SatCom For Net-Centric Warfare September/October 2010

MilsatMagazine

STS-S26 STAGE SET

MILITARY SATELLITES

Kodiak Island Launch Complex, photo courtesy of Alaska Aerospace Corp.

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PAYLOAD

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INTEL

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3
2
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DOOR

COLONEL CAROL P. WELSCH
COMMANDER, SPACE DEVELOPMENT GROUP, SPACE DEVELOPMENT AND TEST WING, SPACE AND MISSILE SYSTEMS CENTER, KIRTLAND AFB, NEW MEXICO

Col Carol P. Welsch arrived at Kirtland AFB from Los Angeles AFB, where she served as the Director of Engineering, Space Superiority Systems Wing (SYSW), Space and Missile Systems Center. As the SYSW Director of Engineering, she was responsible for systems engineering, technology development, and development planning of a $4B space control enterprise including space situational awareness and counterspace systems.

Col. Welsch graduated from Rensselaer Polytechnic Institute in 1988 with a Bachelor of Science in aeronautical engineering and completed Rensselaer's Air Force ROTC program as a distinguished graduate. Col. Welsch's career includes a diverse set of assignments as an engineer in the space acquisition, space operations, cruise missile flight test, and strategic intelligence fields.

Col Welsch temporarily left the engineering field to serve as an Air Force Legislative Fellow to the Office of Senator Wayne Allard. As a member of Senator Allard's staff, she was responsible for all homeland security issues and assisted on military and space legislative issues. She followed this fellowship with assignments to the Air Staff Directorate of Space Operations and the Office of Legislative Liaison, where she served as the Secretary of the Air Force's focal point for all Air Force space legislative issues.

Col Welsch previously served as the Director of the Space Development Group, and is a graduate of the Air War College at Maxwell AFB, Alabama.

MilsatMagazine (MSM)

How did you decide to make the U.S. Air Force your career? What generated your interest in developing expertise within the space segment of the service?

Col. Carol Welsch

My first two assignments in the Air Force were related to survivability analysis and flight testing of strategic bomber weapon systems, and I found those assignments to be interesting and challenging. However, I always had an interest in space programs and applied for a position at the **50th Space Wing** at **Schriever AFB** for my third assignment. I was fortunate enough to get the position, and have stayed in the space community ever since.

I immensely enjoy the challenges associated with building satellites — the exquisite technologies, the creative problem solving, and the perfection demanded by systems which must operate flawlessly since they generally can't be repaired after launch. My decision to make the Air Force my career is a result of my passion for the work I am lucky enough to be assigned to perform.

MSM

How do you manage to juggle family and career successfully?

Col. Carol Welsch

Well, one may argue whether or not I do it successfully! I think juggling family and career is a struggle for many professionals today, and I'm no different. I am fortunate enough to have an incredibly supportive and understanding spouse, without which I'm certain I would not be where I am in the Air Force today. And I do my best to find time for family; it's amazing how much just taking a day off and spending it with loved ones can help you keep a balanced perspective.

MSM

What prompted your decision to enter the USAF's ROTC program at Rensselaer Polytechnic Institute, where we understand you also graduated, with honors?

Col. Carol Welsch

It wasn't "what" prompted me but rather "who", and that would be my parents. I had my heart set on going to **Rensselaer** to study aeronautical engineering, but my family couldn't really afford it and encouraged me to talk with the Air Force recruiter about an ROTC scholarship. The Air Force needed engineers and I needed a way to pay for Rensselaer, so it worked out well for everyone. And yes, I ended receiving a commission as a Distinguished Graduate. And while it's true that I signed up because of the scholarship, ROTC also instilled in me leadership and self-discipline, and was one of the smartest decisions I ever made.

MSM

Your time with the 50th Space Wing at Schriever AFB found you as the Chief, Studies and Analysis, for the Plans and Programs office. Did this deepen your resolve to achieve higher command and to influence the overall program with your developing expertise in this arena?

Col. Carol Welsch

The assignment at the 50th Space Wing provided me an excellent understanding of the challenges associated with day-to-day operations of many national security space systems. It also provided me the opportunity to work closely with many of the commanders at the 50th. These combined experiences gave me a broad understanding of Air Force space operations, which has been helpful throughout my career. Building space systems is great fun, but at the end of the day it's all about providing capability to the warfighter, and I credit my experiences at the 50th SW with helping me keep this perspective.

MSM

How much safer today are our warfighters, thanks to the U.S.A.F. and other services' commitment to space technology and military satellite communications?

Col. Carol Welsch

Our nation's space-based capabilities, including military satellite communications, is fundamental to the way we fight wars today. Satellite communications provide our forces the ability to synchronize efforts and move rapidly, able to stay ahead of an adversary's decision cycle.

Thanks to satellite communications, our forces can receive and send crucial information quickly and securely, all contributing to an unprecedented awareness of the battlespace. While these space-based capabilities provide our forces a distinctive advantage, it also drives an imperative to ensure that we can protect them and replace them in a responsive manner if necessary.

At **SDTW**, we are working to provide responsive satellites, launch systems, and ground systems to ensure our warfighters have the space-based capabilities where and when they need them.

MSM

Kirtland AFB in New Mexico has been your base home for a number of your most recent assignments... what are your responsibilities as the Commander of the Space Development Group? How does the SDDG support the activities of the Space Development and Test Wing, which is an integral part of the Space and Missile Center?

Col. Carol Welsch

As Commander of the Space Development Group, I'm responsible for managing and executing the ***Space Test Program*** (**STP**) and acquiring responsive space systems, including Operationally Responsive Space-1 (**ORS-1**).

Under construction — the ORS-1 satellite, photo courtesy of Goodrich ISR Systems

Our core competencies are acquiring satellites to support the R&D and responsive space communities, designing missions to get those satellites on orbit, and integrating the satellites to launch vehicles or to other spacecraft. The nature of our R&D and responsive space missions drives us to focus on smaller, more affordable spacecraft and innovative methods to get as many payloads on orbit as possible.

Our missions tend to be fast-moving and dynamic, which creates many challenges and often forces us to accept more risk than a typical space program. The technologies proven out by the ***Space Development Group*** are available for ***Space and Missile Systems Center*** operational programs, which helps these operational programs reduce the risk to their system development efforts.

MSM

What are the current online projects for your group, and how viable are these project assignments, given the current administration's whimsy with military budgets?

Col. Carol Welsch

Our major projects right now are the ***ORS-1*** spacecraft development, the ***STP S26*** mission, and a number of collaborative projects with **NASA**. Our Space Test Program funding has been quite stable over the last couple of years and we expect it to continue to be stable in the future.

MSM

You temporarily left the engineering field to serve as an Air Force Legislative Fellow to the Office of Senator Wayne Allard. As a member of Senator Allard's staff, you were responsible for all homeland security issues and assisted on military and space legislative issues. You then followed this fellowship with assignments to the Air Staff Directorate of Space Operations, and the Office of Legislative Liaison serving as the Secretary of the Air Force's focal point for all Air Force space legislative issues. Given this political experience, has it been helpful in your dialogs with the previous/current administrations? How so?

Col. Carol Welsch

My assignments in Senator *Allard*'s office and the *Office of Legislative Liaison* were tremendous experiences and provided me invaluable insights into the dynamics of our nation's legislative branch. Our nation's leaders face very difficult choices, and often don't have a lot of time to make tough decisions.

My experiences in Washington emphasized the criticality of providing decision-makers the best information possible, in a manner which is timely, understandable, and succinctly explains available options along an objective assessment of the costs, benefits, and risks associated with each of those options.

I recently attended the ***AIAA/Utah State University Small Satellite Conference*** (http://www.smallsat.org/) and was struck by the increasing number of students attending this conference. They were enthusiastic and their projects showed great innovation. It seems that building cubesats is capturing the imagination of young students today. I'm hopeful that we can build on this momentum and continue to encourage young students to study STEM programs.

MSM

From previous interviews, you have expressed a concern over the shortfall of qualified engineers for the US aerospace program. Is this situation still true? How do you define a qualified engineer? And how, in your opinion, can we interest today's young students to pursue aerospace careers and entice them into STEM educational programs?

Col. Carol Welsch

I understand that the financial downturn may have helped aerospace companies address their shortages of engineers. However, this is not a long-term solution and we need to continue to encourage students to pursue STEM degrees.

Today I'm more optimistic than I was just three years ago. I haven't seen any statistics lately — my optimism is based purely on anecdotal evidence. The advent of **cubesats** has provided more students the opportunity to have hands-on experience in building satellites, and the quality of their cubesat experiments is very impressive.

MSM

How are STP-funded missions assigned their manifest priority? And for those clients who have their own funding capabilities, how do they manage to receive SDG support for their spaceflight-testing projects?

Col. Carol Welsch

A 16-person multi-service executive panel serves as the *DoD Space Experiments Review Board* (**SERB**) to approve and rank experiments from across the DoD. DoD-sponsorship is the prerequisite which allows prospective experiments to seek SERB approval. SERB approval and ranking depends on the experiment's military relevance and scientific quality. We consider experiment priority, readiness, orbital requirements, and available flight options when developing a mission.For those clients who have their own funding capabilities, DoD policy authorizes STP to provide spaceflight services on a reimbursable basis.

MSM

How were you able to bring together all of the disparate third-party and service "parts" to cement together this unique mission?

Col. Carol Welsch

STP's charter is to provide spaceflight for the maximum number of experiments with the available STP budget. Launch is one of the most expensive aspects of providing spaceflight, so we seek to provide spaceflight for as many experiments as possible on any given launch opportunity. We have a long history of building technically and organizationally complex missions that involve multiple payloads and their respective supporting organizations.

MSM

Upcoming is the STP-S26 mission... could you describe this mission to our readers? Why is STP-S26 so important? Is there much in the way of inter-service cooperation?

Col. Carol Welsch

Space Test Program Mission S26 (**STP-S26**) is the 26th dedicated small launch vehicle mission of the Department of Defense Space Test Program. STP-S26 is a multi-payload, dual-orbit mission launching scientific research satellites into low earth orbit. It will carry four micro-satellites (mini-fridge sized) and two nano-satellites (loaf of bread sized), deployed from *Poly-Picosat Orbital Deployers* (**P/PODs**), into a primary orbit of 650 km. The *Hydrazine Auxiliary Propulsion System* (**HAPS**) will then deliver two ballast masses to a secondary orbit as high as possible with a goal of 1200 km, demonstrating the dual orbit capability of the ***Minotaur IV*** launch vehicle.

S26 will enable 16 scientific experiments on orbit. These experiments will pave the way for a variety of future technologies ranging from miniaturized spacecraft components to space weather sensors. The STP-S26 mission has SERB experiments sponsored from throughout the DoD, including **Air Force Research Lab**, the **USAF Academy**, **Army** and Navy. The mission also includes **NASA**, **NSF**, and universities.

MSM

Would you please describe the various elements of this mission — what satellites are to be included in the payload and what is their individual purpose?

Col. Carol Welsch

One of the four micro-satellites on the mission is ***STPSat-2***, which hosts two SERB experiments and is the first *Standard Interface Vehicle* (**SIV**). The SIV was developed by STP as a means to reduce mission cost and lead-time with a common spacecraft bus, a standard interface, and a streamlined acquisition process.

STPSat-2, the first Standard Interface Vehicle (SIV), photo courtesy of Ball Aerospace

Each SIV spacecraft can accommodate as many as four independent payloads. The potential to share the spacecraft and launch provides an opportunity for cost effective spaceflight for a variety of payloads. STPSat-2 will fly the *Space Phenomenology EXperiment* (**SPEX**), and *Ocean Data Telemetry Microsat Link* (**ODTML**) ranked #1 and #6 respectively by the 2006 SERB. The other three micro-satellites on this mission include the **Air Force Academy**'s ***FalconSat-5***, NASA's ***FASTSAT***, and the University of Texas at Austin's ***FASTRAC***. In addition to the four micro-satellites, this mission will launch two cubesats: NASA's ***O/OREOS*** and the **National Science Foundation**'s ***RAX***.

