SATCOM For Net-Centric Warfare September 2015

# MilsatMagazine

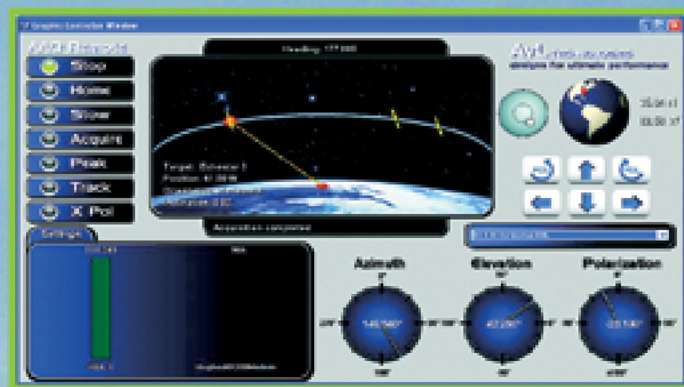

## ORIGINS:
## The National Geospatial Intelligency Agency

Additional $$$ To Russia For Space Access?
Heyman On Spatial Battlegrounds: ASATS
HPA Corner
Intelsat General
NSR On MilSmallSats
A Future For Army Nanos?

# The industry's best performing antennas just got BETTER.

**Introducing AvL's new AAQ Auto-Acquire Antenna Controller:**

- All leading industry capabilities including auto-acquire and jog control
- Ethernet-based access - wired or wireless with optional handheld remote
- User-friendly system interface tools for configuration, operation & diagnostics
- Web-based GUI for remote access or GUI software installable on customer laptop
- Configurable feed frequency profiles for single or multi-band feed systems
- Optional step tracking & program tracking





AvL TECHNOLOGIES

www.avltech.com

30 YEARS
Newtec
CONNECTING PEOPLE
MEET NEWTEC DIALOG
THE PLATFORM THAT
EMBRACES CHANGE
Newtec Dialog allows you to adapt your infrastructure easily as your business changes.
THAT'S FLEXIBILITY
Newtec Dialog offers you a platform to build your business to the size you need it.
THAT'S SCALABILITY
Newtec Dialog enables the most optimal modulation and bandwidth allocation.
THAT'S EFFICIENCY
WTA TECHNOLOGY OF THE YEAR AWARD 2015
SUPPORTED GOVDEF APPLICATIONS
AIRBORNE ISR
DISASTER RECOVERY
GOVERNMENT NETWORKS
BORDER SURVEILLANCE
ISR / SIGINT / COMINT
MWR
www.newtec.eu
Follow Newtec Satcom on
Newtec
Dialog®

# MilsatMagazine

September 2015

## PUBLISHING OPERATIONS

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

## SENIOR CONTRIBUTORS

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

## AUTHORS

*Carolyn Belle*
*Jason B. Cutshaw*
*Jos Heyman*
*Rebecca M. Cowen-Hirsch*
*Elliot H. Pulham*
*Kay Sears*
*Garr R. Stephenson Jr.*
*David Thompson*
*Dr. Gary E. Weir*

## DISPATCHES + FEATURES



## ADVERTISER INDEX



*MilsatMagazine is published 11 times a year by SatNews Publishers, 800 Siesta Way, Sonoma, CA, 95476, USA, Phone: (707) 939-9306, Fax: (707) 939-9235 — © 2015 Satnews Publishers*

Advantech Wireless | SMARTER SOLUTIONS, GLOBAL REACH.

# GOVERNMENT & MILITARY SOLUTIONS

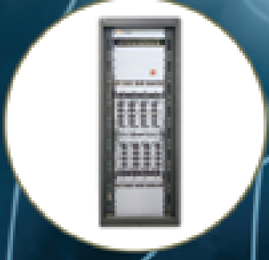
## EMPOWERING FASTER & MORE SECURE COMMUNICATIONS FOR MILITARY & GOVERNMENT LEADERS

**WGS CERTIFIED**

At Advantech Wireless, we have over 25 years of experience empowering military special forces and government agencies, delivering cutting-edge innovations in communications that solve mission critical communications challenges.
We understand the challenges that government & military forces face and our technologies empower them with the freedom to communicate beyond line of sight quickly, reliably and securely. We provide diverse and extensive technologies with proven flexibility to deliver video, voice, data as well as operational mission critical data transmitted to troops on the move anywhere and at any time.

Multi Services VSAT Solution

Second Generation GaN based SSPAs



TROPOSCATTER Modular Solid State GaN Power Amplifiers

- MODERN RADAR APPLICATIONS •
- SATCOM ON THE MOVE (SOTM) •
- SECURE TROPOSCATTER LINKS •
- ADVANCED SATCOM •
- MANPACK • UAV •

**Higher Power and Higher Traffic Rates for Mission Critical Operations**

sales@advantechwireless.com

www.advantechwireless.com/gov

## Multiples Of MUOS — ULA Launches Number Four For U.S.A.F.

**The U.S. Navy's fourth Mobile User Objective System (MUOS-4) satellite, built by Lockheed Martin, continues to successfully talk from orbit to the satellite control team at the Naval Spacecraft Operations Control facility after a successful Florida launch on the morning of September 2nd—MUOS-4 will enable near-global coverage for a new secure military communications network offering enhanced capabilities for mobile forces.**

The MUOS-4 satellite launched at 6:18 a.m. EDT on September 2nd aboard a United Launch Alliance Atlas V rocket from Cape Canaveral Air Force Station, Florida.

A Lockheed Martin-led initialization team, stationed at Naval Base Ventura County, Point Mugu, California, is operating the satellite from its transfer orbit to the spacecraft's test slot.

The Navy's Program Executive Office for Space Systems and the Communications Satellite Program Office that are responsible for the MUOS program are based in San Diego.

Lockheed Martin assembled and tested MUOS-4 at its Sunnyvale, California facility.

MUOS-4 is the latest addition to a network of orbiting satellites and relay ground stations that is revolutionizing secure communications for mobile military forces.

Users with operational MUOS terminals can seamlessly connect beyond line-of-sight around the globe and into the Global Information Grid (GIG).

MUOS' new smart phone-like capabilities include simultaneous, crystal-clear voice, video and mission data, over a high-speed Internet Protocol-based system.

The addition of MUOS-4 completes the initial constellation and provides the MUOS network with near-global coverage, extending the reach of communications further toward the North and South poles than ever before experienced.

The MUOS-4 satellite separated from its Atlas V rocket approximately three hours after its successful launch.


*An Atlas V rocket carrying the MUOS-4 mission lifts off from Space Launch Complex 41. The MUOS-4 spacecraft will bring advanced, new, global communications capabilities to mobile military forces, as well as ensure continued mission capability of the existing ultra high frequency satellite communications system. Photo is courtesy of United Launch Alliance.*

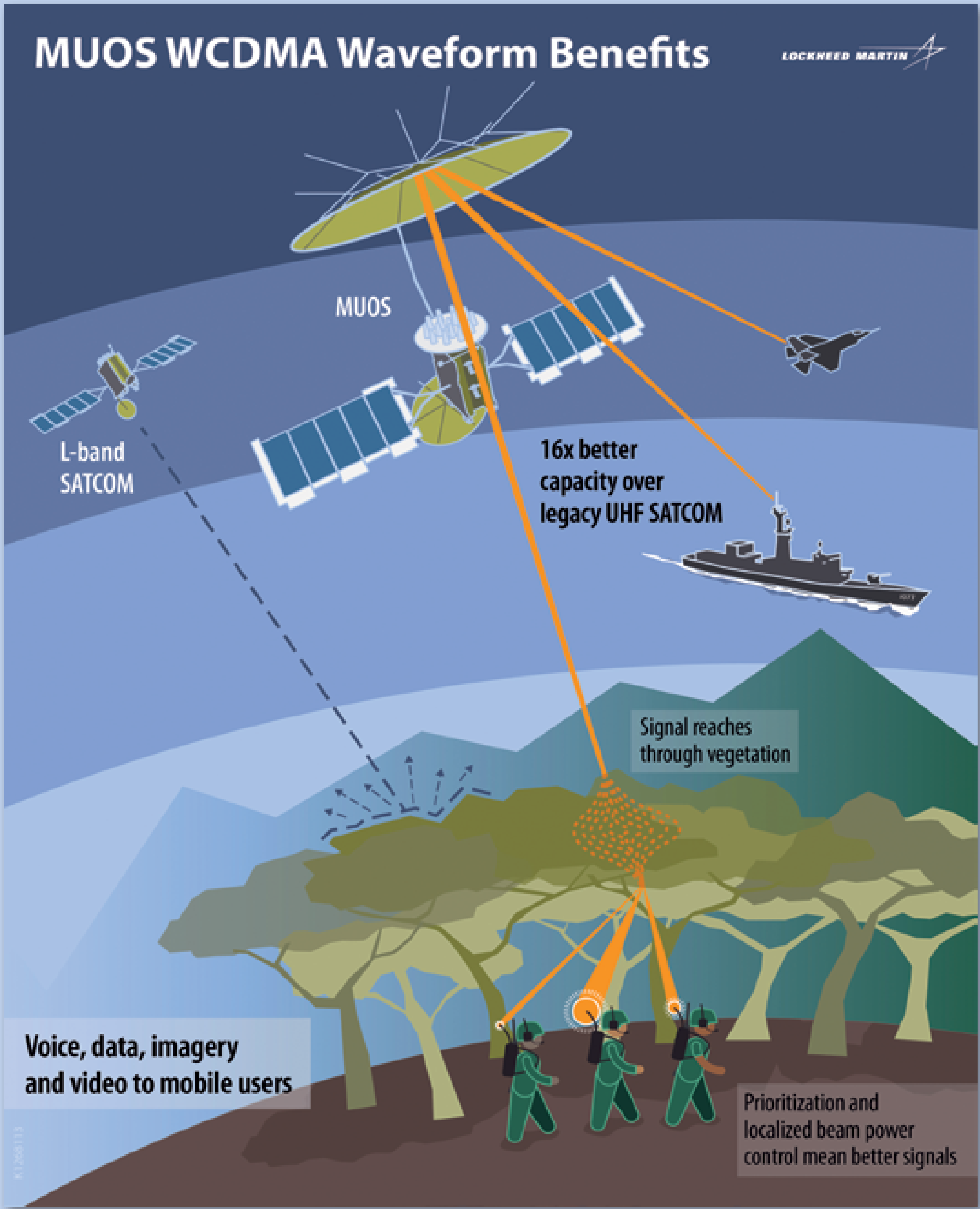
MUOS-4 transitioned to reach geosynchronous orbit location approximately 22,000 miles (37,586 km) above the Earth.

The satellite's solar arrays and antennas were then deployed, and on-orbit testing was initiated for a subsequent turn-over to the Navy for test and commissioning to service.

Last June, Lockheed Martin completed and shipped the MUOS-4 satellite from Moffet Federal Airfield, California, where the 60th Air Mobility Wing of Travis Air Force Base loaded the satellite aboard a C-5 Galaxy aircraft for delivery to the Cape.

*MUOS-4 being loaded for shipment. Photo is courtesy of Lockheed Martin.*

*The delivery of MUOS-4. Photo is courtesy of Lockheed Martin.*




*MUOS WCDMA Waveform Benefits infographic is courtesy of Lockheed Martin.*

*A distant view of the MUOS-4 launch.*
*Photo is courtesy of United Launch Alliance.*

After arrival at Canaveral, Astrotech Space Operations, a wholly-owned subsidiary of Lockheed Martin, completed MUOS-4's pre-launch processing. In August, technicians encapsulated the satellite in its protective launch fairing.

*MUOS-4, the next satellite scheduled to join the US Navy's Mobile User Objective System (MUOS) secure communications network, has been encapsulated in its protective launch vehicle fairing for its launch from Cape Canaveral Air Force Station.*
*Photo is courtesy of United Launch Alliance.*

The MUOS-4 satellite joins a network that already includes MUOS-1, MUOS-2 and MUOS-3, launched respectively in 2012, 2013 and January 2015, and four required MUOS ground stations already completed. This satellite addition now completes the initial constellation and provides the MUOS network with near-global coverage, extending the reach of communications further toward the North and South poles than ever before.

The MUOS-4 satellite successfully separated from its Atlas V rocket approximately three hours after the launch. MUOS-4 then transitioned to reach its geosynchronous orbit location approximately 22,000 miles (37,586 km) above the Earth.

The satellite's solar arrays and antennas were deployed and on orbit testing began for subsequent turnover to the Navy where additional testing and commissioning to service will occur.

Once fully operational, the MUOS network will provide, comparatively, 16 times the capacity of the legacy ultra high frequency communications satellite system, which it will continue to support, and eventually replace.

More than 55,000 currently fielded radio terminals can be upgraded to be MUOS-compatible, with many of them requiring just a software upgrade.

The MUOS network is expected to be fully operational by year's end. All four required MUOS ground stations have been completed.

***Executive Comment***

"MUOS allows troops all over the world to talk, text and share mission data seamlessly, while traveling—like a cellular network, without having to worry about where they are in relation to a satellite," said Iris Bombelyn, Lockheed Martin's vice president for narrowband communications. "MUOS-4 will complete our near global coverage, reaching further north and south toward the poles than ever before."

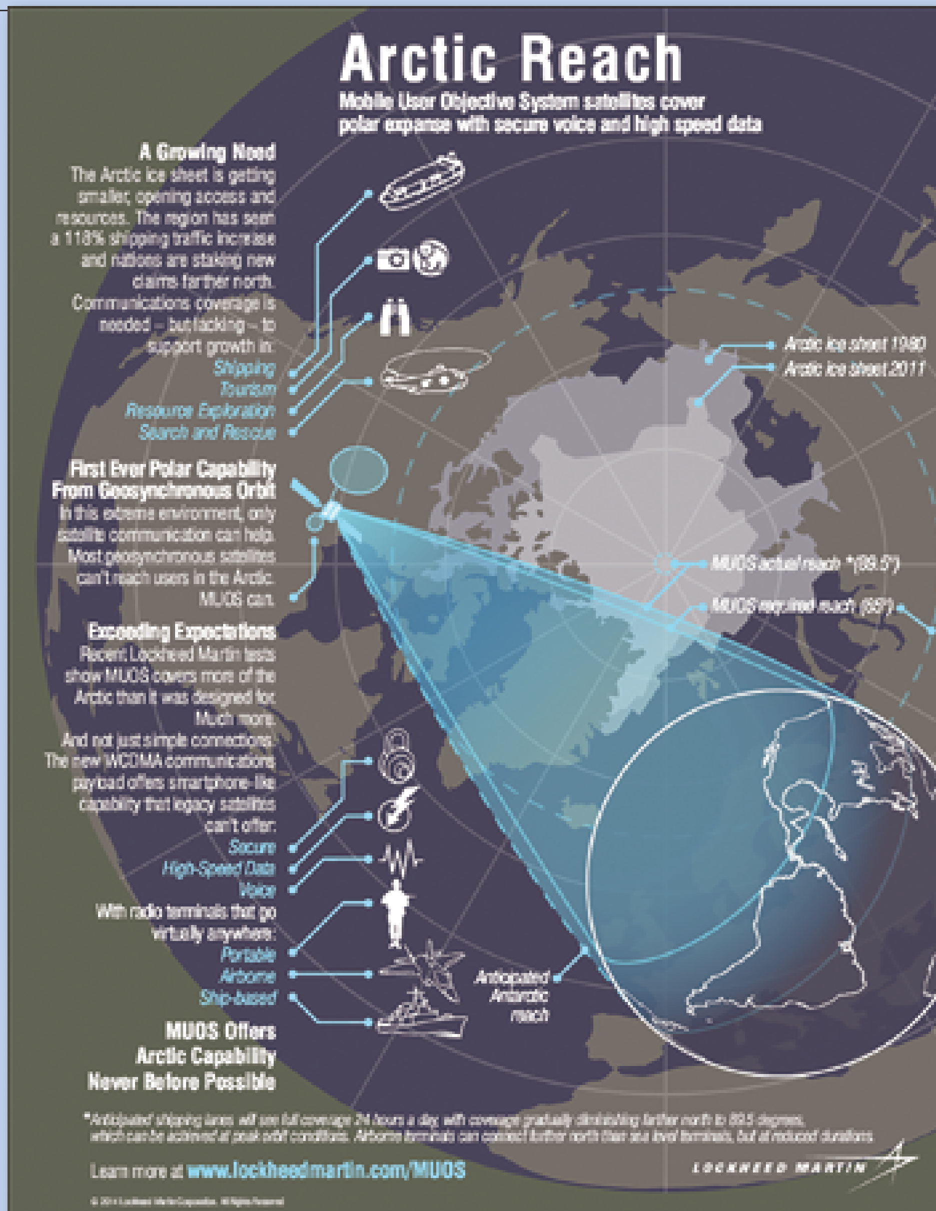
Bombelyn added, "The most dangerous part of a satellite's life is launch and getting into orbit. I really want to thank our entire team whose hard work prepared MUOS-4 for this mission-critical event and the Atlas team who ultimately carried us safely to our transfer orbit. We look forward to completing our on orbit health checks and delivering this important asset to the US Navy and these new capabilities to our mobile forces."

