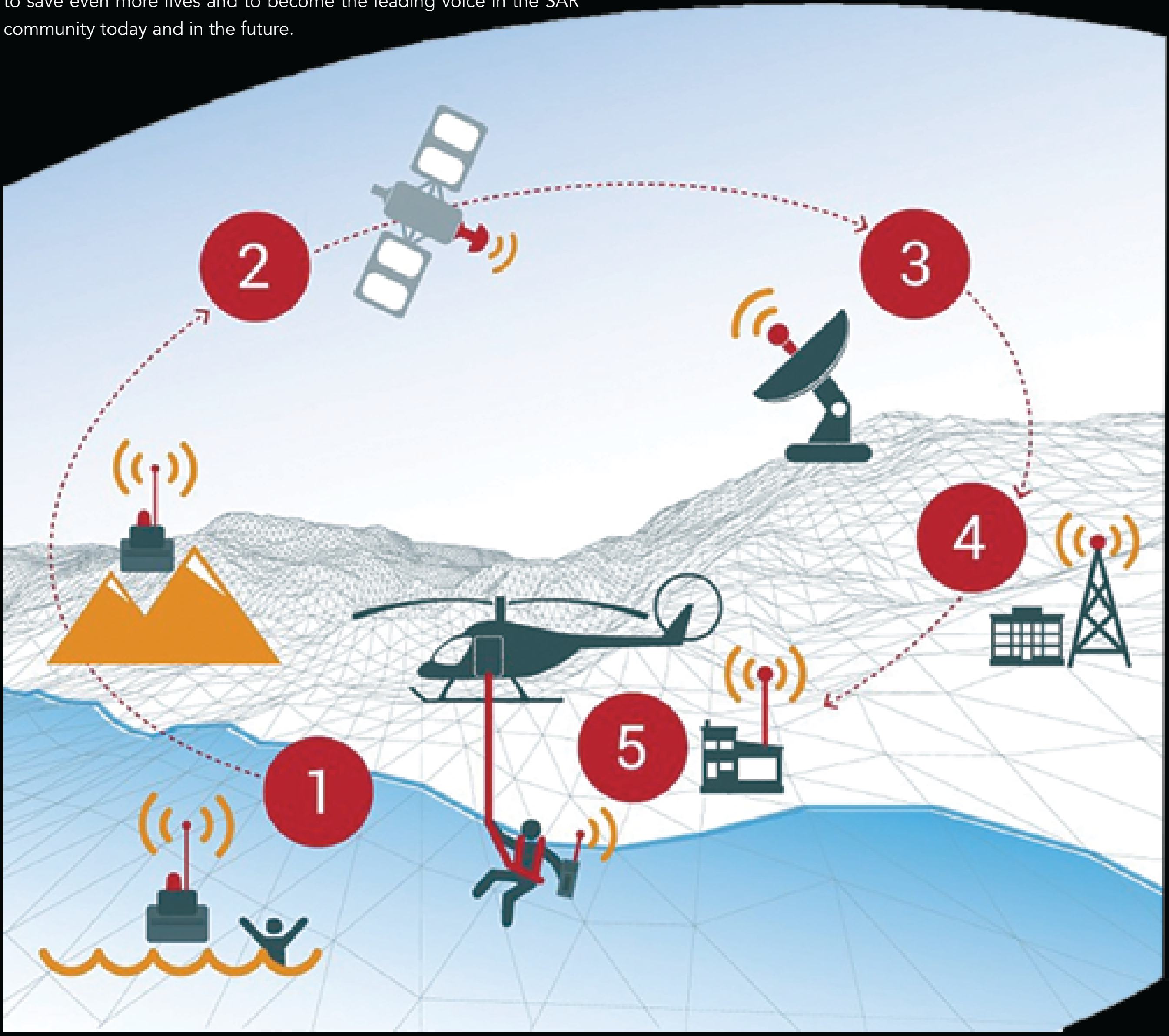
In an industry known for its diverse players (beacon manufacturers, satellite ground station developers, control center operators, rescue equipment providers, rescue teams, regulators and others), McMurdo Group brings leadership, expertise and stability to this fragmented industry.