U.S.A.F. Academy's FalconSat-5

MSM

STP-S26 is also a return to the Kodiak Launch Complex — given some of the funding issues faced by this facility, how did the USAF decide on Kodiak as the center of launch activities for STP-S26? Also, how viable is the Minotaur IV launch vehicle for this mission?

Col. Carol Welsch

We launched DoD space experiments out of **KLC** on the ***Kodiak Star*** mission as a rideshare with NASA nine years ago, September 29, 2001, and are looking forward to returning to Kodiak. We considered Vandenberg AFB and Kodiak Launch Center (KLC) for the STP-S26 mission, and Kodiak was selected in early 2008. The facilities at Kodiak are excellent, and the Alaska Aerospace Corporation's support has been outstanding. The Minotaur IV launch vehicle meets or exceeds the performance requirements for the S26 mission.

MSM

The launch schedule for STP-S26 was delayed for a while, with a new launch date now set, are all of the elements for this launch tracking as expected?

Col. Carol Welsch

Yes. All of the micro-satellites have arrived at the launch site, and the motor has undergone primary processing. The remaining launch campaign consists of the final integration, and finally launch. As of now everything is on schedule for a November 19th launch (knock on wood!).

STP-S26 will demonstrate emerging space technologies that reduce the cost and risk to the development of operational space systems. Additionally, we look forward to the successful demonstration of the Minotaur IV multi-payload adapter, HAPS, STP-SIV and NASA Marshall Spaceflight Center's ***Fast Affordable Science and Technology Satellite***; all key enablers to greater cost efficiencies in providing spaceflight for DoD payloads. A mission success will also extend STP's heritage of using innovative approaches to provide access to space for as many SERB-approved DoD space experiments as possible for minimum cost. In fact, launch of the STP-S26 mission will mark a significant milestone in STP's 43 year history — the launch of the 500th experiment!

interview by: Pattie + Hartley Lesser, MSM

special thanks to SMC's PAs LaGina Jackson + Joe Davidson

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THE PLAYERS

The DoD Space Test Program serves as the primary provider of spaceflight for the entire Department of Defense space science and technology community and is administered by the Space Development Group based at Kirtland AFB, New Mexico. The Space Test Program is chartered by the Office of the Secretary of Defense to serve as "...the primary provider of mission design, spacecraft acquisition, integration, launch, and on-orbit operations for DOD's most innovative space experiments, technologies and demonstrations," and "...the single manager of all DOD payloads on the Space Shuttle and International Space Station." The Space Test Program is also the front door for all auxiliary payload launch service requests on Air Force expendable launch vehicles.

The Space Test Program has been providing access to space for the DOD space research and development community since 1965. The technologies behind most military satellite programs flying today, such as the Global Positioning System, military communications satellites and space-based surveillance and weather systems, had their initial demonstrations as Space Test Program risk reduction experiments. The Space Test Program has a long history and well-developed expertise in mission design; spacecraft bus acquisition, payload integration and testing, launch and on-orbit operations.

Space Test Program has successfully flown 443 experiments on 175 spaceflights (as of November 2006). Access to space is provided through all spaceflight means available, including Space Shuttle and the International Space Station and commercial and military expendable launch vehicles.

Space Test Program services are available for two categories of customers: experiments selected by the DOD Space Experiments Review Board that are eligible for Space Test Program funding and customers supplying their own funds. The Space Experiments Review Board serves as the focal point of space technology demonstration in DOD. Experiments that have a high potential for providing a new warfighting capability or enhancing an existing capability compete for Space Experiments Review Board approval and eventual spaceflight through Space Test Program.

Each year the Space Experiments Review Board releases a rank-order listing of all experiments they wish to have spaceflight-tested. This list is provided to the Space Test Program, which then manifests as many experiments as its budget will allow. DOD customers with their own funding can access all the services of the Space Test Program provided through the Space Development and Test Wing without having to compete at the Space Experiments Review Board.

Capabilities

- Mission design
- Spacecraft bus acquisition
- Payload test and integration
- Launch
- On-orbit operations

The Space Development and Test Wing develops, tests and evaluates Air Force space systems, executes advanced space development and demonstration projects, and rapidly transitions capabilities to the warfighter and is a 219-person government organization (189 at Kirtland Air Force Base), with 345 in contract support.

In July 1992, the Space and Missile Systems Center consolidated four separate reporting space and missile research, developmental test and evaluation organizations and stood up as the Space Experimentation Program Office. The newly aligned programs included the Rocket Systems Launch program, the DOD Space Test program, the Research and Development Space and Missile Operations program, and test and evaluation functions located at Vandenberg Air Force Base, California. Beginning in June 1993, research, developmental test and evaluation organizations activities at Los Angeles AFB, Onizuka Air Station, and San Bernardino, all in California, were collocated at Kirtland AFB alongside the Air Force Research Laboratory Phillips Site. In July 1995, the organization was renamed the Space and Missile Test and Evaluation Directorate. The consolidation of the organization at Kirtland AFB was completed on October 1997.

On June 29, 2001, SMC/TE stood down and SMC activated Detachment 12 at Kirtland AFB in preparation for the October 1, 2001, realignment of SMC to Air Force Space Command. The mission of SMC Detachment 12 was "to serve as the primary provider of launch capability, space flight, and on-orbit operations for the entire DOD space research, development, test and evaluation community."

The Space Development and Test Wing was activated on August 1, 2006, and performs development, test and evaluation of Air Force space systems; executes advanced space development and demonstration projects to exploit new concepts and technologies and rapidly migrates capabilities to the warfighter.

Space Test Group

The Space Test Squadron operates two Satellite Operations Centers, SOC 96 at Schriever AFB, Colorado and SOC 97 at Kirtland AFB. STS prepares and conducts on-orbit operations of DoD, U.S. Air Force, research and development and post-operational satellites. The Space Test Operations Squadron consists of an on-orbit communications satellite test site, mobile telemetry systems and the wing's space developmental test and

evaluation experts. STOS performs space vehicle developmental test and evaluation and supports launch and on-orbit operations around the world.

The Launch Test Squadron uses retired Minuteman II and Peacekeeper rocket motors for government research and development space launches and missile defense tests target vehicles Averaging more than eight flight tests a year, LTS has maintained a 100 percent success rate for the past 10 years for LTS managed launches.

Space Development Group

The Spacecraft Development Squadron provides spaceflight for DOD Space Test Program payloads, develops, integrates, tests and launches experimental technologies and prototypical space systems.

The Responsive Satellite Command and Control Division develops, integrates, tests, fields and maintains telemetry, tracking and control systems, data processing and distribution systems and operations support equipment for experimental and prototypical spacecraft and other unique spacecraft as assigned.

The Responsive Space Squadron integrates, tests, launches, fields and supports operations of an Operationally Responsive Space capability for the DoD. They directly interface with the organizations responsible for commanding, controlling and using ORS capabilities in support of Unified Command Plan-defined operational missions.

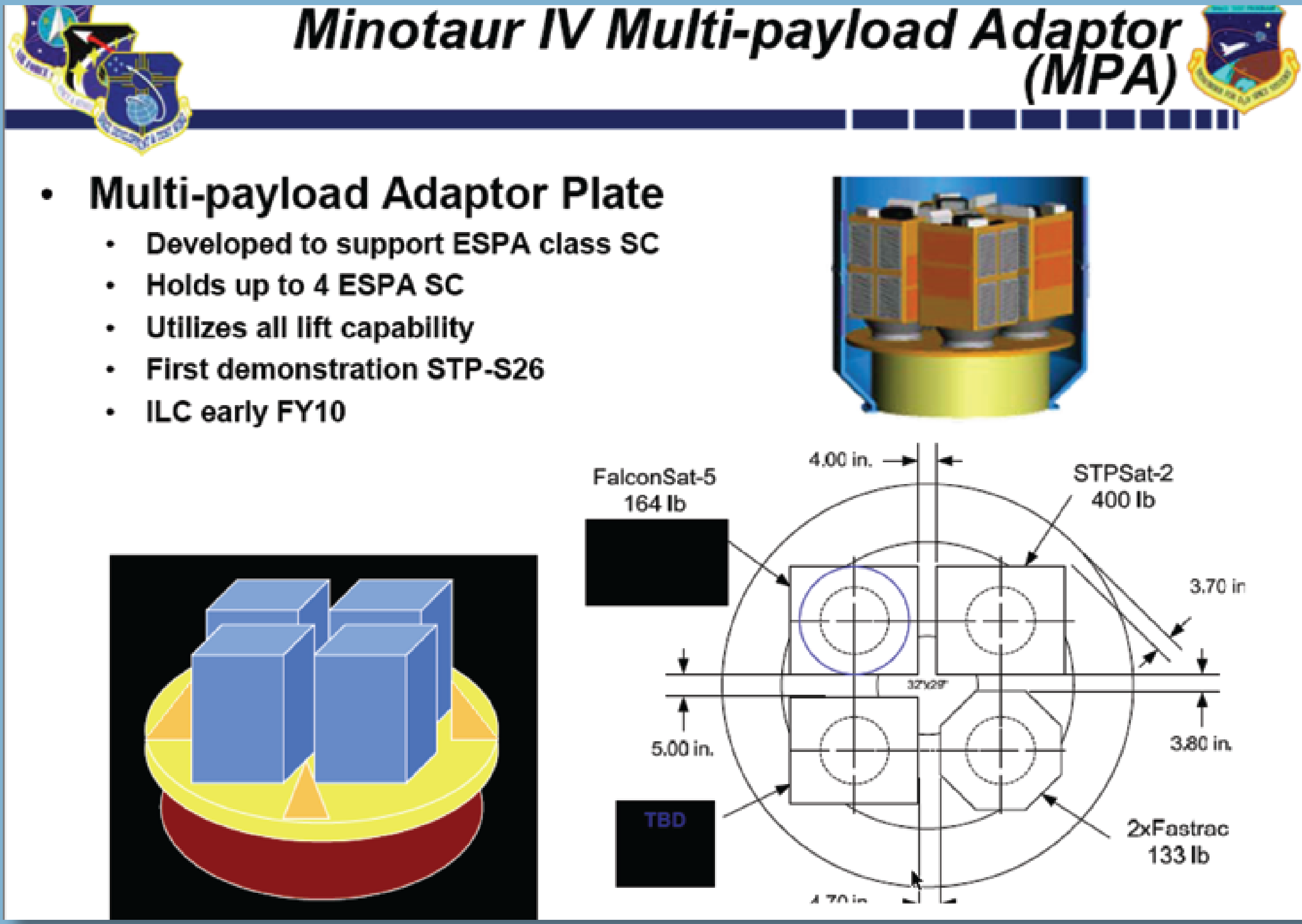
The Human Spaceflight Payloads Division provides spaceflight for advanced DOD research and development experiments and prototype operational systems aboard human rated space-based platforms and provides for integration, launch, and on-orbit operations of DOD operational and research and development satellites in the Space Shuttle and International Space Station.

author: Hartley Lesser, Editorial Director, MSM

GPS IIR Spacecraft launch

THE PLATFORM + THE PASSENGERS

Space Test Program Mission S26 (STP-S26) is the 26th dedicated small launch vehicle mission of the DoD's Space Test Program. STP-S26 extends previous standard interface development efforts and implements a number of capabilities aimed at enabling responsive access to space for small experimental satellites and payloads. The STP-S26 Minotaur-IV launch vehicle is configured in a Multi-Payload Adaptor configuration which includes the following features...