***The MUOS Reach Into The Arctic***

Earlier this year, Lockheed Martin demonstrated that the MUOS satellites could help to solve communication challenges in the Arctic. Access to more secure and reliable communications could be incorporated for people who are spread out over thousands of square miles.

Earlier this year, during company-funded tests, MUOS voice and data signals reached much farther north than previously thought could be achieved, just 30 miles and 0.5 degrees of latitude shy of the North Pole.

A team demonstrated Wideband Code Division Multiple Access (WCDMA) capability using three different radios as far north as 89.5 degrees, under peak orbit conditions. This inherent voice and data access is well beyond the 65-degree system requirement.




The additional coverage comes at a time when demand is surging for dependable polar communications.

"As the Arctic becomes more accessible, the US and its allies need reliable communications to maintain a safe and secure presence," said Paul Scearce, director of Military Space Advanced Programs at Lockheed Martin.

"Demand for consistent voice and data services will only increase. The area is experiencing more shipping, tourism and natural resource exploration, which will also likely increase demands for search and rescue."

The demonstrations show MUOS has an advantage over legacy satellite communications.

"This joint testing gave us important system operation data at extreme conditions," said Dr. Amy Sun, Narrowband Advanced Programs lead at Lockheed Martin.

"We did these evaluations to explore growing Arctic communication demand, yet it also highlighted the dramatic capability improvements the WCDMA architecture will provide. Using MUOS, we were able communicate from the aircraft at high latitudes, which wasn't the case for the legacy Ultra High Frequency signal."

Lockheed Martin performed two rounds of testing in 2014 aboard an L-100 aircraft, the commercial variant of the C-130 Hercules.

Multi-hour flights set out from Barrow, Alaska, to test transmit and receive capabilities.

Three terminal providers developing MUOS-compatible radios were on board—the General Dynamics PRC-155 Manpack, the Harris PRC-117G Manpack and the Rockwell Collins ARC-210 V5 airborne terminal.

Anticipated shipping lanes will see full coverage 24 hours a day, with the signal gradually dropping off farther north to 89.5 degrees, which can be achieved at peak orbit conditions.

Airborne terminals can connect further north than sea level terminals, but at reduced durations.

Analysis of Mobile User Objective System (MUOS) satellites during the US Navy's 2014 Ice Exercise (ICEX) showed they provided nearly 150 hours of secure data connections.

This was the first time military users could transfer large megabyte data files over stable satellite connections in the Arctic.

Working atop a floating ice camp above the Arctic Circle, the team from Lockheed Martin provided secure satellite communications and delivered further evidence that MUOS is, indeed, a reliable asset in the far north.

"Last year we proved the constellation's reach, but this is the first time MUOS has been used for secure government exercises," said Paul Scearce, director of Military Space Advanced Programs at Lockheed Martin.

"This means users could traverse the globe using one radio, without needing to switch out because of different coverage areas. This goes far in increasing the value that MUOS provides mobile users, not just in traditional theaters of operation, but those at the furthest extents of the planet," Scearce added.

Lockheed Martin first demonstrated the MUOS constellation's ability to reach Arctic users in tests during 2013. Those tests marked a significant gain in signal reach from the required latitude of 65 degrees north—roughly Fairbanks, Alaska. This expansion in coverage, inherent with the system, comes at a time when governments are focusing on Arctic security.

"We downloaded multiple files—up to 20 megabytes, nearly at the top of the world," said Dr. Amy Sun, Narrowband Advanced Programs lead at Lockheed Martin.

"We sent a steady stream of photos, maps and other large data pieces securely through the system, something that could never be done by legacy communication satellites."

From March 17 to 27, MUOS provided more than 8,800 minutes of service to Ice Camp Nautilus. US Navy users at the camp could connect to both secure and classified communication systems and send data files. US and Canadian officials monitored the activities as part of ICEX, an annual Arctic submarine exercise.

*MUOS satellites provided reliable high-speed data connections to the Arctic for the first time during the US Navy's Ice Experiments (ICEX). Over ten days, MUOS provided nearly 150 hours of service to Ice Camp NAUTILUS, the headquarters for the exercise.*
*Photo is courtesy of the US Navy.*

***The MUOS-STEM Connection***

Just a few miles down the road from the MUOS-4 launch site is the Ronald McNair Magnet School, where nearly 500 seventh and eighth grade students engaged in an engineering design challenge of their own in connection with this launch.

Guided by about 60 Lockheed Martin and United Launch Alliance (ULA) volunteers—some from the Military Space team responsible for MUOS-4 and others as part of a Launch Experience Award Program—the entire middle school worked together to test theories and problem solve to create a solution within their constraints.

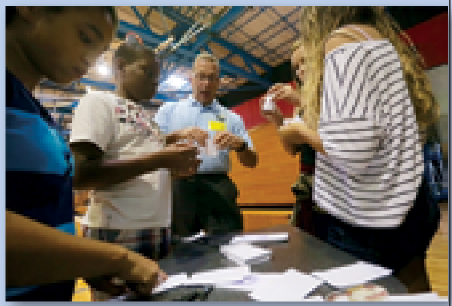
The students needed to build a structure 60 centimeters (almost two feet) tall that supports a bag of food for the school's canned food drive, using nothing but index cards and cellophane tape, in about 20 minutes.

As they created their designs, students kept cost in mind as each index card represented $1,000 and each centimeter of tape represented $100.

The teams that built the strongest structures using the least amount of materials were the challenge winners. This familiar balance between effective design and cost is something that rings true with any professional engineer. The challenge tested the students' ingenuity, versatility and ability to perform under both time and cost constraints—all of which are key to succeeding in any career in science, technology, engineering and mathematics (STEM).

US Navy Cmdr. Paul Benishek, said, "America's strength—the Navy's strength—has always been its ability to marshal brainpower and creativity. Our nation's future success depends on programs like STEM because it helps inspire and encourage young minds to bring together their ideas and create beneficial solutions that will help address the challenges that lie ahead."

Mark Valerio, vice president and general manager of Lockheed Martin's Military Space line of business, also stressed the importance of the STEM activity following the launch. "When you see something like a launch that's larger than life, it can be a challenge to connect it to something visible in everyday life. With these STEM events, we're showing students the smaller building blocks that are vital to the technology pipeline that feeds our ongoing journey to space."



*Mark Valerio, Vice President + General Manager of Lockheed Martin's Military Space line of business, joins in as a team builds their structure.*
*Photo is courtesy of Lockheed Martin.*

Lockheed Martin Space Systems is committed to working with schools and educators to expose students to the industry and foster interest in careers in STEM fields through its "Launch and Learn" program. Through STEM activities closely tied to launches, teachers and students can strengthen their content knowledge, thereby improving the learning experience in the classroom.

***The US Navy's MUOS-4 Release***
*By Steven A. Davis, Space and Naval Warfare Systems Command Public Affairs*


**After a two-day delay due to tropical storm conditions, the Navy's fourth Mobile User Objective System (MUOS) satellite launched at 6:18 a.m. EDT from Space Launch Complex 41.**

MUOS-4, whose signal was acquired approximately three hours after launch, completes the initial operational constellation and provides near global network coverage for warfighters and combatant commanders.

This array allows mobile forces, including submarines, surface ships and aircraft, to communicate around the world via the narrowband spectrum.

User communities that will primarily benefit include ground forces at the individual soldier level but also include members of all services and special forces.

"The legacy satellite communication system allowed users to 'talk' as long as they were within the same satellite footprint," said Navy Captain Joe Kan, program manager for the Communications Satellite Program Office. "MUOS allows troops all over the world to talk, text and share mission data seamlessly without having to worry about where they are in relation to a satellite."

The program office falls under the Navy's Program Executive Office for Space Systems, which has responsibility for the MUOS program and is located at the Space and Naval Warfare Systems Command in San Diego, California.

The Internet Protocol-based nature of MUOS allows network access to classified and unclassified networks. This network access for deployed tactical users will allow the exchange of critical situation awareness and targeting information.

"With the launch of MUOS-4 we're going to deliver that worldwide coverage and communication service for users," explained Nina Tran, the program office's space division director. "The legacy payload we have on MUOS satellites allows a smooth transition to a newer, better MUOS capability. We are benefitting from providing the legacy channels for current users and we are exploring all the capability that MUOS has to offer."

MUOS is an architecture comprised of a five-satellite constellation—a fifth on orbit spare to be launched in 2016—four ground stations across the globe, complex software to manage the network and an integrated waveform for use with user radios.

According to the program office's technical director, Jim Parsons, it's the system's flexible design that allows rapid insertion of technology to keep the system up-to-speed.

"The nice thing about MUOS is that the ground system and terminals contain all the switching and routing technology," Parsons said. "The satellite remains unchanged over time and can allow technology insertion into the ground stations and the waveform over time to increase capability without having to make any satellite changes."

Commander Pete Sheehy, principal assistant program manager, explained that 24/7, beyond-line-of-sight communications will greatly benefit ground forces needing aviation support.

"With MUOS, the population of disadvantaged users is going to shrink considerably," Sheehy said. "And that new population of folks who have beyond-line-of-sight communication are going to be able to do their jobs more efficiently and safely. It could be as simple as that one person who otherwise might not have had beyond-line-of-sight comms being able to say 'This is where I am. This is who I am and I need help.' And know that someone is on the other side to be able to provide that support."

MUOS is already providing legacy communications to combatant commanders via active satellites on-orbit. MUOS' advanced capability—Wideband Code Division Multiple Access—has been demonstrated in various environments, platforms and applications such as integration testing with the newest submarine antennas, Navy special operations scenario exercises and Air Force C-17 in-flight tests.

"In our testing we've tried to be as realistic as possible," said Jarratt Mowery, director of end-to-end system testing. "In several events we've brought uniformed warfighters in and given them training on the MUOS system and operating its components. They were able to define the types of operations they would like to use with the system and allowed them to exercise those operations in a realistic environment. Be that in vehicles driving around, in a forest with a thick canopy or even in airborne platforms."

An added benefit beyond the system's initial requirements is extending communications further north and south toward the polar regions. This polar coverage, up to approximately 85 degrees in the Arctic under peak conditions, is significant considering that wireless and satellite communications has always been a struggle at extreme north and south latitudes.

Two MUOS satellites, launched in 2012 and 2013, are already providing legacy communications capability from their geosynchronous orbits over the Pacific Ocean and the United States.

MUOS-3, launched in January of this year, was accepted by the Navy in June after on orbit testing. The third satellite is awaiting final testing before being accepted for operational use.

Ultimately, the constellation and associated network will extend narrowband communications availability well past 2025.

The Navy's Program Executive Office for Space Systems, located at the Space and Naval Warfare Systems Command in San Diego, is responsible for the MUOS program.

Space and Naval Warfare Systems Command
***www.navy.mil/local/spawar/***

*The Orbital ATK Role*

**Orbital ATK, Inc. provided critical hardware for the September 2nd United Launch Alliance Atlas V launch from Cape Canaveral Air Force Station, Florida. The company contributed products on the fourth satellite in the US Navy's Mobile User Objective System (MUOS), designated MUOS-4, and the United Launch Alliance (ULA) Atlas V launch vehicle.**

Using advanced fiber placement manufacturing and automated inspection techniques, Orbital ATK produced three components for the ULA Atlas V vehicle, including the 10-foot diameter composite heat shield that provides essential protection to the first stage engine, the Centaur Interstage Adapter (CISA) that houses the second stage engine and the boattail that adapts from the core vehicle to the five-meter diameter fairing.

The structures were fabricated by Orbital ATK at its Iuka, Mississippi, facility. This is the 56th Atlas V launch using Orbital ATK-built composite structures.

The ULA Atlas V rocket flew in the 551 vehicle configuration with a five-meter fairing, five solid rocket boosters and a single-engine Centaur upper stage.

Orbital ATK manufactured the Reaction Control System propellant tank for the ULA Atlas V at its Commerce, California facility.

This flight marked the 21st successful flight of the Orbital ATK retro motors. Eight of these solid motors provided thrust for separation of the spent first stage. The ULA Atlas V retrorocket is built at Orbital ATK's Elkton, Maryland, facility.

For the MUOS-4 satellite, Orbital ATK provided multiple components and structures from the following company locations: San Diego, Goleta and Commerce, California; Magna, Utah; and Beltsville, Maryland.

The MUOS-4 is the fourth satellite in the Navy's planned five-satellite MUOS constellation. Once the constellation is complete, MUOS satellites will provide a 16x increase in number of accesses over the current Ultra High Frequency (UHF) satellite system requirement.

MUOS-1, MUOS-2 and MUOS-3 launched respectively in 2012, 2013 and January 2015, and are already providing high-quality voice communications. MUOS-5 is expected to launch in 2016.

*Executive Comment*

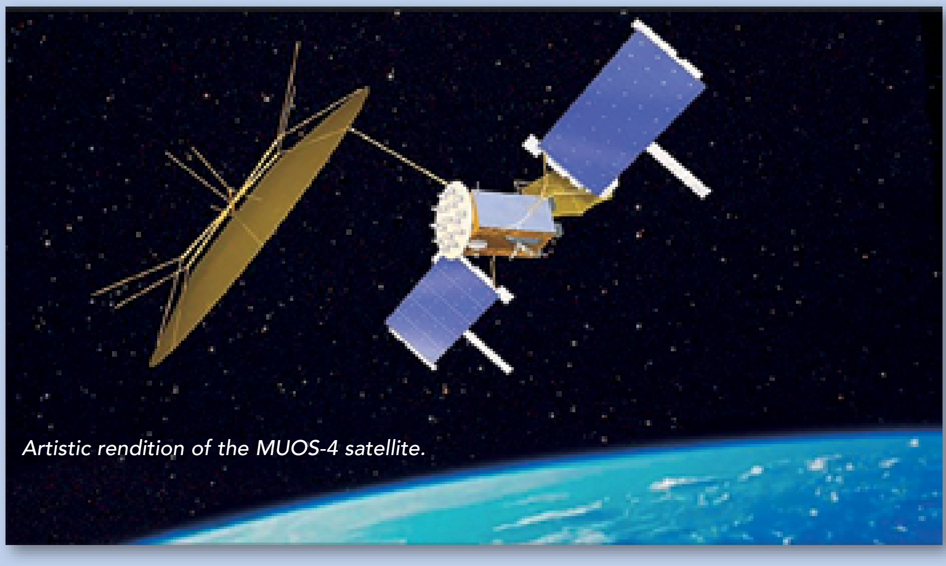
"It was great to see another successful ULA Atlas V launch that flew Orbital ATK-produced structures and components for both the launch vehicle and satellite," said Scott Lehr, President of Orbital ATK's Flight Systems Group. "Once again, this is a really good example of the breadth of our product line and the critical role we play in almost every EELV launch."