McMurdo Group expects to speed introduction of innovative SAR solutions, drive education and standardization throughout the industry as well as create entirely new solutions that leverage joint partner development efforts.

As a key provider of MEOSAR infrastructure, the company is poised to save even more lives and to become the leading voice in the SAR community today and in the future.

McMurdo Group is a division of Orolia (NYSE Alternext Paris – FR0010501015– ALORO).

The McMurdo Group infosite offers more information at **http://www.mcmurdogroup.com**




*(1) When an emergency occurs, the 406MHz beacon is activated manually or automatically.*

*(2) The beacon's radio signal is relayed to the ground by a moving satellite within the constellation.*

*(3) One of the ground receiving stations.*

*(4) Will locate the emergency situation and relay this position to the closest control center which will in turn relay the information to the control centre with which the beacon has been pre registered.*

*(5) This control center will receive the alert and forward the information to the rescue coordination center that is closest to the emergency.*

# AFFORDABLE SPACE STRATEGIES

*By Wendy Lewis, Director of Communications, Space Systems/Loral (SSL)*

**As the strategies for the nexgen space mission area architectures are being discussed and developed, there are expectations that government and military teamwork with commercial satellite operators and manufacturers will enable more affordable and resilient solutions. Hosted payloads offer a cost-effective way to ensure a broad range of U.S. government capabilities are delivered into space. However, there are other means, as well, for the U.S. government to work with industry to build in the resilience that is derived from disaggregating important assets.**

Driven by budget cuts and fierce competition, the satellite industry is exploring a variety of ways to make "access to space" easier and more cost-effective for commercial and government missions. This article discusses some of the ways that U.S. government agencies are working with industry; and creative, non-traditional ways available today to meet next-generation requirements for national defense and space exploration.

## The Benefits Of Hosted Payloads

There are typically 20 to 23 commercial satellites launched to GEO annually. Each of these satellites has the potential to carry additional payloads. The benefits of hosted payloads have been discussed frequently over the last several years and much attention is given to reduced cost, shortened time to launch, and the opportunity to disaggregate important capabilities. However, an often overlooked benefit is the use of commercial ground systems.