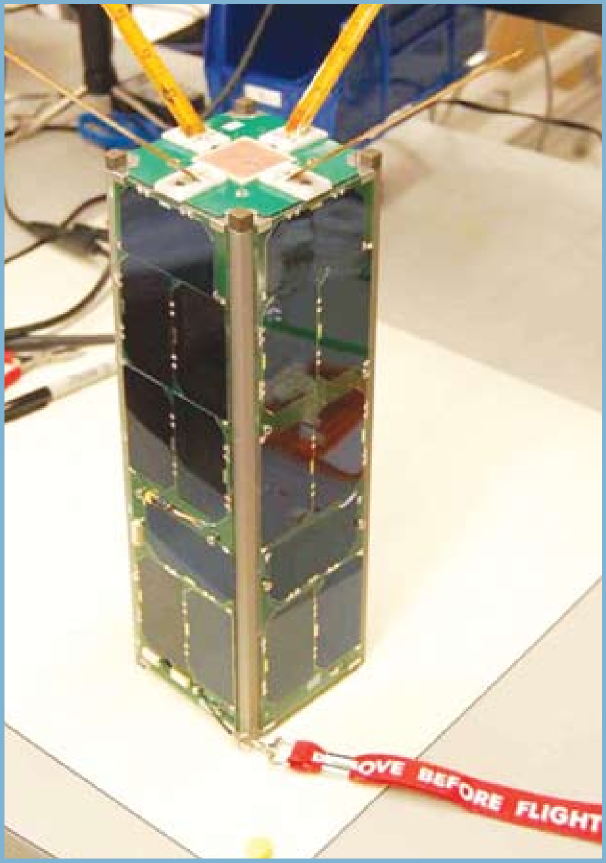
The Multi-Payload Adaptor (MPA) was developed by Orbital Sciences Corporation for STP to launch as many as four ESPA-class satellites on the Minotaur-IV.

P-POD illustration

Provisions have been made for the inclusion of up to four Poly-Picosat Orbital Deployers (P/PODs) to be mounted on the Stage 4 avionics cylinder. A team lead by professor Bob Twigs at Stanford University developed the Poly Picosat Orbital Deployer, or P-POD. This small container holds a payload of 10 x 10 x 30 cm3. The P-POD payload is used for small satellites, either with the full 10 x 10 x 30 cm3 size, or even smaller 10 x 10 x 10 cm3 cubes.

NASA's GeneSat-1 was flown in December of 2008 as secondary payload on the TacSat-2 mission. NASA is currently exploring the standard integration of P-PODs on all NASA Atlas V launch vehicles. The P-POD accepts a wide range of payloads — optical & magnetic sensors, tethers,

STPSat-2, photo courtesy of Ball Aerospace



The RAX CubeSat

computer processors, ADCS components, batteries, solar cells, MEMS — and it can fly on wide range of launch vehicles.

A dual orbit capability is provided by the Hydrazine Auxiliary Propulsion System (HAPS). The design provides volume and mass for four additional payloads attached to the HAPS avionics cylinder.

The Minotaur IV launch vehicle's primary payload for the STP-S26 mission will be the STPSat-2, which is an ESPA Class satellite and will pack the Space Phenomenology EXperiment (SPEX) and the Ocean Data Telemtry Microsat Link (ODTML), which will measure space phenomenology as well as relay ocean buoy data. Also onboard will be the National Science Foundation's RAX (Radio Aurora eXplorer) CubeSat, to be launched from the P-POD, which will study plasma instabilities leading to irregularities of electron density in the ionosphere, the 5th secondary payload.

NASA's Marshal Space Flight Center's contribution to the mission is their FASTSAT-HSV01, which will demo Fast Affordable Science & Technology SATellite bus technology, and will analyze costs and mission integration approaches. FASTSA is one of six secondary payloads. The FASTSAT-HSV01 is an ESPA class satellite and will present an affordable cost model in the small (microsatellite) spacecraft

NASA's FASTSAT-HSV01

University of Texas at Austin's FASTRAC

market, providing numerous opportunities for science, research and technology payloads. Incorporated into FASTSAT-HSV01 will be the Threat Detection System (TDS), comprised of a Thermospheric Temperature Imager (TTI), a Plasma Impedance Spectrum Analyzer (PISA) and a Miniature Imager for Neutral Ionospheric atoms and Magnetospheric electronics (MINI-ME). Additionally, the NanoSail-Demonstration (NSD2) is part of the delivery, a CubeSat technology demonstration, and the Miniature Star Tracker (MST).

The University of Texas at Austin developed the FASTRAC (Formation Autonomous Spacecraft with Thruster, Relnav, Attitude and Crosslink), which was created through the Air Force Research Laboratory University Nanosat program and is actually comprised of two satellites, FAST-1 and FAST-2, and will demonstrate relative Global Positioning System navigation, as the 2nd secondary payload.

U.S.A.F. Academy's FalconSAT-5

FalconSAT-5, the 3rd. secondary payload, was developed by the U.S. Air Force Academy, with Integrated Miniaturized ElectroSatics Analyzer (iMESA) and Wafer-Integrated Spectrometers (WISPERS), also an ESPA Class satellite that will detect ambient plasma density as well as validate thruster plume models.

The 4th secondary payload is from NASA Ames Research Center is the O/OREOS (Organisms/ORganics Exposure to Orbital Stress) CubeSat, to be launched from the P-POD, which will expose organisms to the space environment. The 6th secondary payload is Demonstration Separation System (DSS), built by Boeing,

author: Hartley Lesser, Editorial Director, MSM

illustration of O/OREOS CubeSat

LAUNCH CENTER: KODIAK LAUNCH COMPLEX

Many know Alaska as the 49th state — however, it wasn't that long ago that it was merely a territory of the United States of America. Even as a territory, the U.S. has appreciated the importance of maintaining a military presence in Alaska and in 1898 Fort Kodiak was established.

Since then, there have been many evolutions involving this northern land. After Alaska was purchased from the Russian Empire on March 30, 1867, for $7.2 million, at about two cents per acre, the land went through several administrative changes before becoming an organized territory on May 11, 1912. Then, on January 3, 1959, Alaska became the 49th state.

In 1911, before Alaska was an organized territory, on **Kodiak**'s neighboring **Woody Island,** the U.S. Navy established a radio facility. Later, the *Civil Aeronautics Authority* (**CAA**) and the *Federal Aviation Administration* (**FAA**) built extensive facilities there.

What started with the Navy's radio facility brought additional interest, and in 1939, construction on the **Kodiak Navy Base** began. The Navy remained based on Kodiak until 1971.

A joint operations center at Kodiak directed Alaskan operations in 1942-1943 and was the principal advance naval base in Alaska and the North Pacific when World War II erupted. The Army stood tall to defend Kodiak and in April 1943, the Army erected a permanent eight-inch

Kodiak launch facilities - photo courtesy of Alaska Aerospace Corporation

gun battery north of Kodiak, establishing it as a sub-post of *Fort Greely*, in Fairbanks, and named it **Fort Abercrombie**.

Kodiak's ships and submarines played a critical role in the Aleutian campaign. Fort Greely, with its coast artillery and infantry troops, stood ready to repel an invader, but in the end the enemy did not come. The U.S Navy selected Kodiak for their principal base because of the surprisingly ice-free waters.

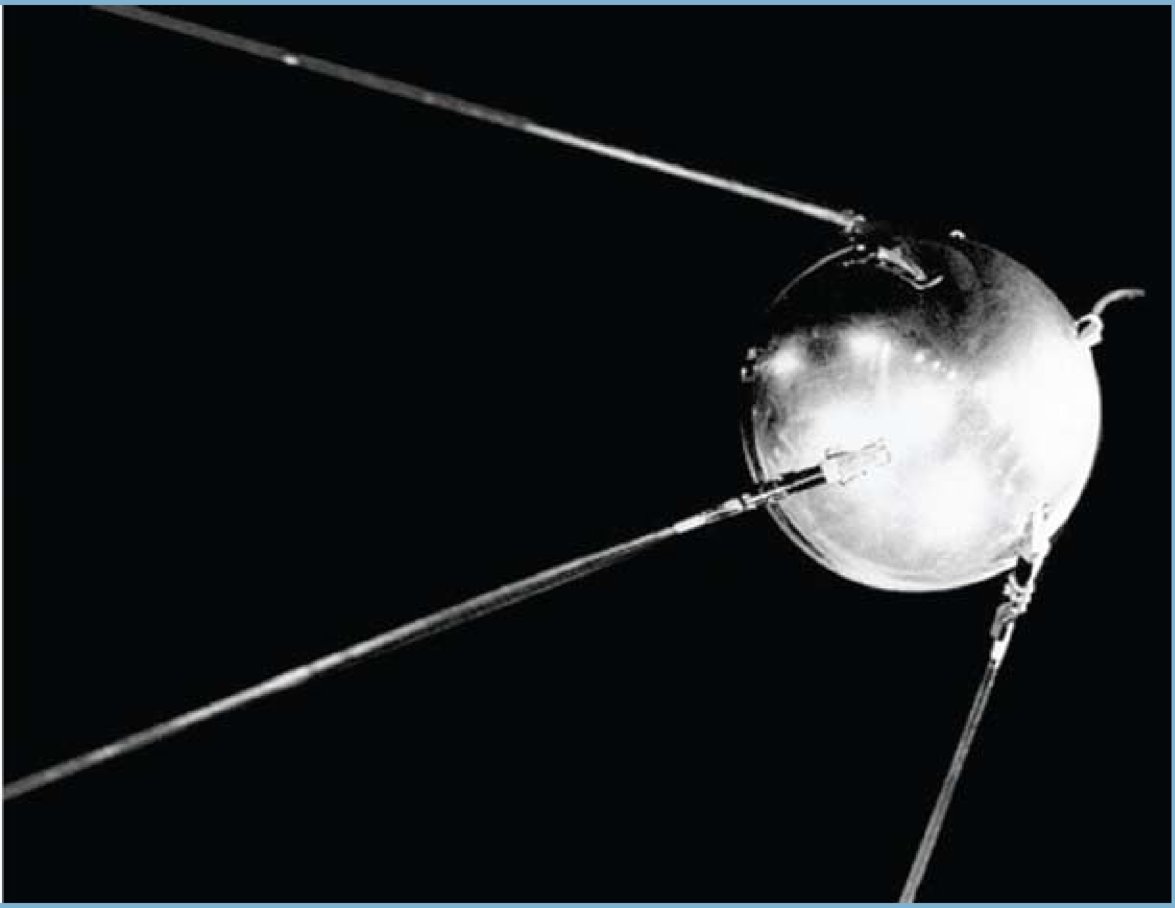
Upon the launch of ***Sputnik*** on October 4, 1957, the U.S. Air Force established a satellite tracking and control facility not far from the World War II army guns at *Chiniak*. Here, the Air Force base operated until 1975.

Today, this location serves as the **U.S. Coast Guard** base. A portion of one army gun battery has been partially restored and houses the *Kodiak Military History Museum* at **Ft. Abercrombie State Historical Park**.

The **Coast Guard Air Station Kodiak** is a *Seventeenth Coast Guard District* (**D17**) unit. The Air Station was commissioned as an *Air Detachment* on April 17, 1947, with one *PBY Catalina* aircraft, seven pilots, and 30 crewmen. It represented the first permanent Coast Guard aviation resource in Alaska. The Air Station is the major tenant of ***Integrated Support Command*** (**ISC**) Kodiak, and the largest command in D17 and the entire *Pacific Area* (**PACAREA**).

The present complement of 65 officers and 317 enlisted men and women support and operate six **HC-130H** long-range fixed-wing aircraft, four **HH-60J** medium range helicopters, and five **HH-65A** short range military helicopters.

Air Station Kodiak won the coveted *Association of Naval Aviators Award for Outstanding Achievement in Maritime Patrol* in 1992, and the *Coast Guard Unit Commendation Award* for exceptionally meritorious service from September 1993 to September 1995. The individual awards that have been won by the officers and enlisted men and



The Soviet Union launched Sputnik 1 on Oct. 4, 1957. The world's first artificial satellite, Sputnik 1 was a 183-pound beach ball-sized sphere that took about 98 minutes to orbit Earth. The launch of Sputnik marked the start of the space age and the U.S. – U.S.S.R. space race. Photo courtesy of NASA.

women of Air Station Kodiak include the highly prestigious *Admiral Bender*, *Admiral Hayes*, and *Admiral Gracey* awards since July 1991. Air Station Kodiak has been featured in a nationwide TV documentary by the *Arts and Entertainment Network* (**A&E**) entitled *Dangerous Seas*.