## Orbital ATK's Crucial Hardware Assets For The MUOS-4's Launch

**Orbital ATK, Inc. provided critical hardware for the September 2nd United Launch Alliance Atlas V launch from Cape Canaveral Air Force Station, Florida—the company contributed products on the fourth satellite in the US Navy's Mobile User Objective System (MUOS), designated MUOS-4, and the United Launch Alliance (ULA) Atlas V launch vehicle.**

This flight marked the 21st successful flight of the Orbital ATK retro motors. Eight of these solid motors provided thrust for separation of the spent first stage. The ULA Atlas V retrorocket is built at Orbital ATK's Elkton, Maryland, facility.

For the MUOS-4 satellite, Orbital ATK provided multiple components and structures from the following company locations:



*Artistic rendition of the MUOS-4 satellite.*

San Diego, Goleta and Commerce, California; Magna, Utah; and Beltsville, Maryland.

MUOS is the next generation in narrowband tactical satellite communications systems. The MUOS constellation, for which Lockheed Martin Space Systems is the prime contractor, will provide mobile warfighters with significantly improved and secure communications.

Using advanced fiber placement manufacturing and automated inspection techniques, Orbital ATK produced three components for the ULA Atlas V vehicle, including the 10-foot diameter composite heat shield that provides essential protection to the first stage engine, the Centaur Interstage Adapter (CISA) that houses the second stage engine and the boattail that adapts from the core vehicle to the five-meter diameter fairing. The structures were fabricated by Orbital ATK at its Iuka, Mississippi, facility. This is the 56th Atlas V launch using Orbital ATK-built composite structures.

The ULA Atlas V rocket flew in the 551 vehicle configuration with a five-meter fairing, five solid rocket boosters and a single-engine Centaur upper stage. Orbital ATK manufactured the Reaction Control System propellant tank for the ULA Atlas V at its Commerce, California, facility.

The MUOS-4 is the fourth satellite in the Navy's planned five-satellite MUOS constellation. Once the constellation is complete, MUOS satellites will provide a 16x increase in number of accesses over the current Ultra High Frequency (UHF) satellite system requirement. MUOS-1, MUOS-2 and MUOS-3 launched respectively in 2012, 2013 and January 2015, and are already providing high-quality voice communications. MUOS-5 is expected to launch in 2016.

"It was great to see another successful ULA Atlas V launch that flew Orbital ATK-produced structures and components for both the launch vehicle and satellite," said Scott Lehr, President of Orbital ATK's Flight Systems Group. "Once again, this is a really good example of the breadth of our product line and the critical role we play in almost every EELV launch."

***www.orbitalatk.com/***

## ND SatCom's Partner Program

**ND SatCom announces the official launch of its Partner Program for integrating its new SKYWAN 5G product as the key element in VSAT terminal solutions by selected partners.**

Introduced in June this year, the highly anticipated SKYWAN 5G VSAT modem is now available with full capabilities for integration in all types of partner solutions.

SKYWAN 5G is flexible, scalable and reliable. The hardware design of this all-in-one compact unit provides full functionality on board. Whether a star, multi-star, hybrid or full mesh network is needed, SKYWAN 5G fits all topologies and supports switching to another topology over time.

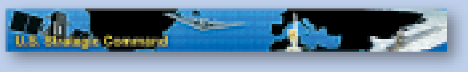
SKYWAN 5G also plays any network role such as hub or remote, thereby simplifying logistics and customs' handling, and enables unprecedented scalability as demand for network growth increases.

Additionally, SKYWAN 5G can be, with this new partner program, reliably integrated in Manpaks, Fly-Aways or any other VSAT solution.

SKYWAN 5G includes an MF-TDMA modem and is capable of achieving significant data rates. Designed as an all-in-one device with high network redundancy and a wide range of IP support, SKYWAN 5G allows data to be transmitted in a single hop directly from their origin to their destination, thereby avoiding double hops and extra delays. Bandwidth is dynamically allocated as required, generating savings in satellite capacity cost.

***www.ndsatcom.com/***

## DoD Initiates Combined Space Ops Center @ Vandenberg AFB—JICSpOC




**The Department of Defense announces the agency will establish a Joint Interagency Combined Space Operations Center (JICSpOC), in conjunction with U.S. Strategic Command, Air Force Space Command, and the intelligence community.**

The center, to be located at Schriever Air Force Base in Colorado Springs, Colorado, will create unity of effort and facilitate information sharing across the national security space enterprise. The new JICSpOC will improve processes and procedures, ensuring data fusion among DoD, intelligence community, interagency, allied and commercial space entities.

The JICSpOC will have embedded capabilities that enable it to provide backup to the Joint Space Operations Center (JSpOC), located at Vanderberg Air Force Base, California, but is not intended as a replacement for the JSpOC. The JICSpOC will be located within existing facilities on Schriever AFB. Military construction funding is not required.

The center will have the capability to develop, test, validate and integrate new space system tactics, techniques and procedures in support of both DoD and Intelligence Community space operations.

The increasing threats to space capabilities necessitates better operational integration of these two space communities, as well as civil, commercial, allied and international partners. The JICSpOC experimentation and test effort will boost the ability to detect, characterize, and attribute irresponsible or threatening space activity in a timely manner.

Ultimately, the output of the JICSpOC will enhance U.S. space operations, contribute to operational command and control within the DoD, and improve the nation's ability to protect and defend critical national space infrastructure in an increasingly contested space environment.

Along with JSpOC, the new JICSpOC will support the Joint Functional Component Commander for Space, the Space Component Commander for USSTRATCOM. An initial cadre of approximately 30 personnel will develop the facility, network and analytic requirements, as well as the skill sets and organizational representation required to provide the proper experimentation and testing environment for the JICSpOC. Membership of this initial group will come from the DoD and the Intelligence Community. Additional personnel from these and other stakeholders will be added as the detailed experimentation plan is refined.

Preparatory activities have already commenced. Operational experimentation and testing will begin on 1 October 2015. Completion of the initial series of experiments, including incorporation of the results into standard operating procedures, is expected by January 1, 2017.

# ORIGINS: NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY (NGA)

*By Dr. Gary E. Weir, Chief Historian, National Geospatial-Intelligence Agency (NGA)*

**The National Geospatial-Intelligence Agency is one of a kind; a community of professionals generating a unique type of intelligence for both national defense and direct combat support.**

Those who navigate American ships and aircraft, make national policy, serve on the front lines, respond to natural disasters, or simply invoke GPS on a handheld device rely profoundly on NGA.

The NGA serves as the world leader for timely, relevant, accurate, and actionable geospatial intelligence, or GEOINT. However, this did not happen overnight. Over the past 20 years, the confluence of tradecraft, skill, and vision made GEOINT critical to American efforts all over the world.

## SOMETHING HAPPENED IN DAYTON

On November 1, 1995, President Clinton called on the warring factions in Bosnia to end the conflict that had cost more than 300,000 Serb, Croat, and Muslim lives since 1991. He invited their representatives to come to Wright-Patterson Air Force Base in Dayton, Ohio, to negotiate an end to the ethnic discord.

At Dayton the U. S. delegation relied on a technical team led by the Defense Mapping Agency and the US Army Topographic Engineer Center. These agencies drew together a support team of over 50 individuals who digitally mapped the disputed Balkan areas in near real-time to assist the diplomats in their deliberations. The digital renderings included up-to-date terrain visualization with cultural and economic data relating to potential boundaries.

The power and flexibility of the technology and the technicians gave the political decision makers the confidence needed to reach agreement. Three-dimensional visual imagery of the disputed areas permitted cartographers to walk negotiators through disputed terrain, giving them a vivid and virtual experience of the space. In at least one instance, this three-dimensional experience proved crucial in persuading Yugoslav President Slobodan Milosevic to compromise on a disputed area.

These hard-working cartographers and analysts collectively contributed to the Dayton Peace Accords in 1995, leading to a temporary, but significant, suspension of regional violence. In this case, the professional lesson did not go unlearned.

Combining people and talent from eight agencies and offices into the National Imagery and Mapping Agency (NIMA) in 1996 certainly reflected initiatives underway in the Congress, the Department of Defense, and the Central Intelligence Agency after the first Gulf War in 1991. However, this move also spoke to the wisdom of asking those involved in both defense imagery and mapping to emulate the Dayton success on a more permanent basis.

Of course, the agency's enabling legislation from Congress simply brought people together and initially could do nothing more. For many months after the creation of NIMA, imagery analysis and geospatial information services within the agency remained in separate and culturally distinct worlds.

Seeing the potential in integration, a number of senior defense and intelligence leaders highly recommended that the agency actively integrate the talents assembled under the NIMA umbrella. Strong cultural identities on all sides at times made the idea of imagery analysts and geospatial specialists regularly emulating the Dayton experience a most difficult and most unlikely prospect.

Recognizing possibilities in the combination, a number of people stepped forward to bridge the gap. In one case, a DMA veteran and senior cartographer felt that she might be able to help.

Having worked for a time in private industry on one of the first automobile navigation system studies, the need to integrate skills and personnel to achieve a goal seemed natural. Working with the NIMA Production Cell at the Washington Navy Yard, she gained approval for a plan to blend the analytical skills applied to imagery with those of the geospatial arts and sciences. In 1999 she began to hire cartographers, geographers, and other geospatial professionals for placement in some of NIMA's imagery analysis offices.

The bloody conflict in Chechnya presented the perfect opportunity. Driven for a time by this civil war, NIMA's Eurasian Branch turned potential into practice. In 2000 those leading the integration initiative asked a Bethesda-based cartographer to join the Eurasia group to merge his talent with their imagery analysis.

*Interior view of the National Geospatial-Intelligence Agency's Headquarters.*
*Photo courtesy of the US Army Corps of Engineers North Atlantic Division—Marc Barnes, photographer.*

The newcomer to the Eurasia Branch had only recently joined NIMA via Rand McNally and a senior colleague felt that he had "a sense for cartography. He had a sense for displaying information in a thematic context, and wove it into a story."

Once augmented by a geospatial professional, the Eurasia group managed to set cultural barriers aside, listened, shared, and proceeded to issue intelligence products that had their customers immediately clamoring for more, frequently describing the output as "phenomenal."

As one senior NIMA manager remembered it, Eurasia's new cartographer "was a rock star": He provided the magic ingredient that brought the effort and the output to another level. Intellectual insight into a crisis situation expressed in a tight, complementary symphony of image and idea quickly set a new standard for professional achievement.

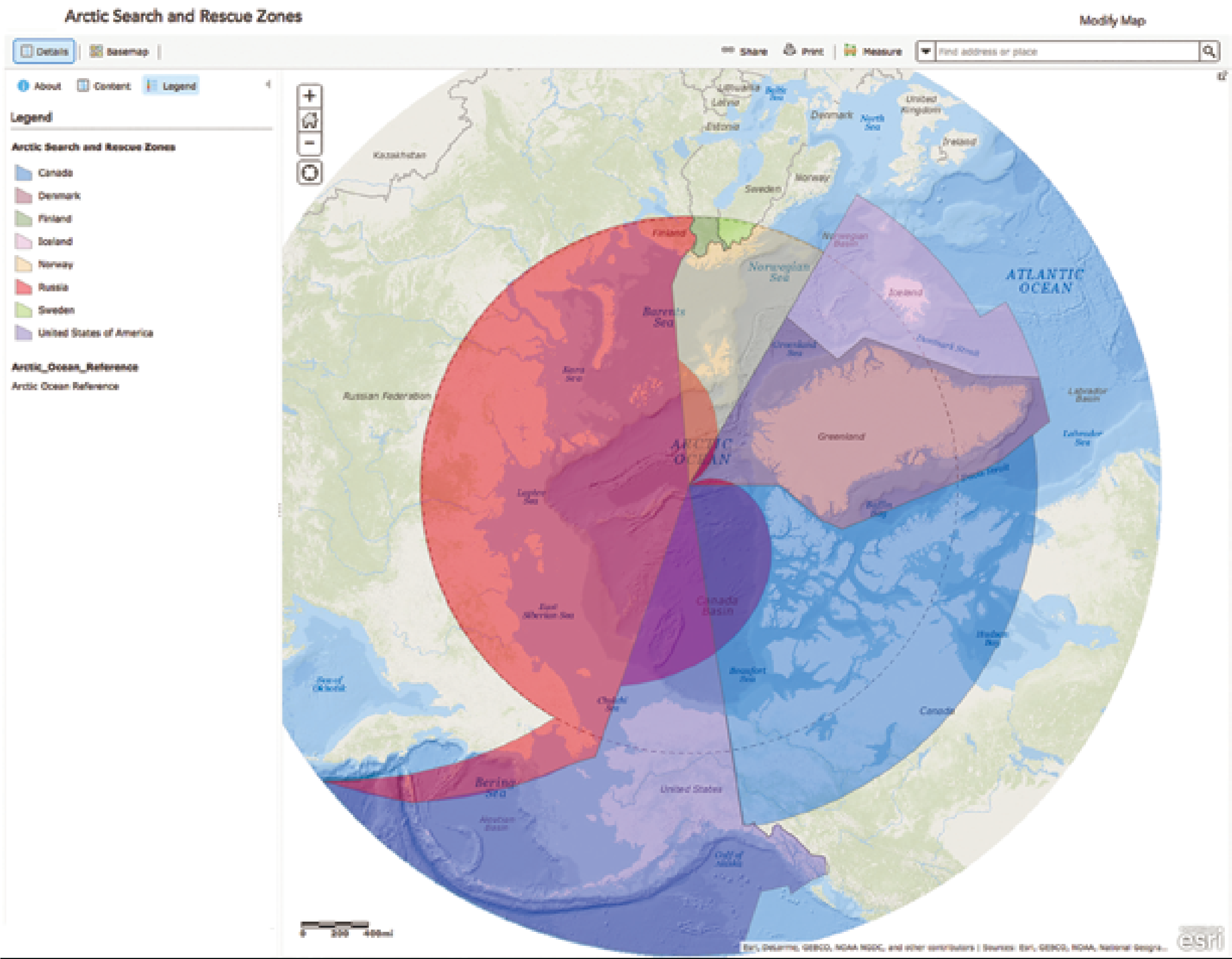
This pioneering group, one among many, arrayed their early products on a display surface at the Navy Yard that quickly became known as the "Wall of Fame." In a visit to NIMA during this period, CIA director George Tenet lingered for a considerable time over the intelligence on the Wall of Fame, viewing this imagery enhanced by geospatial context with the distinct feeling that the future lay before him.

Starting with eight embedded geospatial specialists, within six months those leading the integration initiative had little trouble placing eighteen more in various imagery offices in NIMA.

The success of the Navy Yard Eurasia Branch eroded cultural barriers and promoted professional integration. Coming together as NIMA certainly created the critical mass of talent and insight, but people willing to trust, to collaborate, and to experiment provided the catalyst. NIMA's customers understood the crisis in Chechnya as never before, through the GEOINT lens. Intelligence had entered a new era.

## September 11, 2001

On September 11, radical Islamic terrorists hijacked four commercial airliners and flew one of them into the Pentagon and two others into the twin towers of the World Trade Center in lower Manhattan.




*An example of an NGA public infosite service.*
*This is an Arctic Search and Rescue Zones map, courtesy of NGA.*

The fourth crashed in Pennsylvania when the passengers resisted and fought against their hijackers. In all some 3,000 innocent individuals lost their lives. President George W. Bush declared a global war on terrorism.