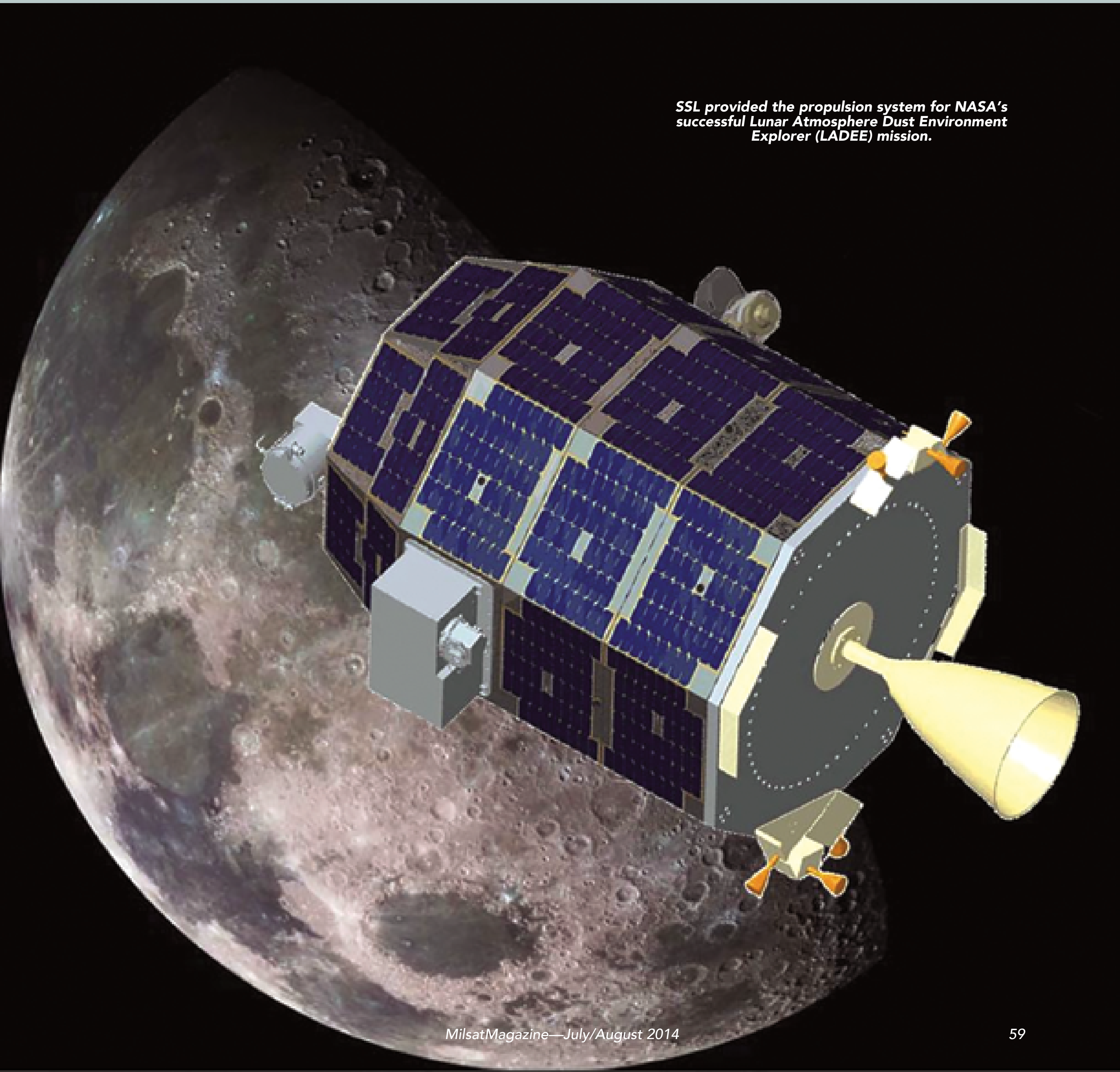

*The Payload Orbital Delivery (POD) system can dispense a small free-flying spacecraft from an SSL 1300 satellite.*

A primary issue relative to U.S. government satellite systems is the proprietary nature of the related ground infrastructure. These are known to be stove-piped systems, each with its own infrastructure and little or no compatibility between the systems. This makes data transport on the ground less resilient, more expensive to operate, and even more expensive to upgrade.

In the "*View From the Top*" panel at the 2014 Space Symposium in Colorado Springs, Eric Spittle, president of SSL Federal, pointed out that the commercial satellite industry provides a remarkably resilient, redundant and widely geographically dispersed array of gateways, teleports and connecting fiber networks that all use interoperable standards.

"One of the key benefits to hosting U.S. Government payloads on commercial satellites is the use of this ground infrastructure," he said. "This provides compatibility between systems, making data transport on the ground more resilient, less expensive to operate, and easier to upgrade."

With today's advanced encryption and data protection schemes, government missions can directly and securely leverage the abundant



***SSL provided the propulsion system for NASA's successful Lunar Atmosphere Dust Environment Explorer (LADEE) mission.***

commercial ground infrastructure for tactical missions. Such may well be that the use of commercial ground infrastructure is one of the substantial benefits hosted payloads brings to this environment.