This historical account provides an appreciation of all who have gone before in contributing to the establishment of the stated-owned KLC, which is located on Narrow Cape of Kodiak Island.

HTV-2a launch

The base inhabits 3,100 acres on *Kodiak Island*, located 41 miles south of Kodiak and 250 south of Anchorage. Kodiak Island is a perfect setting for **polar orbit launches**. KLC is owned and operated by the Alaska Aerospace Corporation (AAC) which is an independent corporation established by the State of Alaska in 1991. The spaceport is located approximately 250 miles southwest of Anchorage, Alaska on a primarily treeless plateau overlooking the Gulf of Alaska.

Historically, KLC has served as the launch site for a variety of customers including: U.S. Air Force, U.S. Army, NASA, and the Missile Defense Agency. Of the 15 previous missions executed at KLC, there has been one orbital launch, 13 sub-orbital launches, and one mission where KLC served as a satellite ground station for a launch from the Vandenberg AFB.

Now the excitement and attention is focused on the launch of research satellite ***STPSat-2*** (*Space Test Program Satellite 2*). Now planned to carry the STPSat-2 are three rocket boosters manufactured by Colorado-based **Orbital Sciences Corp.,** which are more than twice as long as a school bus. The satellite is the principal payload among seven set to blast off aboard a ***Minotaur IV*** rocket this fall — the launch mission is named ***STP-S26***. The STP-S26 is the third Minotaur IV rocket launch in the world. Initially, the mission was

The Athena 1 rocket carried four small satellite payloads for NASA and the Air Force. This was the first space launch from the Alaska Aerospace Development Corporation spaceport on Kodiak Island, Alaska, carrying the Starshine 3, PCSat, PICOsat, and SAPPHIRE satellites.

delayed to adapt a motor designed for an intercontinental ballistic missile (ICBM) to launch satellites.

"We want to make sure the rocket's really going to work," said Air Force Col. *Carol Welsch*, director of the *Space Development Group*, speaking from New Mexico. "We want our experiments to be the risky part of the mission, not the rocket. This experiment, if it works, is going to provide us with the capability so that now whenever we launch... we're able to de-orbit and be good stewards of the space environment," she said.

Kodiak was selected for the launch in part because the mission requires a near-polar high inclination orbit. Vandenberg Air Force base in California could have been used, but it is harder to schedule launches at that location. Kodiak was also attractive because the Air Force encourages the practice of using a variety of launch sites.

"It's very appealing to us to launch out of Kodiak, get familiar with the facilities up there, get familiar with the people and how business works up there," *Welsch* said.

After the STPSat-2 launch from Kodiak, ***TacSat-4***, a Navy-led communications satellite mission, will launch in this fall aboard a second Minotaur IV. The first Minotaur IV rocket was launched earlier this year.

author: Pattie Lesser, Editor, MSM

WARFIGHTER ON-THE-MOVE

AUTHOR: BHUMIKA BAKSHI, C-COM SATELLITE SYTEMS, INC.

Providing mobile warfighters with broadband communications over satellite is an uphill battle as military forces must establish tactical networks that connect hundreds of remote locations quickly and under the most stressful of conditions.

Using satellite links, armed forces can transfer millions of networked applications and services, including video and Voice over IP (VoIP), Global Positioning Systems (GPS), email, instant messenger, even news feeds from news networks, with high reliability. Effective collaboration and communication across thousands of miles between military and governmental agencies is not simply an option anymore... such needs are a crucial "must-have."

With flexible operational services and compact ground terminals, SATCOM services offer attractive solutions for military users in theater and those operating via global links. When deployed in theater, SATCOM offers communications across varying terrains, flexible networking, and direct links to the various destinations — all without reliance on radio relays.

Military Satellite Communications (MILSATCOM) has become a necessity over recent years as the technology offers flexible access to various levels of command and control for global military operations. The well designed **iNetVu®** satellite antenna systems bring *Communication-On-The-Pause* into play, providing continuous connectivity under adverse conditions in many parts of the world. The system is capable of automatically and rapidly recovering from signal blockages caused by terrain/foliage, weather, and other obstructions.

Fast, Reliable + Secure Communications

Mobile satellite communication systems have proven to be quite reliable for the military, where the use of wire services is simply not an option. For users, it is extremely important to keep missions undisclosed for national security reasons. Satellite communication service meets this requirement — none of the calls or any other communication made via satellite communication can be tracked, as extremely high encryption technologies are employed by MILSATCOM providers.

The Russian Army using an iNetVu antenna

A pioneer in mobile SATCOM technology, **C-COM** has been delivering such high-speed Internet services to military forces worldwide. Automatically deployable iNetVu® antenna systems the company allow for the delivery of broadband services into military vehicles while stationary virtually anywhere one can drive.The iNetVu® systems can also be configured to operate from transportable cases, making it possible to deploy them anywhere, and at anytime.

Supporting mobile satellite Internet, broadband connectivity, streaming video and VoIP, the iNetVu® mobile VSAT antenna systems have become the choice for Emergency Response, Military, Police, Fire and Disaster Recovery applications around the world. In the most remote locations and under most adverse conditions, the iNetVu can quickly locate the satellite, automatically repeak (if required), and deliver instant broadband communication, cost effectively.

C-COM's design and development team's expertise in electronics and software development bring the latest industry features to the iNetVu® controller technology. Field feedback and specific requests have been rapidly developed into working customer solutions.

The iNetVu® antenna systems have been deployed by the Canadian, US, Russian, Polish, Czech, Danish, Chinese, and British military forces, as well as by South African,

iNetVu, as deployed by the Polish military

Vietnamese, UK, Russian, and Canadian police forces. C-COM's dealer — INTV, a leader in providing SATCOM solutions in the Czech Republic, has been providing iNetVu terminals since 2008. The main customer who benefits from high mobility and other advantages of these selfdeployable units is the Czech Army.

"The C-COM terminals are widely used by the Military, Geography and Hydrometeorology Services, by troops deployed in field missions abroad and by some special remote units as deployed throughout the Czech Republic. Besides the Army, there are also some civilian users already. For instance, an iNetVu terminal was deployed in late 2009 within the Crisis Management System of the Capital City of Prague, to serve in case of need as a quick-deployable mean of communication with the Crisis Management authorities in the Centre." says Mr. *Pavel Podhorny*, INTV.

The iNetVu® technology has also proven to be helpful during natural disasters, such as Hurricane Katrina in the state of Louisiana, Mexican floods, and the Sichuan earthquake, when wired services failed. The units enabled an easy to deploy, versatile, and transportable solution that supported all of the required communication applications such as VoIP, video, e-mail and critical data transfer.

Providing reliable communications to the remote warfighter through the iNetVu® mobile satellite antenna systems can make a huge difference, especially when split-second decision making is the key to the success of the mission.

VIDEO INTELLIGENCE

Full Motion Video (*FMV*) captured by Unmanned Aerial Systems (UAS), ground mobile platforms, and fixed persistent surveillance systems is emerging as a very powerful weapon in the arsenal of remote sensing. Harris is providing the Intelligence Community and their customers with the capability to harness that power into an intelligence resource for advanced processing, exploitation, and dissemination.

At the core of these capabilities is the Harris Full Motion Video ***Asset Management Engine*** (**FAME™**), a COTS-based solution developed

from decades of experience in the commercial broadcast industry. FAME is a video ingestion, management, and distribution architecture that provides the infrastructure for improving the way that video and other sources are ingested, cataloged, retrieved, and distributed. FAME integrates proven COTS products and practices from Harris' commercial broadcast business with the image processing, system integration, and security expertise we provide to our government customers.

Designed with input from government intelligence analysts, FAME is a collaborative platform that provides video, audio, and metadata encoding, video analytics, and archive capabilities within a unified full motion video solution.

It provides a platform where various metadata tracks are integrated and referenced against each other and against the content for intelligence fusion.

Simultaneous video feeds, received in multiple formats from multiple sensor types, can be ingested, annotated, discovered, exploited, and shared in real time. Discovery and dissemination of FMV products within bandwidth-challenged networks for situational awareness—enabled with products such as **Harris *Falcon III*® *AN/PRC-117G*** manpack radios — are supported with a thin web-based client for at-distance access and collaboration.

Harris Falcon III® AN/PRC-117G manpack

Harris provides analysts the capability to select from among multiple live feeds or prerecorded streams and to perform exploitation and dissemination in real time within a collaborative environment. Analysts can now collaborate simultaneously to annotate the video with mission text chat, telestration, and audio annotations such as universal time, video time code, and geospatial position are saved as rich metadata and are associated with the video content for later search, retrieval, and publication to the *Distributed Common Ground Station* (DCGS) *Integration Backbone* (**DIB**).

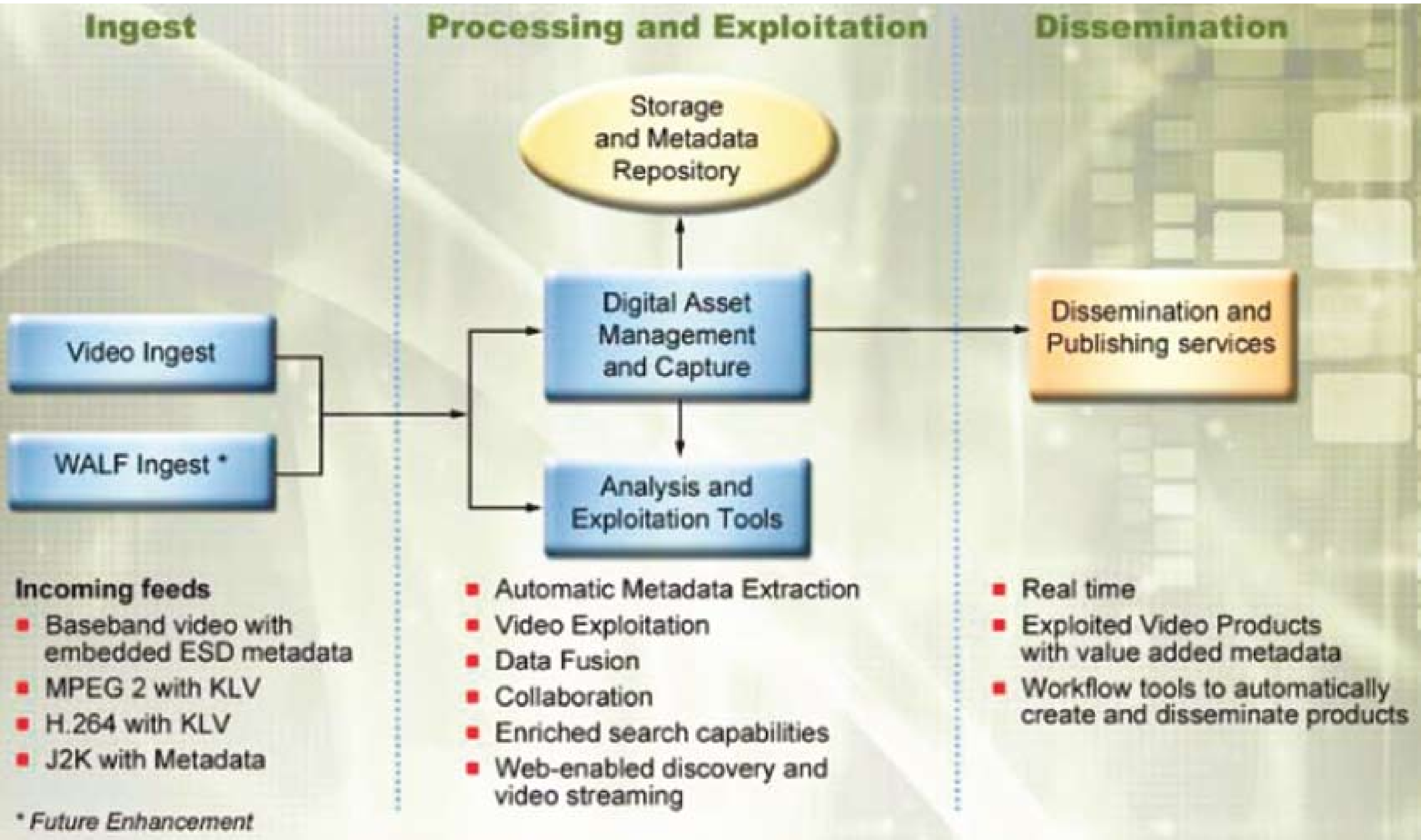
The Harris FAME-based solution solves many of the current issues that limit the exploitation of Full Motion Video. It provides for more robust archival, search, and retrieval capabilities. It associates extensive metadata with the video content for more efficient discovery and resolves the issue of video data essentially falling on the floor. Perhaps most importantly, it enables collaboration among multiple distributed users to yield better and more accurate actionable intelligence.