Two days later, NIMA welcomed retired Air Force Lieutenant General James R. Clapper Jr. as its third, and first civilian, director. He succeeded Army Lieutenant General James C. King.

Soon after his arrival the new director began to promote products that emerged from a variety of new initiatives, such as NIMA's work on Chechnya in 2000.

This ambitious synthesis of source and image emerged during General King's tenure and became known simply as geospatial intelligence. Among his newly created list of offices was the Office of Geospatial-Intelligence Management, whose mission was to provide the director, in his role as the geospatial intelligence functional manager, with the plans and policies to manage geospatial intelligence resources and a new system to be known as the National System for Geospatial Intelligence (NSG).

The first task of the new office was to develop and publish a series of formal communications that would comprise geospatial intelligence doctrine. The first of these, Geospatial Intelligence Basic Doctrine, appeared in July 2004.

The global war on terrorism and the events of September 11, dramatically changed the nature of NIMA's priorities and products. Recognizing that new threats could occur at any time or place, Director Clapper decided both to make regional analytic overviews

more robust, and to embed NIMA analysts throughout the combat support and intelligence community networks.

In November 2003 his concept of a unifying discipline and doctrine evolved into a new agency name: the National Geospatial-Intelligence Agency (NGA). The new name represented the maturation of a new discipline and the increased unification of NIMA's parts.

## BEYOND A NAME

Well before the tragedy of September 11, 2001, intelligence that depended upon the Earth's physical attributes, as well as the art and science of interpreting that information, changed quietly but fundamentally. Combining most of the nation's capable imagery and geospatial intelligence assets within NIMA in 1996 went beyond simply addressing problems of efficiency and economy. Rather, NIMA suddenly provided a critical mass of skills and technologies under a single mission umbrella that soon enabled the intelligence community to realize a significant step in the evolution of its craft and product.

Creating NGA acknowledged, in name and in practice, the confluence of every possible sort of imagery with geospatial, human, signals, electronic, and open source intelligence. This confluence created the innovative, sophisticated, and powerful product that NGA Director James Clapper formally christened GEOINT.


*The NGA Gallery infosite:*
***http://nga.maps.arcgis.com/home/gallery.html#c=organization&o=modified***

The change of name from NIMA to NGA had little to do with semantics. The nature of intelligence had changed forever. GEOINT demonstrated its unique ability to illuminate critical situations in ways that permitted both intelligent policy decisions and timely action. It confirmed ethnic cleansing atrocities in Kosovo through the latest in imaging and geospatial technology enhanced by an incomparable knowledge of culture and geospatial context.

From the cities hosting the Olympics to the Katrina disaster in New Orleans, Louisiana, NGA provided timely GEOINT products that allowed American authorities at every level to improve the quality and the timing of their security and emergency response. Even the 2006 White House report, in reviewing the Katrina disaster response and offering recommendations for improvement, applauded NGA's timeliness during the crisis.

GEOINT offered a preliminary version of the same total picture for responders that the administration proceeded to recommend for the entire nation as a part of a standard plan to address major disasters.

While firmly rooted in a professional past that extends back to surveyors like the young George Washington and President Thomas Jefferson's explorers Lewis and Clark, GEOINT has only recently emerged as a new synthesis of extraordinary technologies and valuable personal skills.

## FOR THE GREATER GOOD

The National Geospatial Intelligence Agency has the dual responsibility to learn daily from past GEOINT achievements and to practice—for the greater good—the powerful combination of technology and art the organization has created.

***www.nga.mil/***

**The Mission**

The National Geospatial-Intelligence Agency (NGA) delivers world-class geospatial intelligence that provides a decisive advantage to policymakers, warfighters, intelligence professionals and first responders.

Anyone who sails a US ship, flies a US aircraft, makes national policy decisions, fights wars, locates targets, responds to natural disasters, or even navigates with a cellphone relies on NGA. NGA enables all of these critical actions and shapes decisions that impact our world through the indispensable discipline of geospatial intelligence (GEOINT).

NGA is a unique combination of intelligence agency and combat support agency. The organization is the world leader in timely, relevant, accurate and actionable GEOINT. NGA enables the US intelligence community and the Department of Defense (DOD) to fulfill the president's national security priorities to protect the nation. NGA also anticipates its partners' future needs and advances the GEOINT discipline to meet them.

NGA is the lead federal agency for GEOINT and manages a global consortium of more than 400 commercial and government relationships. The director of NGA serves as the functional manager for GEOINT, the head of the National System for Geospatial Intelligence (NSG) and the coordinator of the global Allied System for Geospatial Intelligence (ASG). In its multiple roles, NGA receives guidance and oversight from DOD, the Director of National Intelligence (DNI) and Congress.

NGA is headquartered in Springfield, Virginia, and has two major locations in St. Louis and Arnold, Missouri. Hundreds of NGA employees serve on support teams at US military, diplomatic and allied locations around the world.

The National Geospatial-Intelligence Agency has a responsibility to provide the products and services that decision makers, warfighters, and first responders need, when they need it most. As a member of the Intelligence Community and the Department of Defense, NGA supports a unique mission set. We are committed to acquiring, developing and maintaining the proper technology, people and processes that will enable overall mission success.

Geospatial intelligence, or GEOINT is the exploitation and analysis of imagery and geospatial information to describe, assess and visually depict physical features and geographically referenced activities on the Earth. GEOINT consists of imagery, imagery intelligence and geospatial information.

**NGA Sightings**

Especially important, given the global interest in the Arctic of late, is the latest offering by the NGA of unclassified geospatial intelligence for the most northerly region of our planet.

The National Geospatial-Intelligence Agency launched a public website on September 2 that provides unclassified information about the Arctic. The public website supports efforts to strengthen international cooperation, better understand and manage resources responsibly, enhance quality of life in the Arctic and maintain valuable and vulnerable ecosystems.

The public site, located at **nga.maps.arcgis.com**, includes Digital Elevation Models (DEM) that provide 3D representations of the Arctic's surface. The models, derived from NGA-sponsored DigitalGlobe commercial imagery sources, support land management, sustainable development, safe recreation, scientific studies, and domain-specific challenges inherent to directions, shape files and infographics.

A large, downloadable Pan-Arctic map includes multiple layers that allow users to focus on specific issues and information. Layers include search and rescue zones, ice extents, economic exclusion zones, bathymetric data, navigational and meteorological warnings, and potential energy sources.

NGA is working with the National Science Foundation and the White House Office of Science and Technology Policy to support the Arctic initiative by producing and contributing publicly-available products and data layers as they become available. NGA's work also supports the Department of Defense Arctic Strategy and the safety of navigation in the air and on the seas.

NGA's Arctic website shares the publicly-available online platform with its Nepal and Ebola relief sites, using Esri ArcGIS platform, hosted by Amazon Web Services.

# VIEWPOINT: TO RUSSIA, WITH LOVE— ANOTHER HALF BILLION U.S. DOLLARS?

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

**It's not always easy to understand what members of Congress are thinking. For example, in the months leading up to the current recess, there was a great gnashing of teeth over U.S. acquisition of Russian space hardware—in particular, the RD-180 main rocket engine.**

However, in the waning hours of the session, both the House and the Senate took aim at the budget for the NASA commercial crew program—a move which, if implemented, will almost certainly force NASA to spend another half-billion U.S. tax dollars to buy orbital transportation from Russia, while delaying much-needed American capability.

Of course it is reasonable that the administration, or the Congress, might change their tune about U.S. posture toward another nation, over time. Things do change.

However, if you've been tracking the criticism that the Air Force, United Launch Alliance and RD-AMROSS have endured in 2015, you would think that the government never had any oversight of the RD-180 program. That simply isn't true. For years, both branches elected to fund Russian production of the RD-180 rocket engine, rather than invest anything in a domestic, U.S.-produced rocket engine.

Similarly, the Commercial Crew Program is not a "pet rock" that NASA dreamed up in some sort of vacuum. Rather, it is the reasoned, bi-partisan creation of a government that, perhaps, moved precipitously in killing the space shuttle program without a replacement capability standing by.

If you want to track, over time, how consistently short-sighted the U.S. government has been at investing in rocket engine capability, you only need to read Wayne Eleazer's excellent essay in *The Space Review* (August 3, 2015), which, after detailed analysis, concludes:

> *"The rocket engine dilemma the US faces today is not the result of a sudden and unpredicted shift in international relations but is due to both government and industry making the wrong choices, repeatedly, over the course of more than 45 years. Essentially, the country has rather studiously avoided making the effort required for a new engine development. Those decisions seemed logical, reasonable, politically necessary, cheap, or simply inevitable at the time, but ultimately proved to be seriously flawed."*

Wayne's summation—"***politically necessary, cheap, or simply inevitable at the time***"—strikes me as the same set of metrics that killed the Constellation program, and then ended the space shuttle program without an indigenous, human-rated launch system hiding in a hangar.

The shuttle "gap" was more than a gap; it was a plunging chasm, and we are still trying to climb out of it. Like the RD-180 decision, it made us dependent upon Russia. The difference is that, until now, NASA has been allowed to pursue a Commercial Crew Program that could break America's cycle of dependence for human access to Low Earth Orbit, while strengthening U.S. industrial capability. The U.S. Air Force was not allowed to pursue domestic production of the RD-180, despite having negotiated the rights to do so.

In either case, like an addict, the U.S. has become infamously dependent upon our launch tech "dealer"—Russia. ***In both cases, we need to break our cycle of addiction.*** We need to get into rehab, and start believing, and investing, in ourselves again.

It should not be acceptable to the U.S. that only Russia and China can launch astronauts into space. Nor should it be acceptable to our international partners that the only human spaceflight pathways open to them go through Moscow and Beijing.

Congress needs to support full funding for the NASA Commercial Crew Program. Full stop.

I also believe that an accelerated, urgent, priority national program to develop a new main launch engine is critical to the future of our national security space interests. Make no mistake, at this moment in time, we are dependent upon the RD-180. The national security of the United States is in the hands of Russia's rocket engine makers. This should not be acceptable.

Nor should the nation be happy, from an industrial policy and economic competitiveness point of view, with being a minority player in the global launch business. Of 92 launches around the world in 2014, only 23 were from U.S. spaceports (34 were Russian launches).

Now, there is some nuance here. Despite current abhorrent behavior, Russia has, in fact, been a reliable partner in the International Space Station program since its inception. And, the RD-180 has been a reliable workhorse powering the Atlas 5.

On a people-to-people basis, U.S.-Russia collaboration in space has worked, for a long time. So, I'm not suggesting we end collaborating, where it makes sense. What I am suggesting is that we be equal and strong partners, and ***not codependent*** ones.

I also am not suggesting that properly funded government programs, alone, can break our cycle of addiction. Just as I see a bright future in the Commercial Crew Program, I believe we absolutely must support and encourage commercial development of competitive engine technology.

We need to expect the government to buy commercial engine technology whenever practical. This is not a winner-take-all effort pitting government against industry. Rather, it should be a win-win approach, where the more Made in America choices the U.S.

has, and the more domestic capabilities the nation can choose from, the better.

A competitive marketplace is good for government, good for industry, and good for the taxpayer. A competitive space industry that assures American technical leadership in the space domain is good for national security—both hard power, and soft power.

The most recent Congressional recess ended on Tuesday, September 8th. The top priority for both houses should be to agree on a 2016 budget. A Continuing Resolution would be a bad outcome; kicking the budget can down the road is not leadership, and has bad effects on the economy in general and government programs in particular. Allowing sequestration provisions of the Budget Control Act would be even worse. (See "*Autopilot is No Way to Run a Country*," Space Watch, November 2014.)

House and Senate conferees need to set their political differences aside right now, and agree to a 2016 federal budget that fully funds NASA, including the Commercial Crew Program. Congress should also make a serious, credible start on a long-overdue, U.S., main rocket engine program. Politics as usual will only exacerbate the nation's dependence upon Russia—unacceptable at any time, but particularly troublesome now.

Here's a brain teaser to contemplate: with all the technical advances that have taken place since the Delta Clipper/DCX program (mid 1990's), and the X-33 Venture Star (late 1990's)... might it not be time to take another shot at developing a Single Stage to Orbit (SSTO) system that would revolutionize space transportation and relegate costly, expendable launch systems to the history books?

**Editor's note**: *our thanks to Space Foundation and their Space Watch blog in allowing* ***MilsatMagazine*** *to republish Elliot's article.*

*Named chief executive officer of the Space Foundation in 2001, Elliot Pulham leads a premier team of space and education professionals providing services to educators and students, government officials, news media and the space industry around the world. He is widely quoted by national, international and trade media in coverage of space activities and space-related issues.*

*Before joining the Space Foundation, he was senior manager of public relations, employee communication and advertising for all space programs of Boeing, serving as spokesperson at the Kennedy Space Center for the Magellan, Galileo and Ulysses interplanetary missions, among others.*

*He is a recipient of the coveted Silver Anvil Award from the Public Relations Society of America—the profession's highest honor. In 2003, the Rotary National Awards for Space Achievement Foundation presented him with the coveted Space Communicator Award, an honor he shares with the late legendary CBS News Anchor Walter Cronkite and former CNN News Anchor Miles O'Brien*

*Pulham is a former Air Force Civic Leader and advisor to the Chief of Staff and Secretary of the Air Force and a recipient of the U.S. Air Force Distinguished Public Service Medal. He serves on the editorial board of New Space Journal.*

# SPATIAL BATTLEGROUNDS: ANTI-SATELLITE SYSTEMS (ASATS)

*By Jos Heyman, Senior Contributor*

**Out of the 7,110 satellites launched since October 4, 1957, 44 percent of those are either primarily, or secondarily, military in nature.**

Although this number may vary, due to the interpretation of the objectives of the satellites by those who own them, this figure is a good indicator of the plethora of military assets that have been deployed in space over the stated time period.

The satellites can be roughly grouped as communications, navigational, reconnaissance, early warning and intelligence gathering spacecraft.

Clearly, these programs are clouded in secrecy. The USSR/Russia assigned the name Kosmos to many of their military satellites (although not all Kosmos satellites are of a military nature), while the USA introduced the USA series identification in 1984 to cover a wide range of military satellites.

## HOW DO WE KNOW WHAT'S WHAT?

If the data is not revealed at the launch through press releases (such is the case for the Navstar satellites which, in spite of their civilian use, are, in the first instance for military purposes), the objective can often be deducted from the type of launch vehicle, the launch site, incidental pieces of information, as well as amateur observations.

Together, these military satellites are significant tools for the conduct of warfare, be such on a local or a global basis. However, they also serve as a means of the superpowers to keep tabs on each other, thereby [hopefully] avoiding accidental, global warfare.

The outcome of any military conflict can be influenced by the ability to deny the opponent access to space-based resources. The interesting element here is that if the destruction of an opponent's space assets is not done in a 'smart' way, a snowball

effect may result, wherein the debris resulting from the first satellite's destruction could randomly destroy other satellites—including 'friendly' ones—which, in turn, create more debris that destroys even more satellites, and so on and so on. Known as the Kessler Syndrome, so-named after NASA scientist Donald J. Kessler, such actions could render space exploration, and even the use of satellites, unfeasible for many generations to come.

Three means are currently being explored to destroy an on orbit satellite:

- **Missiles**
- **Laser beams**
- **Satellites**

Due to the secrecy surrounding this topic, information is extremely limited. Certainly more advantageous means that are mentioned in this article are being researched, even in operation to silence, or even destroy, satellites—however, such crucial information remains shrouded in secrecy. There could well be methods currently under investigation that would result in the silencing of opponent satellites through cyber warfare, which would negate the occurrence of debilitating debris.

## Missiles

Both the USA and the USSR were considering ground launched missiles in the 1950s as a means of destroying orbiting satellites. Both countries were concerned about the deployment of nuclear weapons from an Earth orbit.