## Non-Traditional Approaches To Nexgen Requirements

### *NASA Leading the Way*

SSL is encouraged by the trend of U.S. government agencies in their move to actively partner with industry to lower the cost of space missions in general. A good example is NASA's recently completed Lunar Atmosphere Dust Environment Explorer (LADEE) mission (*artistic rendition of LADEE is on the previous page*). NASA tapped SSL to provide a propulsion system, similar to the one used in its commercial satellites, for the moon orbiter. The mission was highly successful and the propulsion system performed flawlessly.

"SSL has been an important part of the team that created the LADEE spacecraft," said Butler Hine, LADEE Project Manager at NASA Ames Research Center. "The commercial experience that SSL brought to the team really enabled an innovative approach for LADEE."

In addition to its primary mission, which was to gather detailed information about the structure and composition of the thin lunar atmosphere, the LADEE spacecraft carried a Lunar Laser Communication Demonstration (LLCD) on board and set a record for transmitting data from the moon to Earth. The test demonstrated high data rate communications that have the potential to transform communications for deep space missions. This successful demonstration is a vital precursor to a more comprehensive and enduring demonstration that will also be facilitated by SSL.

NASA Goddard Space Flight Center has contracted with SSL to place a Laser Communications Relay Demonstration (LCRD), as a hosted payload, on its heritage 1300 communications satellite platform. Sponsored by NASA's Space Technology Mission Directorate and Human Exploration and Operations Mission Directorate, LCRD is a technology demonstration that combines commercial and government developments. By hosting the LCRD payload on a commercial communications satellite built by SSL, this demonstration will be an enduring test bed that helps transition optical communications technology into viable operation.

As the optical modules and ground stations for LCRD are being developed, SSL is working with its commercial customers to identify an appropriate host satellite for the demonstration. Laser communications technology is expected to provide next generation capability for NASA exploration missions and may also hold significant benefits for future commercial satellite communications.

Mike Weiss, who was the initial LCRD Project Manager at NASA's Goddard Space Flight Center, commented in a 2013 press release: "SSL's performance on the LCRD payload accommodation has met all of our accommodation criteria and exceeded all of our expectations. Companies with a commercial space focus, such as SSL, are helping NASA to reduce costs and maximize benefits while we continue to implement game-changing new technologies."

### *SMC Next Generation Architecture Studies*

Most government agencies are now looking at how to leverage the commercial industry to help reduce acquisition timelines and cost. SSL is one of several companies selected by the U.S. Air Force Space and Missile Systems Center (SMC) to develop affordable design concepts for nexgen Protected Military Satellite Communications (MILSATCOM). As a prime contractor leading several protected communications system and technology domain expert companies, SSL focused on providing proven solutions with shorter schedules and lower, better controlled cost, to defend against growing and changing intentional jamming and cyber threats and to deliver advanced communications capability to the warfighter.

For many years, commercial satellite operators and manufacturers have addressed changing requirements in mobile communications, broadband, and HD video broadcasting with highly competitive budget and schedule constraints. The SMC's future Protected MILSATCOM efforts are leveraging this experience to develop cost-effective solutions for secure SATCOM connectivity for highly mobile platforms such as remotely piloted aircrafts and ground command and control vehicles operating in contested environments.

The objective of the ongoing SMC program is to advance practical new architectures and technologies to protect increasingly contested and threatened warfighting communications. This year, there have been demonstrations of protected communications in Ka- and Ku-band over satellites built by SSL. This potential use of protected waveforms over commercial satellites could also have the benefit of unlocking the value of the integrated ground infrastructure previously discussed.

### *Affordable Access to Space*

Teaming with commercial satellite operators can provide a variety of innovative means to gain affordable access to space. Smaller payloads can be attached to commercial satellites, sharing a variety of subsystems, as in the traditional hosted payload configuration.

As an alternative, smaller payloads can travel to orbit with a commercial satellite and then be released into space as free flyers. Another option for vastly reducing the cost of getting to space is for a government spacecraft to share a launch vehicle with a commercial satellite in a dual launch configuration on a single launch vehicle.