Enhanced Full Motion Video Capabilities

- ***Feeds — Ingests analog or digital video feeds with embedded (KLV or ESD) metadata; baseband, MPEG2, and H.264 streams in Standard Definition (SD) and High Definition (HD). Wide Area Large Format (WALF) feed ingest is a planned enhancement.***

- ***Multiple Feed Support — Enables selection of a feed of interest from a display of multiple real time incoming feeds from UAS or other platforms.***

- ***Metadata Extraction — Automatically extracts KLV metadata encoded in the FMV streams or files in compliance with MISP and STANAG 4609 standards.***



- ***Video Exploitation — The user, too, can add annotated text, telestration, and other sources as data.***

- ***Interface to DIB (DSCS Integration Backbone) — Extends motion imagery asset discovery, data fusion, and publishing.***

- ***Transcoding/ Transrating — Automatically adjusts formats and sizes to disseminate video to multiple users and platforms, including disadvantaged users.***

- ***MISB Standards — Employs Motion Imagery Standards Board (MISB) standards for FMV and metadata.***

- ***Scalable Architecture — Hardware and software elements are adaptable to the number of video feeds and clients to be serviced, as well as to the amount of storage required to support the database.***

- ***Collaboration — Enables multiple users at disparate locations to collaborate through telestration, audio, and chat, all stored for future reference.***

- ***Display Control — Enables the user to pause, rewind, slow-motion, archive, clip, and disseminate ingested content.***

- *Data Fusion — Enables the fusion of related data, such as maps, previous motion imagery, graphics, SIGINT, etc., through overlays.*

- *Web Enabled — Accomplishes discovery, communications, and interaction through web services. Web client allows streaming of low resolution content upon discovery using search or browse capabilities.*

- *Search Criteria — Enables the search and retrieval of motion imagery assets based on a large variety of criteria, including geospatial, temporal, and audio.*

- *Products — Provides an exploited FMV product with metadata, including Internet chat multiplexed into the MPEG2 transport stream. Exports NITF imagery files captured from video frames along with embedded metadata.*

All images used in this article are courtesy of Harris Corporation

KARL FUCHS, VP OF ENGINEERING IDIRECT GOVERNMENT TECHNOLOGIES (IGT)

Karl Fuchs joined iDirect Government Technologies (iGT) in 2004 as the Director of Engineering, just as the satellite-based IP communications company was expanding its very small aperture satellite (VSAT) market presence into the federal government and international Internet Protocol (IP) networking world. He now works as the Vice President of Engineering.

As Vice President of Engineering, Fuchs leads iGT's team of federal systems engineers and serves as chief architect for new product integration. Fuchs has more than 20 years of experience in the areas of technology and the federal government.

Prior to joining iGT, Fuchs was Director of Systems Engineering at Nortel Networks, where he oversaw the Verizon account team of systems engineers, leading the design of IP, Frame Relay, Asynchronous Transfer Mode (ATM) and dense wavelength division multiplexing (DWDM) networks. Before joining Nortel, he designed IP and ATM networks for Sprint and the federal government.

Participants at the massive Joint User Interoperability Communications Exercise (JUICE) evaluate new and emerging technologies in a joint task force environment.

MilsatMagazine (MSM)

How did iGT become involved in the JUICE project?

Karl Fuchs

In spring of 2004, **iDirect Government Technologies** (**iGT**) was asked by the **Missouri National Guard** to participate in the ***Joint User Interoperability Communications Exercise*** (**JUICE**). At the time, iGT had been working with the Missouri National Guard and the National Guard Bureau. The Missouri National Guard needed a way to demonstrate *Non-classified Internet Protocol Router Network* (**NIPRNet**) access for the National Guard and Internet access for first responders who also were participating in the exercise. iGT was the first Very Small Aperture Terminal (VSAT) provider to offer Virtual Local Area Network (VLAN) support on its remotes, allowing for access to both networks on a single platform. Every year since, iGT has demonstrated new, cutting-edge technologies including *Communications on the Move* (**COTM**), *Transmission Security* (**TRANSEC**), geographic hub redundancy and more innovations at annual JUICE events.

MSM

How can iGT leverage what was learned during JUICE to fortify their offerings in the MILSATCOM arena? What are iGT's initial thoughts regarding what they can do to improve MILSATCOM?

Karl Fuchs

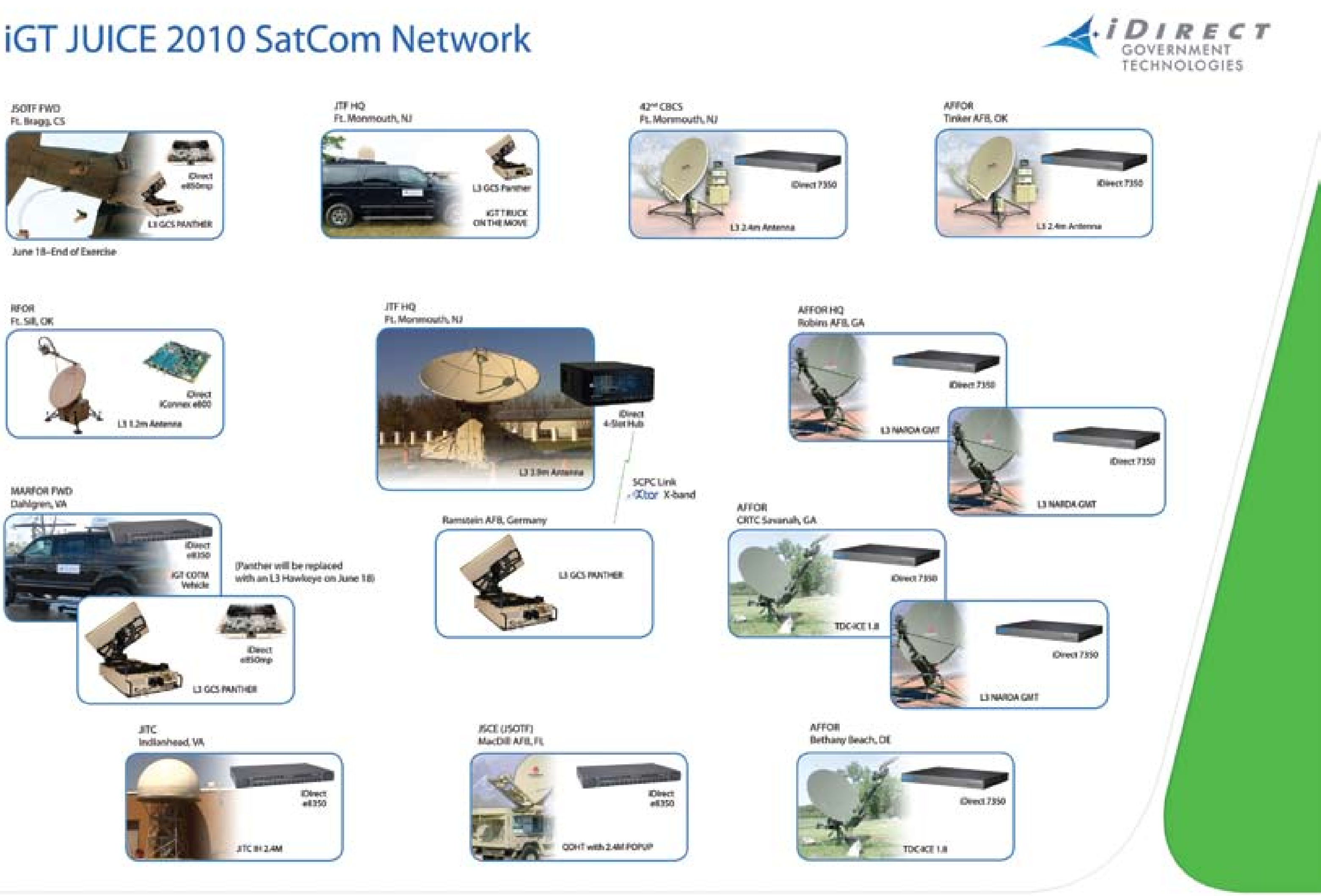
At JUICE 2010, iGT ***Evolution*** SATCOM equipment and engineering support was used to provide joint communications interoperability to U.S. military organizations in eight states as well as Ramstein, Germany. Additionally, *Secret Internet Protocol Router Network* (**SIPRNet**) connectivity between JUICE and the *Coalition Warrior Interoperability Demonstration* (**CWID**) was successfully implemented; a first.

Numerous VTC sessions were conducted between four participants; two *On the Move* (**OTM**) vehicles, the *JUICE Joint NETOPS Control Center* (**JNCC**) and *Joint Interoperability Test Command*'s (**JITC**'s) Indian Head, Maryland, test bed. The OTM vehicles were driven in the vicinity of **Fort Monmouth**, New Jersey, supporting JUICE, and in Dahlgren, Virginia, supporting CWID.

The VTC quality was exceptional considering that the JUICE Ku bandwidth was extremely constrained and the 18-inch OTM antenna are disadvantaged. JITC observation,

"...*on a scale of one to 10, voice was 10 and video between seven and eight. The latency was noticeable but well with acceptable limits*..."

Based on these results, iGT can leverage what was learned at JUICE to bring critical



iGT's JUICE SATCOM network

communications to the warfighter. The Air Force is an excellent example of how iGT can partner with the military to improve MILSATCOM — a JUICE 2010 primary objective of the **U.S. Air Force Space Command**, *689th Combat Communications Wing*, *5th Combat Communications Group* (**CCG** — was to establish a *Time Division Multiple Access* (**TDMA**) network over Ku-band SATCOM and implement *Everything over Internet Protocol* (**EoIP**) to support *Theater Deployable Communications Initial Communications Element version 3.0* (**TDC/ICEv3**.)

5th CCG, also acting as the *Air Force Forward Element* (**AFFOR**), accomplished these objectives over the iGT JUICE 2010 TDMA SATCOM NIPRNet with SIPRNet tunneled and TRANSEC enabled. The iGT modem-based terminals operated from Bethany, Deleware; Savannah, Georgia; **Tinker and Robins Air Force Bases**; and **Fort Monmouth**, New Jersey.

iGT is also helping to improve MILSATCOM, by enabling soldiers to receive battlefield imagery that identifies potential enemy threats, and transmit situational video to back to base. We also receive command and control information and even transmit X-rays and imagery of a wounded soldier to doctors who can interpret the injury and provide guidance on proper treatment.

MSM

Will the Warfighter actually experience some immediate benefits from the lessons learned at JUICE, or are these conclusions only applicable to future offerings?

Karl Fuchs

Our participation in JUICE has always included products and solutions that are readily available. For example, in this year's exercise, the COTM demonstrations and solutions would solve immediate needs of soldiers and commanders in current conflict.

Our own engineers benefit greatly from participating in the JUICE exercises as they gain a greater appreciation for how soldiers in the field actually use the equipment, and by understanding the challenges they face. As an example, this kind of shoulder-to-shoulder experience gathering has lead us to understand the difficulties a soldier faces with crypto key management. This lead us to develop our TRANSEC with a *National Security Agency* (**NSA**) approved internal key generation and software key distribution mechanism.