In the USA, an extension to the Weapon System WS-199A project of 1958/59 was considered, in which a Bold Orion, air-launched, ballistic missile (ALBM) was to be fitted with an Altair upper stage to create an anti-satellite missile with a range of 1700 km. (1,100 miles). One test flight of this combination was made on October 13, 1959, in a simulated attack on the Explorer-6 satellite, which was at an altitude of 251 km. (156 miles). To allow control of the missile, telemetry was transmitted to the ground and flares were ejected to aid in the visual tracking of the missiles, as well as tracking by radar. The missile passed within 6.4 km. (4 miles) of the satellite.

In another test on September 22, 1959, a Lockheed High Virgo missile that had been adapted for an anti-satellite role attempted to intercept the Explorer-5 satellite. Communications were lost after the Virgo was launched and no determination could be made regarding any success of this test.

The U.S.A.F. also conducted anti-satellite tests with the Thor missile, wherein a nuclear warhead was to be exploded in space to disable a satellite. Known as Program 437, 16 launches from Johnstone Island took place between February 14, 1964, and November 6, 1975.

| Name | Launch | Serial |
|---|---|---|
| Antisat.-1/Program 437-1 | 14-Feb-1964 | 59-2420 |
| Antisat.-2/Program 437-2 | 1-Mar-1964 | 58-2320 |
| Antisat.-3/Program 437-3 | 21-Apr-1964 | 59-2411 |
| Antisat.-4/Program 437-4 | 28-May-1964 | 59-2348 |
| Antisat.-5/Program 437-5/CTL | 16-Nov-1964 | 59-2357 |
| Antisat.-6/Program 437-6 (CTL) | 5-Apr-1965 | 58-2266 |
| Antisat.-7/Program 437 AP-1 | 7-Dec-1965 | 28-2299 |
| Antisat.-8/Program 437 AP-2 | 18-Jan-1966 | 59-2363 |
| Antisat.-9/Program 437 AP-3 | 12-Mar-1966 | 58-2307 |
| Antisat.-10/Program 437 AP-4 | 2-Jul-1966 | 59-2410 |
| Antisat.-11/Program 437-7 CEL | 31-Mar-1967 | 58-2279 |
| Antisat.-12/Program 437-8 CEL | 14-May-1968 | 58-2316 |
| Antisat.-13/Program 437-9 CEL | 12-Nov-1968 | 59-2373 |
| Missile test/Program 437-10 | 27-Mar-1970 | 58-2263 |
| Program 437/BMDTTP-1 | 19-Sep-1975 | 58-2312 |
| Program 437/BMDTTP-2 | 6-Nov-1975 | 59-2395 |

*Table: 1 launches in Program 437.*

The US Navy engaged in their own testing during the early 1960s with the SIP and Hi-Hoe test programs.

The missile used for these tests was a Caleb missile, developed at the Naval Ordnance Test Station (NOTS) as a fast response expendable orbital launch system to place small reconnaissance satellites and other military payloads into orbit on short notice. Test were conducted as part of Project Pilot, where the launch vehicle was deployed from an F4D Skyray aircraft.

The project was canceled in 1960; however, two leftover and modified Calebs were used in the Satellite Interceptor Project (SIP). These launches were conducted on October 1, 1961 and May 5, 1962, from a launch pad on San Nicolas Island, with the missiles reaching an altitude of 20 km.

The associated Hi-Hoe program saw an additional three, leftover Caleb missiles fired from a McDonnell F4H Phantom II aircraft on May 10, 1961, March 26, 1962 and July 25, 1962—the final launch was successful in reaching an altitude of 1166 km. (724.52 miles).

*Hi-Hoe. Photo is courtesy of the US Navy.*

Further development by the US Navy was canceled following pressure to halt the program by the US Air Force.

The US Army, separately from the US Air Force and the US Navy, explored the possibility of converting their Nike Zeus anti-ballistic missile system into an anti-satellite system as part of Project Mudflap, or project 505.

Work on this commenced around 1960 and resulted in the DM-15S version of the missile. The changes involved a two-stage hydraulic pump and a higher performance booster propellant.

Similar to the US Air Force's Thor missiles, the Nike Zeus DM-15S was to use a high altitude nuclear explosion to knock satellites out of commission via the damaging effects that would be caused by the explosion's electromagnetic pulse on electronic equipment.

Following a test flight of an experimental DM-15B on December 17, 1962, from White Sands in New Mexico, the first launch of a DM-15S occurred on February 15, 1963, and reached an altitude of 280 km. (173.98 miles). This launch was followed by the interception of a simulated satellite on March 21, 1963, at an altitude of 207 km. (128.62 miles). The first attempt at an actual interception took place on May 24, 1963, against an Agena D target.

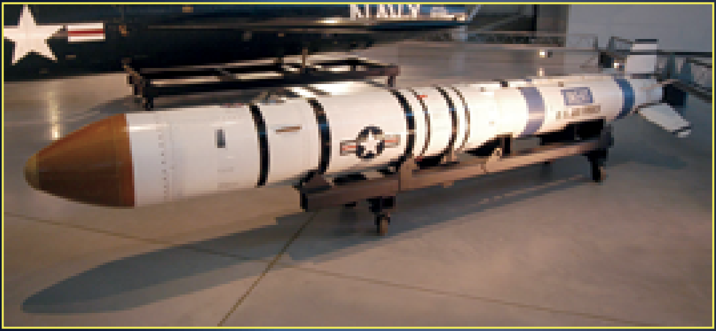
The system was considered successful, resulting in the Nike Zeus DM-15S, as well as five nuclear warheads, becoming secured at their launch site on Kwajalein Island. In May of 1966, the program was declared redundant and closed. (See Table 2: Nike Zeus DM-15B and S launches) One of the factors leading toward this termination was that the nuclear explosion would also have impacted upon other US satellites on orbit.

By 1982 most work on ASAT was undertaken as a low priority—that is, until Russia resumed their anti-satellite tests as described below. This undertaking generated a brief revival that resulted in the Vought ASM-135 ASAT missile, which, on September 13, 1985, was launched from an F-15 Eagle fighter at an altitude of 11,613 meters (7.22 miles) and successfully intercepted a Solwind P78-1 satellite that was flying at an altitude of 555 km. This resulted in 284 pieces of trackable debris.

| Flight | Launch | Site |
|---|---|---|
| 1 | 17-Dec-1962 | White Sands |
| 2 | 15-Feb-1963 | White Sands |
| 3 | 21-Mar-1963 | Kwajalein |
| 4 | 19-Apr-1963 | Kwajalein |
| 5 | 24-May-1963 | Kwajalein |
| 6 | 6-Jan-1964 | Kwajalein |
| 7 | ? Apr-1964 | Kwajalein |
| 8 | ?-Jun-1965 | Kwajalein |
| 9 | ?-Jun-1965 | Kwajalein |
| 10 | ?-Jul-1965 | Kwajalein |
| 11 | ?-Jul-1965 | Kwajalein |
| 12 | 13-Jan-1965 | Kwajalein |

*Table 2. Nike Zeus DM-15B + S launches.*

The plan was to have more than one hundred F-15s become part of this program. Further development was abandoned in 1988 due to problems with the Miniature Homing Vehicle (MHV) interceptor's home guidance system.



*Vought ASM-135 ASAT.*

The US Navy successfully destroyed the USA-193 military satellite on February 29, 2008, using a RIM-161 Standard Missile 3 ABM missile. The reason for this mission was that USA-193, launched on December 14, 2006, had failed to function and the satellite's orbit was rapidly deteriorating into lower orbits. Additionally, the satellite carried approximately 450 kg. of toxic hydrazine fuel which could pose health risks to persons within the immediate vicinity of the crash site, should any significant of the fuel survive re-entry. This problem provided a solid opportunity to test the ABM's ASAT capability. The satellite's resultant destruction caused the satellite's breakup into 174 pieces of trackable debris.

During the 1990s, a Kinetic Energy ASAT (KE ASAT) system was proposed wherein a ground based interceptor would destroy satellites by homing in and deploying a mylar plastic sheet. The plastic sheet was meant to strike the target without a shattering effect. The KE ASAT system was, however, restricted to satellites in Low Earth Orbit (LEO).

The plan by the US Army was to conduct seven test flights, starting in 1996, with two of these flights to undertake interceptions of inactive US satellites, whereas the other five test flights were to conduct close passes of on orbit satellites. The Clinton administration canceled the program.

Little is known about USSR attempts to destroy satellites through the use of missiles, except that during the 1960s, the USSR tested the use of their nuclear Galosh missiles as satellite interceptors, while tests were also conducted with the Gorgon missiles.

Also in the early 1980s, the USSR began developing a counterpart to the US air-launched ASAT system, using modified MiG-31 'Foxhounds'. The belief is that at least six such aircraft were converted for this purpose.

## Laser Beams

The USA and the USSR/Russia have considered energy weapons, including a nuclear-explosion powered X-ray laser, as potential anti-satellite weapons.

One of the features of the laser beam is that as the beam passes through the atmosphere, scattering occurs and power is lost. The destruction of a satellite via laser beams is, therefore, simply not possible; however, a laser beam can interrupt a satellite's operation, which then denies the enemy use of that satellite. This is, in certain situations, an advantage, as debris is not generated to threaten other spacecraft.

In 1985, the US Congress banned the development of anti-satellite weapons for a period of ten years. When that period of time expired, the US Army then tested the Mid-Infrared Advanced Chemical Laser (MIRACL) on October 21, 1997, which was aimed at the MSTI-3 US military satellite at an altitude of 432 km. While the satellite was not destroyed—the vulnerability of the satellite's sensors was certainly tested.

*Artistic rendition of an airborne laser in action.*

The laser beam technology was also expressed in the US Air Force's YAL-1A Airborne Laser (ABL) project that involved a large, chemically powered laser inside a converted Boeing 747 aircraft. Intended primarily to destroy incoming missiles while they were still over enemy territory, one of the other potential uses of this technology was the targeting of satellites. One aircraft was built and flew in 2002, but the program was abandoned in December of 2011.

In a similar way, the USSR experimented with large, ground-based ASAT lasers from the 1970s onwards. A number of US satellites were temporarily 'blinded' during the 1970s and 1980s. The USSR had also researched Directed Energy weapons as part of that nation's Fon project.

## Anti-Satellite Satellites USSR Way

Anti-satellite satellites have always been, and to this day remain, an integral part of the USSR/Russian space warfare plan.

In 1962, Sergei Korolev's OKB-1 bureau proposed the crewed Soyuz P (for Perekhvatchik, which means interceptor), also known as 7K-PPK (Pilotiruemyy Perekhvatchik Korabl, which means manned interceptor spacecraft). This was intended to be a version of the Soyuz spacecraft for the piloted inspection, and destruction of, enemy spacecraft.

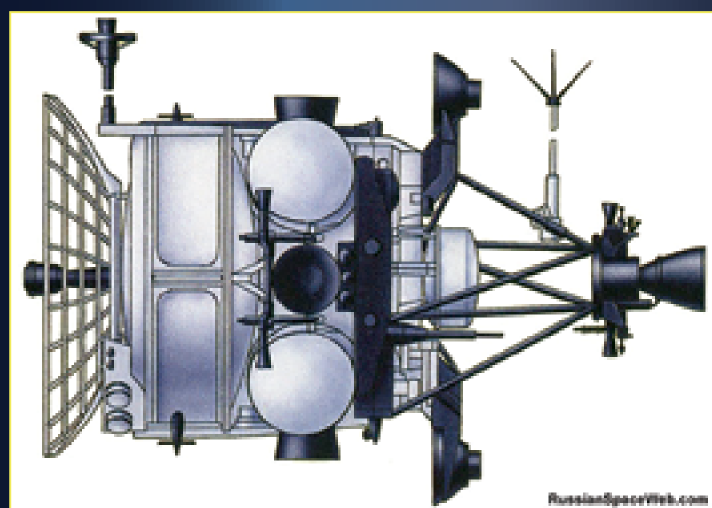
After a rendezvous with an enemy spacecraft, a cosmonaut would engage in extra vehicular activity (EVA) and, depending on the outcome of the inspection, the spacecraft would then be destroyed, neutralized or returned to Earth for further inspection. Development was canceled in early 1965.

The USSR also considered Almaz military space stations, arming them with fixed Rikhter R-23 auto-cannons.

The idea of an automatic satellite destroyer named Istrebitel Sputnikov (IS) in Russian was first conceived by designer Vladimir Chelomei in 1959. Basically, this was to be a semi-guided spacecraft that carried explosives. The IS was to be able to maneuver in space, including inclination maneuvers, a task that requires significant thrust. Work along the same lines was also undertaken by Sergei Korolev's OKB-1 bureau.

Maneuvering spacecraft had first been tested by the USSR with the Polyot-1 and -2, which were launched respectively on November 1, 1963, and April 12, 1964.

Leading on from this was the flight of Kosmos-185, also known as I2-BM. The satellite was based on the Polyot design but was modified as an anti-satellite satellite prototype and was launched on October 27, 1967, for engine maneuverability testing.

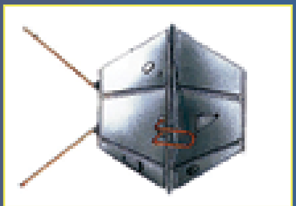



*Kosmos-185. Photo source is TsNII Kometa via RussianSpaceWeb.com*

Other satellites developed for the anti-satellite program were identified as:

- **I2M: a 1400 kg target satellite built by KBYuzhnoye**
- **I2P: a 1400 kg interceptor satellite built by KBYuzhnoye**
- **Istrebitel Sputnikov (IS)-P, an interceptor satellite with a mass of 650 kg and built by OKB-52**
- **Istrebitel Sputnikov (IS)-M, a target satellite with a mass of 640 kg and built by OKB-52**
- **Dneprovskiy Sputnik (DS)-P1-M, also known as Lira, a target satellite with a mass of 600 kg built by KBYuzhnoye**

*(P stands for the PRO anti-ballistic missile radar + M for Mishen=target)*



*DS-P1-M, image courtesy of KBYuzhnoye*

Starting in 1968, the USSR undertook a first series of anti-satellite tests that consisted of placing a target vehicle in orbit and then having this target overtaken by an interceptor which could destroy the target by exploding itself and/or possibly releasing a cloud of metal pellets in the target's orbit. No weapons of any type were carried on these tests, which lasted until 1972, and had a success rate of 70 percent. The tests were suspended when the USA and the USSR signed an anti-missile defense treaty in 1972. Nevertheless, the USSR declared the original IS system operational in the following year.

A second series of tests commenced in 1976 which possibly included a new guidance system that was not susceptible to jamming. The success rate of this series, which lasted until 1978, was only 57 percent.

This series of tests were in a response to a USSR perception that the USA's Space Shuttle could be modified as a space-based weapons carrier. As such, the nature of the test concentrated on the destruction of the target within the first orbit.