### *Dispensed Payloads*

SSL is one of the companies working with the U.S. Defense Advanced Research Projects Agency (DARPA) to design and implement a system that will accommodate what DARPA calls the Payload Orbital Delivery (POD) system. This system enables affordable delivery of small, free-flying spacecraft beyond Low Earth Orbit (LEO) by releasing them from a commercial spacecraft, such as the SSL 1300, while in geo-transfer orbit, or after the satellite has reached its final orbital location. This capability can be leveraged for any type of small operational mission such as servicing or science and technology space missions.

*SSL built SES-5 included a hosted payload for the European Commission.*

POD systems could become an important capability for accomplishing missions in a cost-effective way, enabling refueling, on-orbit assembly, inspection, repair or debris mitigation. The expectation is that these capabilities are likely to enable new kinds of missions that aren't currently thought possible to employ. SSL has sophisticated robotics capability as well as concepts for line replaceable units that will increase the value of future spacecraft and enable valuable assets to be updated in keeping with the rapidly changing technologies that are seen in the terrestrial world.

***Dual Launch***

Another way the cost of access to space can be reduced is by launching two satellites on a single launch vehicle. All electric satellites reduce mass sufficiently to enable dual launch on U.S.-built launch vehicles. SSL's electric, orbit-raising solution is based on one of the industry's highest thrust, highest reliability propulsion systems. The company began developing its electric propulsion technology more than 20 years ago and SSL's first satellite with electric propulsion was launched in 2004.

SSL has an outstanding track record—14 satellites with electric propulsion are currently on orbit with roughly 35,000 hours of successful, on-orbit operation. The SSL all-electric platform is based on the nexgen of this proven thruster. The satellite design has the advantage of enabling dual launch on nearly every launch vehicle, including the Ariane 5, Atlas V, Falcon 9, H-IIA and H-IIB, and the ILS Proton. The platform also has the flexibility to be launched in a single launch configuration.

***LEO Constellations***

For agencies thinking about low-cost constellations that can be regularly refreshed with evolving technologies, there are a number of innovative LEO platforms being developed. In February 2014, SSL was awarded a contract by Skybox Imaging to build an advanced constellation of 13, small, Low Earth Orbit (LEO) satellites for Earth imaging.

This partnership with Skybox gives SSL an exclusive license to the satellite design, which can support a broad range of missions and payloads for commercial and government customers. The satellites are approximately 60 x 60 x 95 centimeters and weigh roughly 120 kilograms and will capture sub-meter color imagery and up to 90-second clips of HD video with 30 frames per second. SSL was delighted to demonstrate that the company could competitively build and deliver low cost, LEOs.

While maintaining its focus on commercial GEO communications satellites and traditional hosted payloads, SSL continues to develop new and untapped technologies that will enable the future space infrastructures. With 74 SSL-built satellites in the GEO belt, and a backlog of 22 GEO satellites in the manufacturing facility, SSL provides a highly effective backbone of commercial satellite infrastructure. The company is uniquely positioned to assist the U.S. government leverage regular access to space as a critical component of the nexgen space mission area architectures.

Hosted payloads, dispensed payloads, dual launches and low-cost LEOs comprise just a few of the new approaches for government agencies to benefit from partnering with commercial satellite manufacturers and telecom operator, all with two goals in mind—minimize cost yet maximize the use of commercially developed innovation for nexgen spatial systems.

***About the author***

*Wendy Lewis is Director of Communications for SSL, a full-service provider of satellites and space systems and the world leader in commercial communications satellites. She is responsible for all of the company's external communications and public affairs.*

*Wendy has worked in the satellite industry since 2006 when she joined SSL and previously worked at a Silicon Valley public relations agency where she supported a broad range of high tech companies. She is an active member of the Hosted Payload Alliance communications committee and also manages investor relations for Loral Space & Communications.*