MSM

One problem has always been the timeline between exercises and viable, produced product... can iGT improve on this and bring into play product that will actually be useful in a shorter time period? If so, how?

Karl Fuchs

SATCOM OTM provides real-time situation awareness and, therefore, better command and control decisions in *non-line-of-site* (**NLOS**) scenarios. As configured and demonstrated during JUICE, the OTM systems are easily certifiable for *Approval to Operate* (**ATO**) and immediate deployment. One vehicle even used the same model **L-3 Communications** OTM antenna that is under consideration by several large programs. Information Assurance policy and procedures were followed and documented and only devices listed on the *Approved Products List* (**APL**) were used, including **KG-250 Type-1** encryption for SIPRNet. In addition, JITC participated in the JUICE OTM VTC sessions.

Another JUICE objective was to demonstrate ultra portability. **U.S. Marine**s participating in CWID and *112th Signal Battalion* (**AB**) paratroopers successfully joined the JUICE SIPRNet VTC sessions using an iGT Evolution-based ***L-3 Panther***, a ~30 lb. SATCOM terminal that fits in a rucksack. Readily available products and technology used by iGT at JUICE means faster deployment to the warfighter. iGT platforms provide support for battlefield and milsat applications today and will continue to evolve to meet the needs of future applications.

MSM

To the military and government users of COTM, the implementation of technology can be a highly frustrating process... are there any methods iGT can use to help assuage such implementations through additional training, product cycle reviews, and in-field activation of systems?

Karl Fuchs

The birth of the COTM market has seen its frustrations as the introduction of any new technology does. In the COTM space, the most difficult challenge has been the integration of the tracking antennas and the remote modems.

iGT has taken a few years and countless trials and demos to work out the kinks between the modem and antenna manufactures. We are working through similar challenges in the airborne COTM space. Airborne COTM is inherently more complex, given both the modem and the auto tracking antennas require input from the aircraft navigational systems. Now, all three must work together.

I believe the best way to speed development and ease the transitional pain of adopting these new technologies is through better communication and integration between the antenna and modem manufacturers. This is one area where the DoD may be able to help.

I have been to many productive DoD industry conferences, and one or more focusing in on development strategies for airborne COTM could be very useful.

MSM

Boots on the ground and bullets in the air tend to cause the Warfighter to become less-than-patient with third-party solutions that possess huge potential but take forever to bring into play. Can iGT do anything to influence decision-makers in regard to ensuring effective product plays its powerful role on the battlefield within short order?

Karl Fuchs

iGT is constantly working with the government and integrators to bring the best communications solution to the field as quickly as possible. We face many of the same challenges all other technology manufactures face including procurement complexities. I believe one of the most effective methods to bring relevant technology to the battlefield quickly is to simplify requirements and focus on what the warfighter really needs and let industry develop the best solution set.

MSM

Karl, what elements in your background make you the ideal spokesperson for your company and the warfighter?

Karl Fuchs

I have more than 20 years of industry experience in designing both terrestrial and satellite networks and products. The majority of my career has been dedicated to working in private industry along side of the **Department of Defense** (**DoD**) to provide robust, communications solutions. My product development role as Vice President of Engineering, coupled with my close relationship with DoD end-users as well as integrators, allows me to understand and articulate all sides of the technology development and insertion equation and provide solutions to the warfighter.

iGT's iConnex e850mp™ Satellite Router Board

This is an extremely compact and lightweight board that is designed to be easily integrated into a portable VSAT solution. The board meets the most rigorous demands for mobility and security, delivering always-on broadband capabilities into smaller form factors that support data, voice, and video connectivity in highly mobile military and government applications.

iGT's e850 manpack board

ZOMBIESATS AND ON-ORBIT SERVICING

AUTHOR: BRIAN WEEDEN

Intelsat's Galaxy 15 satellite

On April 8, 2010, news broke that the world's largest provider of fixed satellite services, Intelsat S.A., lost contact with one of its approximately 50 geosynchronous satellites, *Galaxy 15*. More important, the satellite's receiver and transmitter equipment was still functioning as it started to drift eastwards from its location in the geosynchronous (GEO) belt. Quickly dubbed "zombiesat" by the media, this combination of uncontrolled drifting while still having an active communications payload meant that Galaxy 15 posed a serious concern to other satellite operations in the region of the GEO belt, as it has the capacity to interfere with other satellites' operations.

The first satellite it encountered, ***AMC 11***, receives digital programming from cable-television channels, including the **Food Network** and **MTV**, and transmits it to more than one hundred cable systems across the U.S., Canada, and the Caribbean for distribution. **SES**, which operates AMC 11, was able to put mitigation measures in place to prevent interruption of service as Galaxy 15 drifted past the first week of June. On July 12 and 13, Galaxy 15 drifted past ***Galaxy 13***, and again a successful mitigation plan was executed to prevent interruption of service. Galaxy 15 will continue to drift past three other satellites throughout August and possibly September.

Since April 8th, many significant questions have been raised about the long-term viability of operations in the GEO region, given the current operational practices of global military, civil, and commercial operators. This article examines the Galaxy 15 event in greater detail, and offers recommendations for dealing with similar events in the future.

Key Takeaways

Intelsat is creating best practices for how a spacecraft operator should behave in a responsible manner, by communicating the problem to other space actors (including competitors) and working with them to minimize the negative impacts.

While there is no chance of Galaxy 15 colliding with another satellite in the near-term, it is now one of the hundreds of known pieces of space debris in the most heavily-used and economically valuable zones in Earth orbit, and will pose a long term hazard to GEO satellites located over North America.

The inability to easily and accurately determine what caused Galaxy 15's malfunction is a strong incentive to improve the ability to attribute on-orbit failures, both to try and create solutions and to reduce tensions that could arise from a case of assumed hostile action.

Development of *on-orbit servicing* (**OOS**) technologies and capabilities, along with improved global *space situational awareness* (**SSA**), are essential tools to help prevent situations like this in the future and minimize the negative impacts such situations have on space activities and the space environment.

The dual use and security implications of OOS technologies means these technologies should be developed, and more importantly used, in an open and transparent manner to promote confidence and stability in space security.

The Galaxy 15 Situation

According to news reports, on April 5, Galaxy 15 stopped responding to commands from ground operators. At the time, Galaxy 15 was providing a variety of media services to North American customers, including video transmissions, and also had a payload used by the U.S. Federal Aviation Administration. Intelsat quickly decided to move one of its on-orbit spare satellites, Galaxy 12, from a holding location to take Galaxy 15's spot and customers. Since the satellite continued to provide service to customers, Intelsat originally deemed the anomaly not terribly serious. It would take a while for Galaxy 15 to drift far enough where its service was disrupted; by then Galaxy 12 would be in place and able to take over.

On April 20, Orbital Sciences, the company that built Galaxy 15, suggested the communications problems with Galaxy 15 were potentially caused by a large geomagnetic storm occurring in space. In fact, on April 5, at 12:12pm MST, the NOAA Space Weather Prediction Center had released a space weather advisory warning bulletin about the storm. Galaxy 15 came out of the Earth's shadow and into view of the Sun while this geomagnetic storm was occurring. There is evidence that the storm somehow damaged the satellite's ability to receive or execute commands, although this has not, and may never be, fully verified in large part because of the lack of scientific ability to correlate space weather with specific satellite malfunctions and failures.

Whatever malfunction that did occur did not affect either the satellite's ability to re-broadcast signals or its ability to keep its transponders pointed at the Earth and Solar panels aligned with the Sun (known as "Earth lock"). This allowed the spacecraft to continue to receive and transmit signals. What it did affect was the ability of Intelsat's ground controllers to maneuver Galaxy 15 to maintain its orbital position. Intelsat issued between 150,000 and 200,000 commands to the satellite in an attempt to get a response to either turn off its communications payload or maneuver. When these efforts failed, the company attempted to send an even stronger signal to try and force an overload of the satellite's power system and cause it to shut down. This too failed. As a result, the satellite continued to drift slowly eastward through the GEO belt. What had seemed like a small problem was about to get much bigger.

On April 30, Intelsat raised the issue of possible interference with other satellites publicly for the first time. On May 4, Intelsat announced that Galaxy 15 was too close to another satellite, AMC 11, to attempt any further interventions. Galaxy 15 drifted into AMC 11's orbital slot around May 23 and exited on June 7. During this time, the possibility that it could cause interference with AMC 11's broadcasts prompted SES, the owner of AMC 11, to announce a plan for minimizing any interference caused by Galaxy 15 as it drifted past.

The plan involved moving another satellite, SES-1, into the same orbital box as AMC 11. As Galaxy 15 passed through the area, traffic was switched to SES-1 and then back to AMC 11 to stay as far away from Galaxy 15 as possible. SES has posted a computer animation of this process on their website. The plan also included using a very high-power antenna owned by Intelsat to be able to better distinguish between the three satellites in the same box and transmit to the correct one with pinpoint accuracy.

By all accounts, the plan worked and there was no noticeable interference or interruption of the satellite services provided by AMC 11. However, had the mitigation measures not been taken, SES said some customers would have experienced "severe service degradation". Over the next few months, Galaxy 15 will continue to drift through the GEO belt and past other satellites, potentially causing more interference along the way, and at the very least, causing those satellite operators to consider their own mitigation plans.

Intelsat has announced that they will continue their attempts to regain control or turn off the satellite when the satellite is safely separated from others' systems. Given the immense effort Intelsat has already attempted in this regard, it is unlikely that they will succeed. Fortunately, there is a failsafe option. At some point, the momentum wheels used to maintain the satellite's orientation will saturate and the satellite will lose Earth lock. Once that happens, the satellite will no longer be able to point its solar panels at the Sun, will lose electrical power, and will shut down. Even if control cannot be re-established after Earth lock loss, Galaxy 15 will no longer be able to interfere with the broadcasts of other satellites. However, one question remains, "How long it will be before this happens?" Intelsat's current estimates suggest that the failsafe scenario will occur at some point towards the end of August or early September.

Orbital has stated that the incident cost them $2.5 million as of August 1, and that they expect to spend another $1 million dealing with it over the summer of 2010. These costs are due to Orbital's investigative efforts to try and determine the root cause of the malfunction and development of fixes. Orbital has developed modifications and software patches for other satellites based on the same bus as Galaxy 15 that are currently under construction.

Failed and poorly operated active satellites in GEO can create the risk of physical interference, stemming from the inability to control the satellite and command maneuvers. These maneuvers are important for two reasons: to counter the natural perturbations which cause the satellite to drift east, west, north, or south relative to its assigned slot, and to avoid a collision with another object in the GEO belt.