The third and final test series began in 1980 and lasted until 1983 when the USSR leader Yuri Andropov announced a unilateral moratorium on ASAT tests. (*See Table 3 on this + next page.*)

| Name | Launch | Launch Vehicle | Type | Notes |
|---|---|---|---|---|
| **Preliminary test** | | | | |
| Kosmos-185 | 27-Oct-1967 | Tsyklon 2A | I2-BM | Technology only |
| **First test series** | | | | |
| Kosmos-217 | 24-Apr-1968 | Tsyklon 2A | I2M | Target, failed to achieve a final orbit |
| Kosmos-248 | 19-Oct-1968 | Tsyklon 2A | I2M | Target; was intercepted by Kosmos-249 and Kosmos-252 |
| Kosmos-249 | 20-Oct-1968 | Tsyklon 2A | I2P | Interceptor; intercepted Kosmos-248 |
| Kosmos-252 | 1-Nov-1968 | Tsyklon 2A | I2P | Interceptor; intercepted Kosmos-248 |
| Kosmos-291 | 6-Aug-1969 | Tsyklon 2 | IS-P | Interceptor; engine failure, no intercepts |
| Kosmos-316 | 23-Dec-1969 | Tsyklon 2 | I2P | Interceptor; failed to intercept |
| Kosmos-373 | 20-Oct-1970 | Tsyklon 2 | IS-M | Target; intercepted by Kosmos 374, Kosmos 375 and Kosmos 404 |
| Kosmos-374 | 23-Oct-1970 | Tsyklon 2 | I2P | Interceptor; intercepted Kosmos-373 |
| Kosmos-375 | 30-Oct-1970 | Tsyklon 2 | I2P | Interceptor; intercepted Kosmos-373 |
| --- | 22-Dec-1970 | Kosmos 3M | DS-P1-M | Failed to orbit |
| Kosmos-394 | 9-Feb-1971 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-397 |
| Kosmos-397 | 25-Feb-1971 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-394 |
| Kosmos-400 | 18-Mar-1971 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-404 |
| Kosmos-404 | 4-Apr-1971 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-400 and Kosmos-373 |
| Kosmos-459 | 29-Nov-1971 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-462 |
| Kosmos-462 | 3-Dec-1971 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-459 |
| Kosmos-521 | 29-Sep-1972 | Kosmos 3M | DS-P1-M | Target; malfunctioned and interceptor not launched |
| **Second series** | | | | |
| --- | 19-Dec-1975 | Kosmos 3M | DS-P1-M | Failed to orbit |
| Kosmos-803 | 12-Feb-1976 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-804 and Kosmos-814 |
| Kosmos-804 | 16-Feb-1976 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-803 |
| Kosmos-814 | 13-Apr-1976 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-803 |
| Kosmos-839 | 8-Jul-1976 | Kosmos 3M | DS-P1-M | Target; interception by Kosmos-843 failed |
| Kosmos-843 | 21-Jul-1976 | Tsyklon 2 | I2-P | Interceptor; interception of Kosmos-839 failed |
| Kosmos-880 | 9-Dec-1976 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-886 |
| Kosmos-886 | 27-Dec-1976 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-880 |
| Kosmos-909 | 19-May-1977 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-910 and Kosmos-918 |
| Kosmos-910 | 23-May-1977 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-909 |
| Kosmos-918 | 17-Jun-1977 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-909 |
| Kosmos-959 | 21-Oct-1977 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-961 |
| Kosmos-961 | 26-Oct-1977 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-959 |
| Kosmos-967 | 13-Dec-1977 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-970 and Kosmos-1009 |
| Kosmos-1009 | 19-May-1978 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-967 |

Further developments did, however, continue and in May of 1987, the USSR leader Mikhail Gorbachev was shown the prototype of an anti-satellite and anti-missile platform named Naryad (Guard). This system was to be launched by a UR-100N missile but, as

| Third test series | | | | |
|---|---|---|---|---|
| Kosmos-1171 | 3-Apr-1980 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-1174 |
| Kosmos-1174 | 18-Apr-1980 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-1171 |
| Kosmos-1241 | 21-Jan-1981 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-1243 and Kosmos-1258 |
| Kosmos-1243 | 2-Feb-1981 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-1241 |
| Kosmos-1258 | 14-Mar-1981 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-1241 |
| Kosmos-1375 | 6-Jun-1982 | Kosmos 3M | DS-P1-M | Target; intercepted by Kosmos-1379 |
| Kosmos-1379 | 18-Jun-1982 | Tsyklon 2 | I2-P | Interceptor; intercepted Kosmos-1375 |

*Table 3. USSR ASAT satellites.*

far as is known, no flights were accomplished with this platform. Suggestions have been made that the Rockot/Briz K launch of December 26, 1994 carried, separate from the Radio-15 payload, a Naryad payload that was to be exploded once released.

At about the same time, on May 15, 1987, the first Energia rocket was launched. This rocket carried the Skif DM (Polyus) spacecraft, described as a prototype of a space-based battle station that could also accommodate anti-satellite weapons. The spacecraft failed to achieve orbit.

Also during the 1990s, the USSR anti-satellite system was operational as the IS-MU system and was capable of intercepting a target during first orbit. No satellites were launched in this series. From 1998, the USSR also considered the destruction of satellites in geostationary orbit under the designation IS-MD.

There is current evidence that Russia continues to consider a variety of anti-satellite capabilities. This evidence includes the possibility of satellite maneuvering tests that have been occurring over the past few years.

For instance, the Kosmos-2504 satellite that was launched on March 31, 2015, has made at least 11 close approaches to the upper stage that was placed into orbit. At least on one of these occasions, the upper stage was nudged into a higher orbit by the satellite. The spacecraft also approached, on one occasion, an unidentified piece of orbital debris.

## 4,600 KE ASATs

Another belief is that the USA also considered the use of anti-satellite satellites during the early 1980s. As part of the Brilliant Pebbles system, itself a component of the Strategic Defense Initiative, a satellite constellation of 4,600 kinetic interceptors (KE ASAT) was considered. These 45 kg. satellites would have been placed in LEO. At a later stage, these were thought to have been developed into a larger system of laser and charged particle beam weapons. As far as is known, no hardware was ever developed.

## Chinese Efforts

Chinese development of kinetic and direct energy anti-satellite systems is believed to be occurring.

On July 11, 2007, China successfully destroyed the Feng Yun 1-3 weather satellite with an SC-19 ASAT missile, resulting in 3,393 pieces of trackable debris. Feng Yun 1-3 was, at that time, in a polar orbit of 865 miles and the missile was launched from a mobile Transporter-Erector-Launcher (TEL) vehicle at the Xichang Space Center in northern China.

In May of 2013, the appearance was that China was conducting tests of a ground-based ASAT system, with new approach and maneuvering tests underway.

There are also suggestions that other countries, in particular, India, are developing weapons that could destroy satellites.

## Peaceful Uses Of Outer Space?

All these military tests, ultimately aimed at denying 'an enemy' access to a nation's space hardware, occur against a background in which the United Nations, through the Committee on the Peaceful Uses of Outer Space (COPUOS), advocates the use of space for the benefit of all humanity: for peace, security and development.

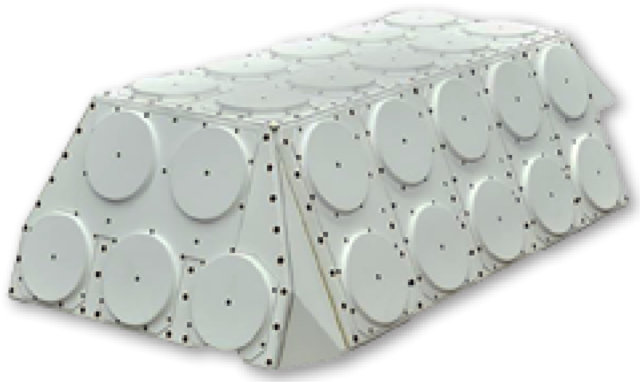
*Jos Heyman is the Managing Director of Tiros Space Information, a Western Australian consultancy specializing in the dissemination of information on the scientific exploration and commercial application of space for use by educational as well as commercial organizations. An accountant by profession, Jos is the editor of the TSI News Bulletin (tiros.zarya.info/) and is also a regular contributor to the British Interplanetary Society's Spaceflight journal.*

# HPA CORNER: SATELLITE SECURITY + INFORMATION ASSURANCE

By David Thompson, Chief Engineer for Information Assurance, Harris Space and Intelligence Systems

**Historically, the protection of satellites has relied on the physically remote location and the fact that satellites were treated as a single entity to mitigate threats.**

As long as the satellite was protected during integration and launch, there was little that could be done to threaten the safe operation of the onboard payload. The bus would provide command and status through an NSA-approved, cryptographic implementation and the payload would be limited to sensor operations or communications, with the channels fully isolated from the bus platform. A limited number of threat vectors could be easily mitigated through onboard segregation and isolation.



*The Harris AppStar hosted payload platform. Image is courtesy of ©Harris Corporation.*

With the advent of hosted payloads, where the owner and operator of the bus can be separate from the owner and operator of the payload, a new threat environment is introduced. The payload operators may now need the ability to send commands and receive status independent of the bus operations. The owners no longer rely on bus-encrypted communications—instead, they must provide their own control channels, or use a satellite provided, shared communications channel with other payload tenants.

The new threat environment now appears to be much like the threats experienced by enterprise architectures. Shared communications systems are exposed to multiple organizations using Internet protocols. This is similar to the environment that businesses work in today and invites the consideration of including protections that are currently effective in enterprise computing.

*The Hosted Payload Alliance (**hostedpayloadalliance.org**) is a satellite industry alliance formed to increase awareness of the benefits of hosted government payloads on commercial satellites. The US National Space Policy published in 2010 calls for an increasing role for commercial space to meet government requirements and explicitly directs the use of non-traditional options for the acquisition of space goods and services, and cites hosted payloads as one of these non-traditional options. The policy notes that public-private partnerships with the commercial space industry can offer timely, cost-effective options to fill government requirements.*

This column's question for HPA Members is…

***What does the commercial industry need to do to ensure the security of satellite and hosted payload operations to meet government information assurance standards?***

"The commercial SATCOM industry has the ability to meet the most daunting Information Assurance (Mission Assurance) requirements, whether those requirements come from Governments or commercial customers. All of the major satellite manufacturers can, or have plans to, offer NSA Type 1 certified command and/or telemetry encryption using the latest NSA approved Gryphon algorithms. In addition, hosted payloads which require their own command, telemetry or data Information Assurance protection can look towards the Air Force's Space and Missile Systems Center hosted payload interface unit specifications to meet these requirements.

"The Air Force's CHIRP program used a dedicated command, telemetry and data channel that was protected by Secret level, NSA Type 1 encryption units for both uplink and downlink data.

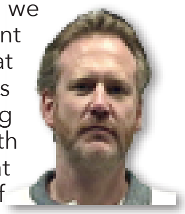
"The commercial SATCOM industry also looks beyond the spacecraft requirements to those requirements that ensure the data is protected while in transport on the ground as well. The Defense Information Systems Agency (DISA) has established Mission Assurance Categories (MAC) for Commercial SATCOM. Designing a system to meet these robust requirements ensures the integrity and availability of the data from its point of origin to its final destination."—***Tim Deaver***, Corporate Vice President, Development, **SES Government Solutions.**

---

"In short, good fences make good neighbors. When a satellite is owned and operated by a single entity, using Cardholder/Pegasus to encrypt commanding and telemetry is a reasonable strategy. When multiple entities coexist on the satellite, the protection boundary moves from the satellite to the payload. In IA terms, this means treating each payload and the satellite bus as "untrusted entities", and protecting each separately. Protection includes cryptography, authentication, auditing, and integrity to the degree dictated by the individual entity's mission.

"Ground systems have used this concept for years, but application to satellites has been rare due to satellites typically being isolated and operated by a single organization. The advent of hosted payloads has changed the dynamic of the industry. Smart hosted payload design requires incorporation of IA techniques adapted to the environment. Commercial industry can do this using existing IA standards and the established approval processes."—***Rob Clark***, Hosted Payload Manger, ***Harris Corporation***

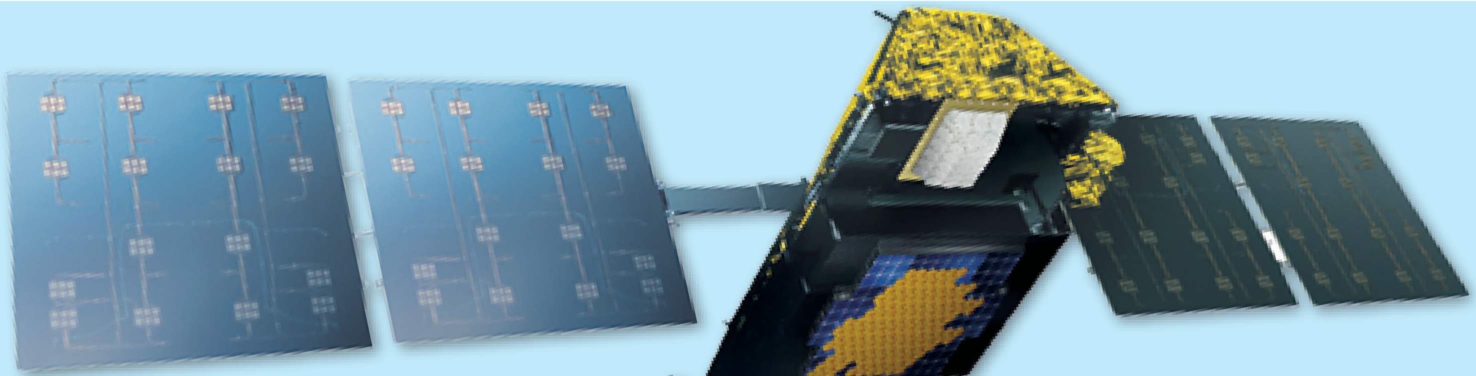
---



"The advanced security issues that we face today continue to gain significant attention. It's important to note that threats are not new, and Intelsat has been addressing the ever-changing security landscape since 2002 with a comprehensive framework that focuses on the three core tenets of security: confidentiality, availability and integrity.

"We believe it is imperative that security belongs in the foundational DNA of every company, especially those in our industry. Our ecosystem must adapt to this persistent threat and invest in the necessary tools to keep our customers safe and preserve the integrity of our networks.

"Intelsat leverages the following governing control frameworks: 1) DoDI 8500.2; 2) NIST 800-53; ISO 27000 series to support the government's information assurance requirements. Pursuant to the government's requirements and objectives, commercial IA methodologies can include these top-level themes: 1) Defining the scope and boundaries of information systems, services, facilities, and architectures; 2) Map applicable existing framework and unique controls from IA requirements and incorporate mapped controls into design and architecture and perform a risk assessment to complete the accreditation process." —***Gerry Jansson***, Director, Space Segment Developing, **Intelsat General Corporation**.