An analysis of the current population of objects in the GEO region shows why both of these functions are important. The annual Classification of Geosynchronous Objects, published by the European Space Agency's Space Debris Office, is the best reference for what sorts of objects are located in GEO and how many there are. The February 2010 report provides the following details:

- ***A total of 1,238 objects known objects are in the GEO region:***
    - ***391 are under some level of control (either in longitude, inclination, or both)***
    - ***594 are in a drift orbit***
    - ***169 have been captured by one of the two libration points***
    - ***11 are uncontrolled with no recent orbital elements available (usually meaning they are lost)***
    - ***66 do not exist in the U.S. military's public satellite catalog but can be associated to a specific launch***

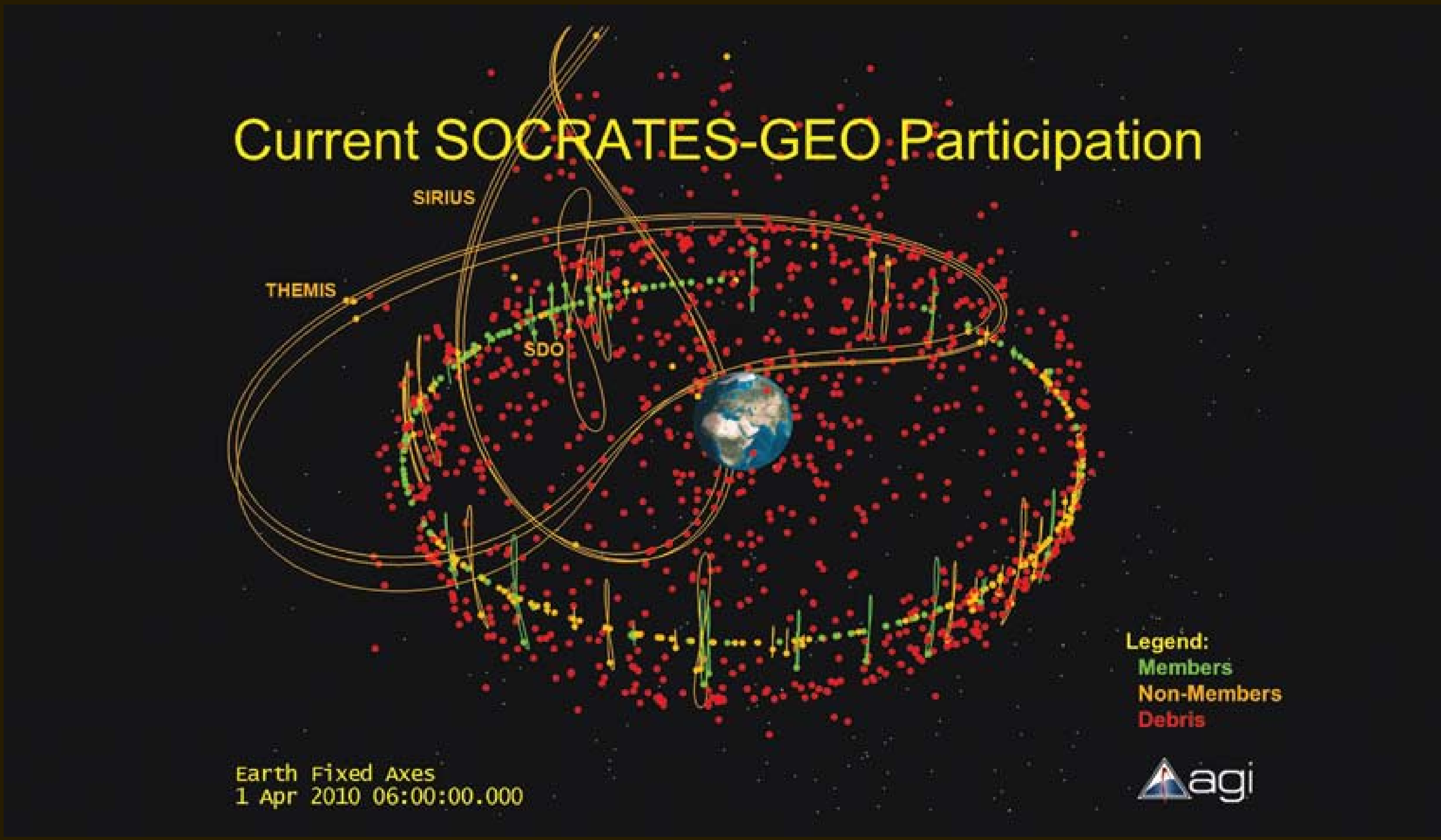


Figure 1: All known objects in the GEO region
Credit: Analytical Graphics Inc.

As these numbers illustrate, there are almost twice as many dead and drifting objects in the GEO belt as there are operational payloads. And there are likely to be many more pieces of space debris that have not yet been detected – current space situational awareness (SSA) capabilities can only reliably detect objects to about the size of a basketball at GEO altitudes.

Compounding the problem of space debris are satellites that are left in the GEO belt at the end of their service life. According to the recently adopted *United Nations Space Debris Mitigation Guidelines*, which are based on the more extensive **IADC Guidelines**, spacecraft operators are supposed to perform an end-of-life disposal maneuver to remove their satellite from the protected GEO region. This usually involves a series of maneuvers to boost it at least 250 kilometers (155 miles) above the active GEO belt.

Figure 1 visually captures what we know about what the GEO environment looks like. Active satellites are in green and orange, while space debris is in red. Far from being the simple, organized region as it is sometimes portrayed, the GEO environment is in reality a chaotic place. Accurate station-keeping by all satellite operators is extremely important, and the in-place failure of a satellite like ***Galaxy 15*** makes this problem worse. While it is unlikely that Galaxy 15 will collide with another object in the near future, our current inability to remove it from the active belt means that it will remain in the region indefinitely.

This physical environment is only part of the picture to fully understanding the scope of the

Galaxy 15 challenge. There is another side to the GEO environment that is invisible to our eyes and even optical telescopes. It is the electromagnetic (EM) environment, and it is here that Galaxy 15 poses the biggest short-term challenge.

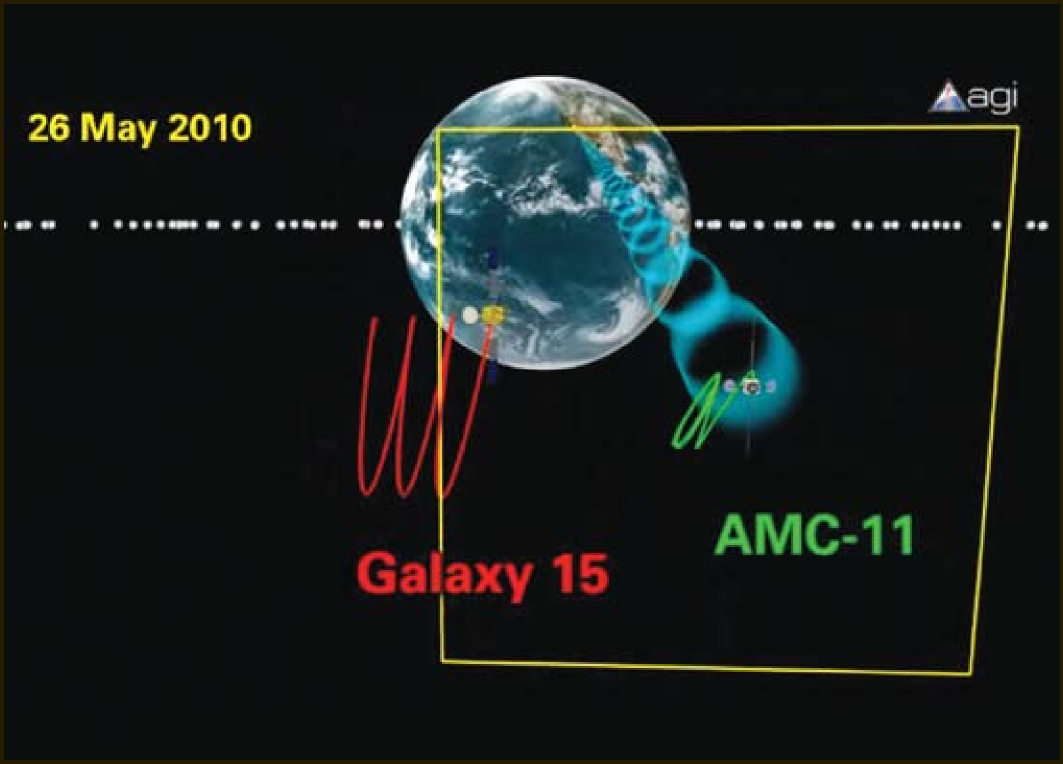
In addition to being the most physically congested region, the GEO belt is also a region in space that suffers from significant electromagnetic and more specifically radiofrequency (RF) inference. This is partly because, as discussed above, the satellites in GEO are all in relative close proximity to each other, as seen from the Earth. But more important, many of the satellites in GEO broadcast on the same radio frequencies.

Most current communications satellites use what is called C-band, between 2 and 4 Ghz. Recent advances in technology and engineering have allowed satellites to be built which use high frequencies such as Ku (12.5 to 18 Ghz) and most recently Ka (27 to 40 Ghz). Commercial communications' satellites are expensive investments, and therefore are usually engineered to last several years or more and tend to utilize common spacecraft buses and designs. Thus, many of the current satellites in use, including Galaxy 15, operate in the C-band.

Galaxy 15's users have been shifted to other satellites, meaning that there is no longer anyone deliberately sending signals for it to re-broadcast and thus it is not actively transmitting. However, because all of its receive and transmit gear is still working, Galaxy 15 is essentially an open microphone which could accidently pickup and re-broadcast C-band signals it comes across as it drifts through the GEO belt potentially causing multi-path interference. This is the primary concern as it drifts past other active C-band satellites, such as ***AMC 11***.

Recommended Steps

Having discussed the physical and electromagnetic problems that Galaxy 15 created, we can now talk about what can be done to mitigate the problem or perhaps even prevent it from happening again. Unfortunately, the answer for right now is "not much."



First, it cannot be understated how important SSA is to preventing such events as Galaxy 15. Essentially, SSA provides critical information about what is happening in Earth's orbit and the possible negative impacts certain events might have on the space environment and satellites. Although SSA is crucial, it is something that no one space actor currently does well. A satellite operator, such as Intelsat, has excellent information about the locations of their satellites, but no accurate information about the locations of other objects in orbit, including satellites operated by others and debris. The United States military operates a global network of ground and space-based radars and optical telescopes which are used to build catalogs of objects in orbit. These catalogs are the best sources of information about space debris, but generally do not have as good information about active satellites as those satellites' owners do.

Therefore, the key to establishing good SSA is data sharing between the states, which operate sensor networks, and thus have the best data on locations of space debris, and the satellite operators, which have the best data on the locations of their satellites. This positional data also needs to be combined with space weather forecasts, modeling, and warning. In this regard, the Iridium-Cosmos collision in February, 2009, prompted the U.S. to reinvigorate its efforts to offer SSA sharing services to nations and commercial operators through its *Shared Space Situational Awareness* program (formerly known as CFE). Intelsat and other members of the GEO satellite operator community have also come together to form the Space Data Association to share data among participating operators and potentially other entities. Both of these are significant developments toward solving some of the issues associated providing SSA and data sharing and should be applauded, but much more still needs to be done.

Unfortunately, satellites fail in the active GEO belt regularly — on average about one per year.

In February 2010, another Intelsat satellite, ***IS-4***, also failed in the active GEO belt at its operational slot of **72 degrees East**, although it was close to the end of its expected service life. On May 17, 2010, a Russian communications satellite, ***Express-AM1***, apparently had an on-orbit failure of its attitude-control system in its operational slot at **40 degrees East** over Europe. As of this writing, it is unknown if it can be moved to a disposal orbit.

There can be a variety of reasons for these failures. The two most likely scenarios are a severe space weather event, for which manufacturing or operational solutions that mitigate the threat are not presently available, or an equipment failure on the satellite, perhaps the result of a problem with design or manufacturing. What is unusual in the case of Galaxy 15 is that the failure did not damage its communications payload. However, this situation could have happened to any of the satellite operators — it just

Intelsat's Galaxy 15

happened to be Intelsat this time, and it is almost certain that similar failures will occur again with another spacecraft.

Through its actions during this event, Intelsat is establishing best practices for how a satellite operator should respond when situations like this occur. Intelsat has been working feverishly not only to try and regain control or turn off the satellite, but also to notify their fellow satellite operators (and competitors) and work with them to try and find ways to mitigate the problem. Intelsat's actions with regard to communication and cooperation in this situation should be considered the standard of care by all satellite operators for future situations of this nature.

This is in stark contrast to what happened with another recent failure, that of **DSP Flight 23** in the fall of 2008. ***DSP-23*** was a U.S. military satellite which was placed into GEO in November 2007 as part of an existing constellation which provides global missile warning.

The first reports of DSP-23's failure came not from the U.S. government but from amateur satellite observers who had noticed that it had stopped station-keeping in its assigned slot and had also stopped broadcasting as powerfully as before. DSP-23 was originally located over Europe and drifted towards the libration point at **75 degrees East** over India, going right through a cluster of three operational satellites operated by **Eutelsat** and then a cluster of six satellites operated by **SES Astra**. Sadly, it was the same amateur observers who provided SES Astra with the first warning that DSP-23 would drift through their constellation, and it was only after it broke in the media that the U.S. government provided assistance to SES Astra.