***The following case study is courtesy of the HPA global infosite (hostedpayloadalliance.org/)***

***The Global Aircraft Surveillance Payload***

*ADS-B Communications Signal Receiver*

*Sponsor: Aireon LLC.*
*Operator: Iridium / Exelis.*
*Manufacturer: Harris Corporation.*
*Spacecraft: Iridium NEXT Constellation.*

*In this day and age, it's hard to comprehend that technology created during the Second World War is still being used to surveil airspace and track aircraft throughout the world. Air Navigation Service Providers (ANSP), airlines, air traffic controllers and other stakeholders continue to rely on radar as their primary source of surveillance. More recently, technologies such as Automatic Dependent Surveillance-Broadcast (ADS-B) and Wide Area Multilateration (WAM) have become accepted alternatives.*

*However, current land-based systems are limited to line-of-sight, leaving an estimated 70 percent of the world's Flight Information Regions (FIR) uncovered by any real-time surveillance. With technology that would provide global real-time surveillance, business practices and safety will be improved and also allow for more environmentally friendly operations.*

*In 2012, Aireon was formed through a joint venture between Iridium Communications and NAV CANADA, with subsequent investments from ENAV, the Irish Aviation Authority and Naviair, to provide a space-based, real-time surveillance system. The backbone of Aireon's technology resides on the Iridium NEXT constellation of satellites gearing up to launch at the end of 2015. To enable the Aireon® system, Iridium will host specially designed payloads on each Iridium NEXT satellite.*

*Aireon's CEO, Don Thoma, understands the importance of hosted payloads, having served as the Hosted Payload Alliance's Founding Chairman. The hosted payload model is a critical enabler of the Aireon space-based aircraft surveillance system and can be a similar enabler for other critical applications.*

*According to Thoma, "Hosted payloads create an unprecedented opportunity for new space applications by providing cost-effective access to space-based infrastructure. When we first started exploring hosted payloads on Iridium NEXT, we realized that the aviation industry would benefit by putting ADS-B, the FAA's next-generation GPS-based surveillance technology, in space. Aireon is coming to fruition by the merging of two important components—Iridium NEXT with ADS-B receiver hosted payloads built by Harris." He added, "This combination of technologies will enable a breakthrough air traffic management capability by providing real-time, global aircraft surveillance at an affordable cost to aviation stakeholders."*

*Iridium NEXT's low-latency, 66 cross-linked Low Earth Orbit (LEO) satellites make it uniquely suited to meet the technical demands of global air traffic monitoring. The LEO satellites will orbit approximately 485 miles above the Earth, and each satellite will be cross-linked, creating a dynamic network to ensure continuous availability in every FIR on the globe with low latency and update rates suitable for air traffic control. The Aireon receivers located in each hosted payload will detect ADS-B signals from next generation equipped commercial aircraft all over the world—including vital airways over oceans, mountains, remote areas and polar regions—relaying them seamlessly to air traffic controllers on the ground.*

*According to Matt Desch, CEO of Iridium "Aireon represents a big milestone for commercially hosted payloads and will serve as a ground-breaking use of Iridium NEXT. Iridium is the only company with the capability and reach to enable this, and we are thrilled that our service will make air travel more efficient and safer. Aireon is truly revolutionary."*

*The Harris Corporation is manufacturing the ADS-B receiver hosted payload that has a highly sensitive Aireon receiver coupled with multiple steerable beams, all capable of detecting aircraft with ADS-B compliant avionics. The overlapping satellite beams provide for multiple views of aircrafts from multiple satellites. This increases the ability to detect the aircraft at a high update rate.*

*Additionally, built into the Iridium® mesh network of satellites is the ability to transfer data between satellites to the ground receivers through a low latency data link. The information will then be distributed through a highly redundant processing center for use by Aireon customers. Aireon is working in partnership with Iridium, along with the leading ANSPs NAV CANADA, ENAV, the Irish Aviation Authority (IAA) and NAVIAIR to deploy the robust system.*

*The system will undergo rigorous testing over the next two years. The testing will be done by Aireon, and its launch customers in the North Atlantic and Europe and will ensure all safety cases are being completed. With the first launch of satellites scheduled later this year, and the full network expected to be completed in 2017, investors and partners will have several years to prove the concept before implementing it, with many additional ANSPs in the process of joining this group of pioneers.*

# WHY KA-BAND BEST SUPPORTS THE MODERN MILITARY MISSION

*By Rebecca M. Cowen-Hirsch, Sr. Vice President for Government Stratey + Policy, US Government Services Unit, Inmarsat*

**To respond effectively to conflicts and humanitarian missions cross the globe, troops have depended upon satellite communications (SATCOM).**

For years, the Defense Satellite Communications System Phase III (DSCS III) and UHF SATCOM programs—with augmentation from commercial SATCOM (COMSATCOM)—supported this function. However, 9/11 changed everything and ushered in a new era of asymmetrical, global conflict, while creating greater demand for data with maximum capacity, connectivity, reliability, interoperability and flexibility requirements.

As a result, the Wideband Global SATCOM (WGS) satellite system began replacing DSCS III in 2007, with each WGS satellite producing ten times the predecessor's capacity. Through WGS, the Department of Defense (DoD) has built a worldwide system to accommodate intensive data rate usage and long-haul communications for the military community, as well as the White House, the US Department of State, international partners and special users.

Each WGS satellite establishes service in X- and Ka-band frequencies. For the first time, military users can cross-band between the two frequencies onboard the satellites.

"These characteristics provide a quantum leap in communications capacity, connectivity and flexibility for US military forces and international partners while seamlessly integrating with current and future X- and Ka-band terminals," according to an official WGS factsheet posted by the Air Force Space Command (AFSPC). "Just one WGS satellite provides more SATCOM capacity than the entire legacy (DSCS) constellation."

While the X-band frequencies deliver critical tactical communication, Ka-band adds an enhanced capability of increased data rates and spectrum for wideband mission flexibility. WGS Ka-band is clearly emerging as government users' top choice for strategic planning.

Government users are increasingly seeking Ka-band from commercial owner/operators, as the DoD has developed a high dependency on COMSATCOM to fill "significant" capability gaps within WGS, according to the Government Accountability Office (GAO). "According to DoD officials, some combatant commands and military services believe they can acquire commercial SATCOM faster, better, and cheaper" than through military satellite communications (MILSATCOM), according to the GAO's recent report, titled ***Defense Satellite Communications: DoD Needs Additional Information to Improve Procurements***.

Historically, government users have turned to commercial providers of Ku-band to supply wideband requirements. But Ku-band is a commercial fixed satellite service that is predominantly

*Artistic rendition of Artist's concept of a Global Xpress satellite on orbit. Image is courtesy of Inmarsat.*

designed for television network broadcasting and is typically designed and ideally suited for fixed locations using large dishes. Military broadcasting can be adequately supported, but not the wide range of mobile communications which are needed in the current and coming age of military operations.

In addition, Ku-band is now a saturated spectrum, a commodity even, with congested orbital and frequency slots at full capacity due to the tremendous demand for broadcast access among land-based commercial users. While there are new generation Ku-band satellites in the pipeline, they are not expected to be operational until around 2018. Future Ku-band systems, as well as any replacement or added capacity, will be only for regional coverage.

In contrast, a single satellite service provider can field global coverage via the comparatively greater number of available orbital slots designated for Ka-band. There's an added advantage here—commercial and military Ka-band frequencies are adjacent, and the development of advanced hybrid terminals is underway to cover an extended Ka-band range.

Where MILSATCOM Ka-band service is not available, users can modify existing military terminals with minimal effort to access commercial Ka-band on those terminals that are already available. This saves on costs by streamlining the use of equipment, while allowing military users to readily switch between government systems and private-sector infrastructure on the same hardware, opting for what is best suited for their mission.

In addition, many new Ka-band systems are built with smaller, steerable beams for high capacity density, which adds some enhanced jam resistance for platforms while supporting significant uplink data rates for programs such as military Intelligence, Surveillance, and Reconnaissance (ISR) and other data-rich applications.

The military community now considers such performance critical for mission assurance. To further elaborate, the following is a detailed breakdown of the aforementioned and other driving factors which differentiate Ka-band as the preferred frequency for today's mobile and global satellite communications that augment existing MILSATCOM services with maximum reliability, capacity, flexibility and capability:

***Reliability***

Alternatives to Ka-band simply are unable to deliver the seamless and ubiquitous coverage that is essential for the military use. Only through a patchwork of satellites and systems, other system users encounter inconsistent power throughout the footprint that results in an unpredictable and varying quality of service between the middle and outer edges of the beam. This results in unreliable data transmission as distributed over "hot" and "cold" spots. In a cold spot, platform bandwidth can drop significantly. Global Xpress Ka-band, conversely, is composed of many "spot" beams that are seamlessly "stitched" together, which results in optimal and consistent coverage across the entire field of view of the satellite.

***Resiliency***

On orbit testing has proven Ka-band systems can transfer high-speed data without degradation, even in adverse weather conditions as well as on terminals measuring as small as 8 by 8 inches. Tests also demonstrated Ka-band high-speed data and video can be transferred securely with anti-jam protections from a protected tactical waveform (PTW) in adverse environmental and weather circumstances, shielding signals from interferences on the part of adversaries and cyber terrorists.

***Size***

The Ka-band antenna is one-fourth the size of those engineered for alternative frequencies. This is particularly crucial for airborne platforms, as smaller antennas can fit on smaller airframes while blending into aerodynamic surfaces better—this extends fuel efficiency and range. Land expeditionary teams benefit as well, using lightweight, easy-to-use terminals to support Communications-On-The Move (COTM) and Communications-On-The-Pause (COTP). With the military increasingly focused upon SWOP (size, weight and power), this advantage cannot be overstated.

**Flexibility**

The government is recognizing what Inmarsat calls "SATCOM as a service" as the standard-setter for satellite acquisition. This robust and global approach integrates complex solutions within an end-to-end managed services architecture and provides uniform Ka-band coverage. With SATCOM as a service, troops access satellite on-demand with round-the-clock availability of transponders, equipment terminals, backhaul, capacity and features. As Ka-band is uniformly global, the bandwidth is custom-ready for SATCOM as a service as well as being fully portable and available to users no matter where they travel. Unlike their experience with heterogeneous transponder leases across a myriad of operators—they do not have to estimate and pre-order bandwidth in advance of a pending mission. That historical piecemeal process costs time and money, which results in a loss of mission effectiveness. Through Ka-band, commanders no longer "guess" about how much bandwidth they will need, much less where, and thereby reduce expense and risk while increasing mission effects.

Innovation is all about continuous improvement—satellite technology is no exception. Engineering and design teams are constantly introducing systems that more immediately connect to high-throughput capabilities for any and all voice, video and data functions.

Ka-band has demonstrated its superiority as a readily available, dependable, flexible and affordable SATCOM option, a position well established through the government's own investment in Ka-band on WGS. The time has now arrived for the military and commercial industry providers to work together to create the best Ka-band environment possible for all concerned parties.

*Rebecca M. Cowen-Hirsch is Inmarsat's Senior Vice President for Government Strategy and Policy in the United States Government Business Unit, based in Washington, D.C.*

# THE CONTINUED EMERGENCE OF SATCOM BLOS FOR AIRBORNE ISR

*By Garr R. Stephenson, Jr., Head of the Airborne Comms-On-The-Move (COTM) Business Unit, UltiSat, Inc.*

**During 2015, SATCOM Beyond-Line-Of-Sight (BLOS) continues to emerge as a crucial element for today's missions, from what used to be known as basic service to one that now encompasses growing user requirements and increased capabilities.**

Absolutely essential is the need to combine real-time mobility operations and reach-back communications for warfighters and government users around the globe, allowing them to share mission-critical applications and information. The challenge of meeting these needs, while maintaining, and even enhancing, defense capability in critical areas to counter unforeseeable asymmetric and conventional warfare threat environments, has not decreased and will not do so, at least for the foreseeable future.

Airborne Intelligence, Surveillance and Reconnaissance (ISR) applications have become among the most important asset for supporting military operations. This has occurred due to the increased pressures regarding the tasking of improved situational awareness for military personnel, with warfighter protection extended into smaller, and additional, expeditionary locations.

In less than a decade, the relevance and reliance on MILSATCOM for delivering these high value ISR applications' information has become one of the primary requirements in concept of operation tactical planning. The ability to deliver all ISR application and sensor data over large areas of the world, with little to no latency, is not only a staple now but also a "must-have" capability—from what used to be a desire is now a demand.

Solution providers are asked to deliver high data rate applications over an IP network via satellite communications, with the connection being secure as well as persistent. Couple these demands with the pivot to unmanned platforms and the multiple variations in the payloads available on Unmanned Aircraft Systems' (UAS) platforms and a complex problem is presented for comms implementation.

Regardless of the wide range of sizes and shapes of UAS platforms, there remains the expectation that MILSATCOM systems will perform identically across all platforms. Simply put, there is no single, "square peg" for all of these "round holes." The solution resides in flexible, open systems architectures that can be integrated seamlessly into current platforms. These solutions have to perform far more reliably than any closed, vertically integrated solutions can do, all the while meeting the varying convolutions of various systems integration required by the wide array of airborne assets that are available today.

At one time, military and commercial organizations had to select solutions based on a vertical or horizontal integration approach. Today, technologies are based primarily on commercial, open architectures, which do provide an advantage in retrieving maximum performance from Airborne Communications, without limiting the ability to address future requirements and changes.

Commercial organizations are continuing to advance Commercial-Off-The-Shelf (COTS) technology at an expedited rate and, for the first time, are able to exceed the increasing demands for higher data rate applications, such as Full Motion Video (FMV). Previous product generations could only select from a handful of closed, vertically integrated options. The multiple options that are available today offer the highest value to the end-user through increased performance at a lower cost and the ability to scale or adapt to changing requirements.

There are multiple modem and antenna systems available that are able to interface with one another to provide true, best of breed capabilities. Customers should no longer be forced to select from limited, packaged offerings—they should now insist and demand flexible solutions that will adapt with the warfighters needed requirements and, over time, continue to evolve and migrate to even more capable systems.

Through the elimination of complex, resource-intensive, proprietary systems, end-users no longer need to be concerned that as soon as a capability is deployed, the technology is no longer able to support comms demands. Commercial systems provide the leverage necessary to remain ahead of the latest advances without any concessions regarding economics, security, or performance.

As a leader in Airborne ISR, UltiSat continues to leverage open systems based architecture to provide the correct "round peg" for global satellite solutions for UAVs as well as manned vehicles. The company will continue to deliver mission critical airborne ISR operations to fill each of our customers' "round holes."

*Garr R. Stephenson, Jr. heads up the Airborne Comms-On-The-Move (COTM) business unit at UltiSat, Inc. UltiSat is a leader in global SATCOM and managed network services and provides innovative strategies for the growing demand of airborne applications, without compromise for security, scalability, and flexibility. UltiSat currently supports Airborne COTM networks on manned Fixed Wing and UAV Programs for domestic and international customers.*

# #2 @ Air Force Space Command

*Story courtesy of Intelsat General's SpaceCom Frontier Blog*

**When then-Lieutenant General John E. Hyten offered his perspective on the value of Space Situational Awareness a year ago, he was, in effect, outlining the qualifications of his successor as Vice Commander of Air Force Space Command, Major General David D. Thompson.**

*U.S.A.F. Major General David. D. Thompson, Vice Commander, Air Force Space Command.*

"I don't know why it's so difficult for people to understand why we need Space Situational Awareness (SSA)," Hyten told the Space and Missile Defense Symposium on August 14, 2014, in Huntsville, Alabama. "If you're a soldier, one of the most important things you need is awareness of the battlespace around you before you go into a fight. If you're a Navy sailor, you don't want to go sailing the seas without full knowledge of everything that's around you, just for safety of passage, if nothing else. If you're in the air, goodness knows you have to set up multiple safety mechanisms to make sure you can fly safely... So why is it so hard for people to understand that in space, the 73 trillion cubic miles of space that is our (Area of Responsibility), we need situational awareness as well? We have to have it."

A year later, Hyten runs Space Command. Thompson answers directly to him and brings not only an understanding of all of those service needs, but a resumé that includes doing something about improving SSA from his former job as Plans and Operations chief (J-5) with US Strategic Command.

In January, Thompson signed a technical agreement wherein Germany joined with the United Kingdom, South Korea, France, Canada, Italy, Japan and Australia, as well as the European Space Agency, the European Organization for the Exploitation of Meteorological Satellites and 46 commercial entities in 16 countries, to share data to enhance multinational space cooperation.

"Our intent with combined space operations is to mirror some of the partnerships we have in other mission areas that are long-term and enduring," Thompson said in a Defense Department blog posting. "Joining together in a coalition is a statement of assurance that each nation is committed to effective, mutually supportive conduct of operations in space."

# Flex For Better SATCOM

*By Kay Sears, President, Intelsat General Corp.*

**Similar to many people, I have a smartphone that I use for email, texting, phone calls and many other daily tasks.**

However, truth be told, most of the time the device is in my purse or pocket, standing by for when I next need to use the phone. However, I pay a fixed monthly fee for talk minutes and data, whether I use the phone or not. Plus, if I travel to a different country, the price of using the phone on a new network goes up quite dramatically.

In many ways, the satellite business has followed this cell-phone-carrier pricing model: the customer leases a fixed amount of transponder capacity covering a certain geographic area, and pays whether the bandwidth is used or not. Intelsat announced recently that the company would like to change that practice with IntelsatOne Flex.

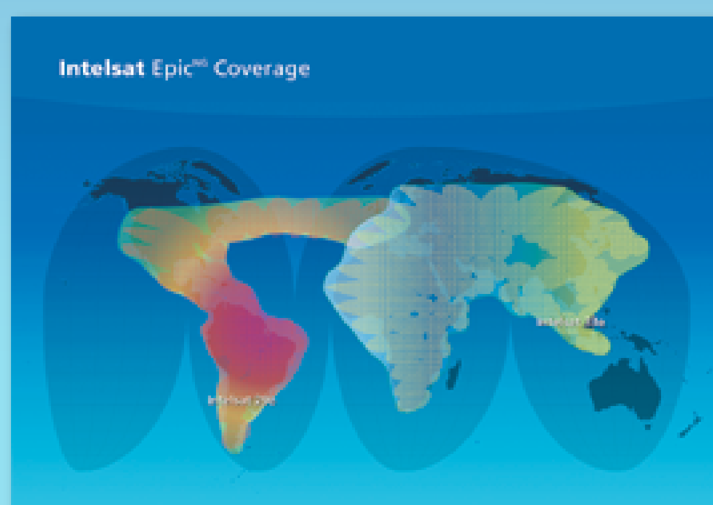
IntelsatOne Flex is a new service that could be of great benefit to the government and commercial user in these budget restrictive times and the needs of ever-more-mobile customers.

IntelsatOne Flex is a customizable service that will bring together the new Intelsat EpicNG high-throughput satellites (HTS), Intelsat's existing Ku-band fleet, the company's global ground network, and optimized iDirect Velocity terminals into a unified ecosystem.

Flex creates a global platform for small, geographically dispersed mobile terminals that will integrate the multi-spot-beam EpicNG platform into a customer's existing infrastructure and address inefficient bandwidth scaling on a customer's network.

Flex will allow customers to:

- **Simplify the integration of EpicNG HTS into current wide-beam network designs**
- **Customize, contend, prioritize and shape bandwidth for end-user segments**
- **Choose among tiered plans to meet average and peak bandwidth requirements**



A month later, General Thompson accompanied STRATCOM commander Admiral Cecil Haney to Intelsat General headquarters in McLean, Virginia, to discuss data sharing between military and commercial satellite operators, and to work on establishing an integrated commercial and government SATCOM architecture.

Acknowledging that the use of space is becoming more competitive and congested, Thompson is acutely aware of the growing problem of space debris that threatens free use of that 73 trillion cubic miles the Air Force is responsible for monitoring. This is an area of concern for commercial satellite operators, as well as the military. Perhaps more to the point, it's an area of concern for everyone.

"We have more than 30 GPS satellites on orbit today providing global navigation and positioning for the world," he said in a Defense Department news story. "Networks that run those and the timing required to keep them all in sync is enabled through the global positioning system that every US citizen and just about every advanced global citizen depends on."

Those concerns are why the Joint Functional Component Command for Space tracks more than 17,000 objects in space, about 1,100 of which are active satellites.

The debris is added to continually. When the Chinese tested an anti-satellite weapon in 2007, 1,500 more objects were created instantly. And when an inoperable Russian spacecraft collided with the Iridium 33 communications satellite in 2009, STRATCOM took on the role of monitoring the debris and warning others when their satellites were threatened.

The warning capability recently became enhanced when an organization of six commercial satellite operators—including Intelsat—stood up to work alongside military personnel at the Joint Space Operations Center at Vandenberg Air Force Base on a six-month trial.

General Thompson is acutely aware of how the debris problem impacts SSA. It's just part of his perspective about the area in which he works.

"Space is not owned by anyone," he said in a Defense Department news story. "It is used by all, and we strongly support responsible and safe use of space and transparency of operations that go on in space."

General Thompson then warned that Earth is not the only fragile environment. "We are talking decades or centuries before (space) will clean itself naturally, so we have to share and act responsibly with this precious resource because it's so important to all of us."

This is an understanding he brings to his new job, gleaned from years of working with satellites and the people who operate them.

- **Quickly and easily scale services to meet surge requirements or geographic shifts in demand**

In mobile applications, we have found that many government and commercial customers experience a wide gap between their average and their peak bandwidth demand, yet they often base contract requirements on expected peak demand. The Flex service will take this into account by pricing services based on both the average and the maximum level of service.

By using a centralized network management system, Intelsat will be able to monitor the utilization for each customer and add MHz capacity to "pinch-points" on a global basis across all vertical markets. This will add bandwidth where needed to create an enterprise-grade quality of service for each customer.

The network management system will also allow us to guarantee throughput for high-priority applications like emergency response or other mission-critical activities.

Commercial availability of Flex is tied to the Intelsat EpicNG launch program. The first EpicNG satellite (IS-29e) is expected to go into service in March/April of 2016, kicking off the first phase of the Flex service.

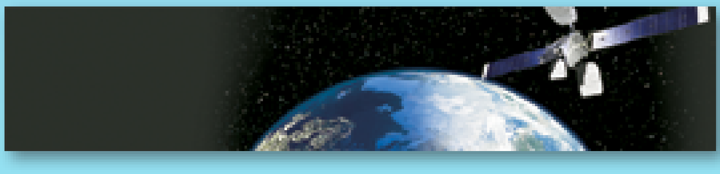
Intelsat will then launch additional EpicNG satellites throughout 2016/2017 and all will be included in this service offering. Wide beam satellites will augment the network for additional coverage on a customer-by-customer basis, starting with full North Atlantic coverage via the upcoming IS-34 satellite, set for launch in August.

The new Flex service is another example of how Intelsat General continually strives to adjust our service offerings to fit the ever-evolving requirements of the government and commercial customer. Additional details of how the service will operate will be provided as the 2016 implementation date draws closer.

***www.intelsat.com/ + www.intelsatgeneral.com/***

*Kay Sears, President of Intelsat General, is responsible for implementing the company's strategic and operational plans and for the overall mission of providing a range of sustainable, cost-effective and secure communications solutions to government and commercial customers. She has worked more than 25 years in the satellite communications industry, including extensive experience in rapid-response solutions for both military and civil agencies of the US government. Ms. Sears has spoken widely on how commercial satellites can be utilized by the military to solve mission-critical needs and she has worked over the past several years to advance the commercial / DoD partnership.*

*In 2009, Ms. Sears was appointed to the President's National Security Telecommunications Advisory Committee (NSTAC) to provide information, technical expertise, advice and guidance regarding issues that may affect national security telecommunications capabilities. Before joining Intelsat, Ms. Sears helped launch government services business units at both G2 Satellite Solutions and Verestar. Ms. Sears has also held sales and product development positions with Intelsat and Comsat World Systems.*



*Editors note: Our thanks to Intelsat General for allowing MilsatMagazine to republish these two articles from their SatCom Frontier blog.*

# NSR ANALYSIS: A MILITARY SPACE FOR SMALLSATS

*By Carolyn Belle, Analyst, NSR—USA*

**Selecting US General Hyten as the keynote speaker for the SmallSat conference in Logan, Utah, may have surprised some, given the nearly non-existent adoption of small satellites within the US Military's operational space architecture to date.**

Yet the factors driving commercial and civil government engagement in the small satellite market equally apply to military users. The question is not if the military and intelligence community can benefit from these, but how quickly they can leverage smallsat advantages within slow moving procurement processes and risk-averse, status quo operating frameworks. Given ongoing spending constraints, ever increasing demand for information and communications connectivity, ISR and a growing focus on resilient space, could these restraints be curbed in the coming years to make military and intelligence a true small sat market?

In its *Nano and Microsatellite Markets, 2nd Edition* report, NSR found that military users generated just one-tenth of activity in 1-100 kg. satellite launches over the last five years. While high volume commercial constellation launches are, in part, responsible for this imbalance, military users unquestionably remain the smallest group of operators. Moreover, nearly all of these satellites were experimental rather than operational.

Gaining successful experience as a customer of commercial ventures will be one way military doubts in small satellite capabilities are countered over the coming years. 2015 has already seen two indications of growing military acceptance of small satellite based services: a US Army contract with Terran Orbital Systems to provide distributed sensor monitoring and asset tracking via nanosatellites, and National Geospatial-Intelligence Agency speeches highlighting the utility of high-revisit small satellite data coverage.

Satellite-based weather data promises to be the next capability procured as a service, and, moving forward, the growing diversity of small satellite applications opens the door to more collaboration. In addition to providing services that are otherwise inaccessible, or overly costly, for budget-limited military entities, commercial small satellite ventures can expose the military to an experience that counteracts internal cultural resistance to the new mode of operations that accompany small satellites.

In addition to these budding commercial relationships, multiple military branches have launched technology development satellites that will pave the way for operational military satellites. While incapable of replacing larger satellites altogether, these experimental nano and microsatellite projects are exploring their potential to act as low-cost complements to larger platforms and serve as nodes in disaggregated architectures currently under discussion.

The opportunity to use smallsats as responsive assets, launched only when required for gap-filler communications or observation coverage, offers a novel capability. This is one aim of the joint Operationally Responsive Space office formed in 2007. While the DoD has, at times, attempted to defund the ORS office in favor of allowing military branches to pursue small satellite projects independently, the $6 million 2016 funding request signals a realization that such projects are not mutually exclusive, and that the platform warrants attention from diverse players.

Key applications for operational military small platforms will be Situational Awareness, Earth Observation, and Communications. The two US Air Force Geosynchronous Space Situational Awareness Program small satellites, launched in July 2014, are a first step, as is the intention to build follow-on weather and Space Based Space Surveillance satellites in a small form factor.

However, risk aversion, bureaucratic hurdles, and program stability both within the military and Congress, remain a stumbling point to implementing these ideas—several have been re-scoped and subsequently canceled before reaching fruition—such as the System F6 formation flying project and the Soldier-Warfighter Operationally Responsive Deployer for Space rapid launch vehicle. While not yet canceled, projects such as DARPA's SeeMe and the Army's Kestrel Eye Earth observation systems experienced ongoing delays and have yet to launch even test satellites. While these constraints are expected to eventually ease, the protracted process of military cultural evolution means the small satellite adoption rate will be slow in the near term, despite interest in their use.

### A Change In Perceptions

Military users are the smallest group to operate nanos and micros to date. Cultural resistance to new and untested ideas is high, and bringing programs to fruition has proven challenging. Yet, a series of experimental satellites from multiple agencies have laid the groundwork for expanding military use of the smallsat form factor, and capability demonstrations alongside successful use of commercial nano and micro services will enhance this further. Ultimately, a gradual perception change, combined with ongoing budget pressure amid growing requirements, will trigger an increasing use of small platforms and establish military and intelligence agencies as true participants in this rapidly growing market.

*Ms. Belle joined NSR as an analyst in 2014. Her main focus is satellite manufacturing and launch markets and, in particular, the trends surrounding the creation of diversified space architectures. She also contributes to research in government and military communications markets, in addition to participating in the diverse, tailored consulting projects undertaken at NSR.*

*Ms. Belle comes to NSR from the Research and Analysis team at the Space Foundation, where she contributed to the creation of the publication The Space Report 2014. Her research efforts primarily addressed new and emerging space products and services. This position was preceded by an internship with the Space Foundation during which Ms. Belle explored the policy considerations and efficacy of international space endeavors, such as the International Space Station.*

*Ms. Belle received a Master's degree in Space Management from the International Space University in 2013. Prior to attending ISU, she coordinated programs for a science outreach non-profit in Colorado. Her Bachelor's degree was awarded from The Colorado College in 2010 with a focus in Biology and Chemistry. During her undergraduate studies, Ms. Belle completed several internships at the NASA Ames Research Center in microbiology and atmospheric chemistry.*

# FUTURE ARMY NANOSATELLITES WILL EMPOWER SOLDIERS

ARMY TECHNOLOGY

*ByJason B. Cutshaw USASMDC/ARSTRAT Public Affairs*

**One Army project is making the future of satellite communications more responsive to Soldiers' needs.**

The US Army Space and Missile Defense Command/Army Forces Strategic Command's Nanosatellite Program, or SNaP, will be a small satellite communications, or SATCOM, constellation. This will allow communication across great distances using existing UHF tactical radios.

"SNaP is a technology demonstration with the goal of showing the military utility nanosatellites can provide to the disadvantaged user," said Thomas E. Webber, director, SMDC Technical Center Space and Strategic Systems Directorate. "The primary uses are beyond line-of-sight communications and data exfiltration. SNaP is a natural fit for the command since we are the Army proponent for space and also the SATCOM provider."

The command is engaged in organizing, manning, equipping and training space forces for the Army. The Army is the largest user of space and space-based capabilities.

In many remote areas where Soldiers operate, service members radio over-the-horizon communication from the field to higher headquarters, such as the brigade, is nonexistent. Army scientists and researchers built the SMDC-ONE nanosatellite as an innovative technology solution. The ONE stands for Orbital Nanosatellite Effect.

SMDC-ONE was a technology demonstration, which showed nanosatellites in Low Earth Orbit (LEO) could be used for beyond-line-of-sight communications and data exfiltration. Three next-generation SNaP nanosatellites are scheduled to launch this year and an undetermined number could go up afterward.

SNaP is a 5 kilogram, mass cube satellite, or CubeSat, which costs about $500,000 and is about the size of a loaf of bread. The CubeSat provides data and over-the-horizon communications capabilities and also has multi-functional relay capability, with five times the data rate of SMDC-ONE.

"SNaP will provide beyond-line-of-sight communications and data in disadvantaged environments to the warfighter and provide communication ability for users, who might not otherwise have communications, due to user location or overhead cover," said Jeff A. Stewart, technical manager, SMDC Space Division.

Another difference from previous satellites is that this is the first CubeSat launch with propulsion capability and SMDC's first with deployable solar arrays for battery charging.

"SNaP uses deployable solar arrays versus fixed arrays to increase power generation over SMDC-ONE," Stewart said. "SNaP also has a propulsion capability for station keeping to maintain constellation spacing."

On previous satellites, solar panels were attached to the sides of the satellite. At any one time, only two panels would be pointed at the sun. With deployable arrays, operators can orient all four toward the sun.

"Nanosatellites in LEO are traveling approximately 17,000 mph and are about the size of a football, which makes them very survivable," Webber said. "Providing the ability for our warfighter to communicate in an environment where traditional SATCOM is unavailable can literally be the difference between life and death."

SMDC plans for future constellations of relatively low-cost nanosatellites deployed in mission-specific, low Earth, which provide cost effective, beyond-line-of-sight data communications capabilities.

"SNaP will provide resiliency to the warfighter communication capability by providing beyond-line-of-site communications when no satellite communication is available due to line-of-site issues or due to a denied or degraded environment," Webber said.

The Army's goal for SNaP seeks to use small satellites to provide dedicated coverage to a wide range of under-served users in remote areas.

"SNaP is another step for the command toward providing a communications capability available to and commanded by the unit level," Stewart said. "SMDC-ONE laid the groundwork upon which SNaP is expanding."

The US Southern Command is partnering with SMDC, the US Naval Postgraduate School and other Department of Defense organizations to evaluate emerging nanosatellite technologies through the SNaP Joint Capability Technology Demonstration.

The project will evaluate the effectiveness of small, lower-cost satellites, which provide communications capabilities, enable mission command on the move and allow tactical leaders to synchronize actions, seize the initiative and maintain situational awareness, officials said.

"SNaP is designed for UHF communication with existing Army and some coalition radios," Webber said. "The advantage low-Earth orbit provides is the fact that satellites are so much closer to the Earth, which allows much lower signal levels to be received and processed."

The command delivered three nanosatellites in March for a late 2015 launch with United Launch Alliance on Vandenberg Air Force Base, California.

***Editor's note****: This article was written for the July/August 2015 issue of Army Technology Magazine (****armytechnologymagazine.com/****), which focuses on innovation. The magazine is available as an electronic download, or print publication.*