It is important to note that the United States is not the only key player that has acted with undue secrecy when it comes to sensitive satellites adrift in the active GEO belt. There are numerous Russian military satellites which either failed or were intentionally left in the active GEO belt, along with many Russian rocket bodies. And while the United States has made significant strides recently in providing conjunction assessment assistance for all space actors, the Russian government still does not even provide basic catalog data on debris to the public.

Although SSA, communication, and cooperation are critical to responsibly dealing with a "zombiesat" situation, they do not solve the problem. This leads one to consider the core problems of placing objects into space, particularly in the GEO orbit: What do we do when a spacecraft "breaks"? Satellite engineers put a lot of time and effort into designing systems that are redundant on multiple levels and can withstand the harsh space environment. However, satellites are complex machines and do fail, and when they do so in orbit, their operator can't just pull over to the side of the road and call for a tow to the nearest repair shop.

That may soon be changing. Recently, there has been renewed interest in the concept of *on-orbit servicing* (**OOS**), the ability to refuel, move, or even fix satellites in orbit. In 2007, a student group from the International Space University produced a detailed report on the topic, outlining which missions have the most viability from a technical and economic standpoint and what the challenges are to making OOS a reality.

In March 2007, the ***Defense Advanced Research Projects Agency*** (**DARPA**) conducted an experimental mission in low

Earth orbit to test some OOS technologies. Dubbed ***Orbital Express***, it consisted of two spacecraft: the ***Autonomous Space Transport Robotic Operations*** (**ASTRO**) vehicle and a prototype next-generation serviceable satellite called ***NEXTSat***. Over the course of three months, the two spacecraft conducted a series of operations, including docking and transfer of fuel and a battery change. Recently, **MacDonald, Dettwiler, and Associates** (**MDA**), a major Canadian space contractor, announced that it saw increased evidence of a business case for OOS, especially in the GEO region, and that it is currently working on further developing the Orbital Express technology for GEO applications.

ASTRLO and NEXTSat

Development of OOS technologies could potentially allow for several beneficial capabilities. The first would be placing an on-orbit "tow truck" located in the GEO belt (or in low Earth orbit) which could be used to move malfunctioning satellites such as Galaxy 15 back to their assigned slots. If everything else is working except for their ability to maneuver, the tow truck or other system could attach an auxiliary maneuvering system to the satellite to repair and allow it to resume operation.

An orbital tow truck could also be used to boost satellites out of the active GEO belt at the end of their service life. This tow truck function could also be expanded to include all the dead spacecraft, rocket bodies, and other large pieces of debris already littering GEO. Known as *orbital debris removal* (**ODR**), this process of actively removing objects is the only known way to clean out the legacy debris that exists in GEO and is a topic that has received a lot of attention lately.

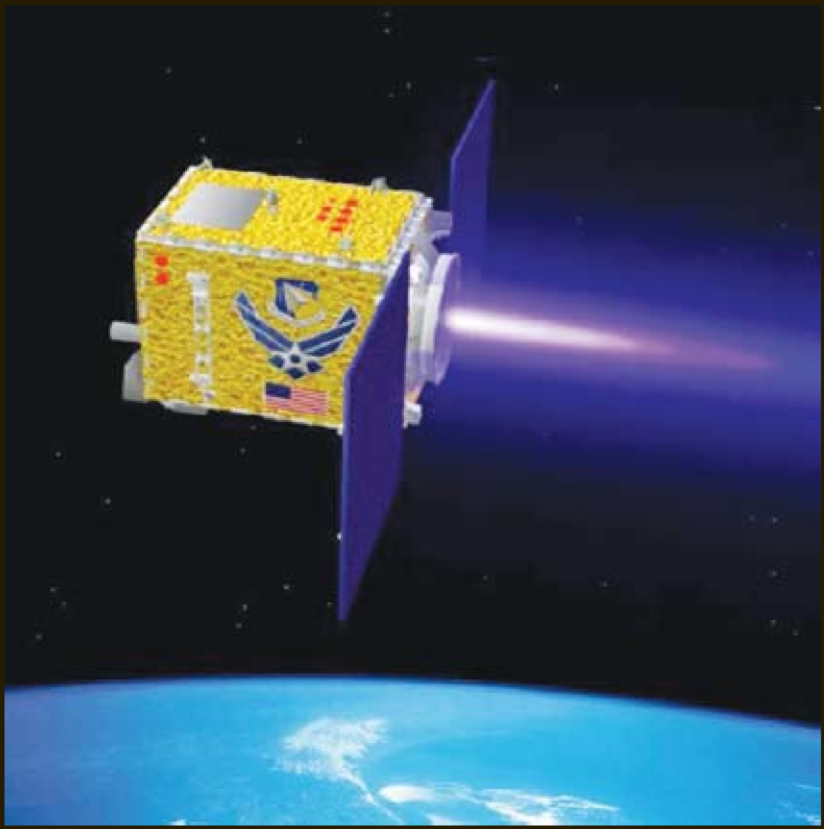
Currently, one of the biggest issues with this end-of-life-disposal process is accurately estimating the amount of fuel remaining onboard a satellite. This is very difficult to do, with potentially serious cost implications for the operator. If they err on the side of caution and dispose of the satellite early, it could mean forgoing months or years of revenue generated by the satellite. But if they wait too long, they might not have enough fuel to move the satellite out of the way. In either case, hiring an OOS satellite to perform the disposal maneuver for them could be very beneficial.

At the **5th European Space Debris Conference** in spring 2009, scientists and debris researchers concluded that simply reducing the amount of space debris we create is not going to solve the problem. There is enough existing debris that even with no new launches, debris-on-debris collisions will continue to create more debris. The researchers concluded that ODR is necessary to ensure the long-term sustainability of Earth orbit, and that removing a few as five or ten of the most massive debris objects each year might be enough to stabilize the growth in debris population. These conclusions prompted DARPA and NASA to jointly sponsor the first International Conference on Orbital Debris Removal, held in December 2009.

There is a downside to developing these OOS capabilities — most of the technologies and capabilities that provide OOS could also be used to intentionally harm satellites and could be considered offensive counterspace capabilities. This is not a new concept — it dates back to almost the dawn of the Space Age with the original proposal by the American military for ***Project SAINT*** (short for **SAtellite INTerceptor**), a satellite consisting of a television camera and radar mounted in the nose of an ***Agena B*** upper stage. After being placed in orbit, SAINT would then maneuver close to an unfriendly target satellite, photograph and analyze it, and report back all the details to the U.S. military. The U.S. Air Force wanted to also give SAINT the ability to destroy or disable the target satellite, but such efforts were blocked by the Eisenhower and Kennedy administrations and the program was eventually canceled before it became reality.

Recently the U.S. military has funded a series of technology demonstration missions and experiments to develop different technology concepts similar to those found on the original non-destructive SAINT program. These include the XSS-11 and inspection satellites (more information at this link: http://www.kirtland.af.mil/shared/media/document/AFD-070404-108.pdf) (located in LEO and GEO, respectively) and NASA's ***Demonstration for Autonomous Rendezvous Technology*** (**DART**) satellite (http://www.space.com/missionlaunches/050422_dart_update.html). Most recently, the United States launched the ***X-37B Orbital Test Vehicle 1*** (**OTV-1**) on April 22, 2010 (http://secureworldfoundation.org/images/X-37BOTVFactsheet.pdf). The X-37B is a miniature version of the space Shuttle which is launched on top of a conventional space launch vehicle.

All that being said, there is no evidence that the United States has developed any of these satellite programs with the goal of using them for offensive counterspace purposes. All of these programs are critical milestones in developing and advancing OOS technology. Moreover, the lessons learned from programs such as **MiTEx** and **XSS-11** could be of great benefit in situations such as another Galaxy 15 and can enable future orbital debris removal vehicles. However, the continued military



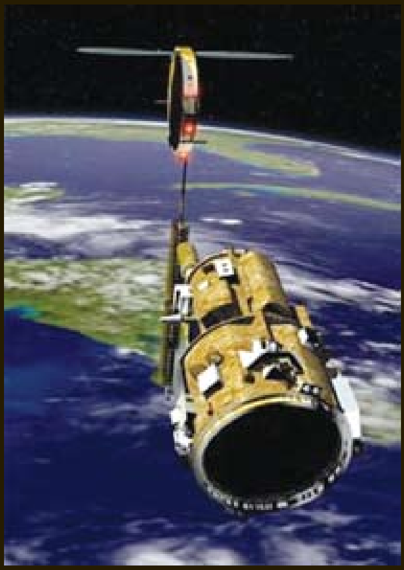
XSS-11 micro satellite

funding of these programs, coupled with the secrecy surrounding their activities in orbit and/or orbital position, serves to garner objections from military space competitors such as Russia and China and promote concerns from global peace activists. This lack of transparency may cause other states to treat these programs as if they are space weapons. This will invariably lead them to pursue policies and programs that could destabilize the space security situation, which in the long run may be detrimental to the security of U.S. space assets and long-term sustainability of Earth orbit.

Thus, it is within the interest of all space actors to continue to develop OOS technologies as they can be very beneficial in the diagnosis, recovery, and disposal of failed satellites as well as the removal of existing space debris. However, it is crucial that this development take place in as open and transparent a manner as possible to provide the necessary confidence that it is being done consistent with the peaceful uses of outer space, as laid down in the *Outer Space Treaty*.

Essential to developing OOS capabilities, and using them to reduce space debris and operational problems, is the need to foster enhanced and integrated global space situational awareness capabilities in as many states as possible, potentially through participation in regional or international data sharing activities. The ability of states to have multiple, independent, and potentially indigenous sources of information about activities in orbit would be a major step towards alleviating many of the concerns regarding developing of OOS capabilities, and to de-conflict OOS capabilities and dual use technologies in general, including the need to service a particular satellite or remove a specific piece of debris.

The satellite and space technology export controls that are currently in place in many countries will make it impossible to have full participation by all states in the technology development and operational testing of OSS capabilities. However, that does not mean that certain countries should be completely excluded from them. Transparency and confidence building can still be done through briefings on planned activities, openness in regard to the orbital location of potential dual-use spacecraft, and international participation in the selection of debris objects for removal and objects to be serviced.



NASA's DART

Some of the core elements of these policy recommendations do have support within the U.S. government. At a recent conference hosted by the Center for Strategic and International Studies, the Vice Chairman of the Joint Chiefs of Staff, General *James Cartwright*, warned that the U.S. and other countries could no longer keep the vast numbers of orbiting satellites a secret, and that in some cases secrecy is hampering the competitiveness of the American space industry. He also called for some level of international rules and management for space traffic to increase safety and stability in space.

On June 28, 2010, the Obama Administration released the new U.S. National Space Policy. The Policy recognizes the importance of space sustainability and the role that transparency and stability play in achieving it:

The X-37B Orbital Test Vehicle (images courtesy of Boeing)

"It is the shared interest of all nations to act responsibly in space to help prevent mishaps, misperceptions, and mistrust. The United States considers the sustainability, stability, and free access to, and use of, space vital to its national interests. Space operations should be conducted in ways that emphasize openness and transparency to improve public awareness of the activities of government, and enable others to share in the benefits provided by the use of space."

In the end, all states need to remember that outer space is not the domain of any one individual or State, and that the actions of any one actor in space can have consequences for the orbital environment and the operations of all other space actors. There is a shared incentive to create stability and sustainability into the environment to ensure that all States can continue to have access to and use space for benefits here on Earth.

About the author
Brian Weeden is the Technical Advisor for Secure World Foundation. Mr. Weeden specializes on the integration and application of technical aspects of the space environment, orbital operations, and spacecraft and launch vehicle engineering to space security policy and law formulation. He focuses on global space situational awareness, space traffic management, protection of space assets, and preventing conflict in space. Mr. Weeden's research and analysis have been featured in numerous news articles, academic journals, presentations to the United Nations, and testimony before the U.S. Congress.

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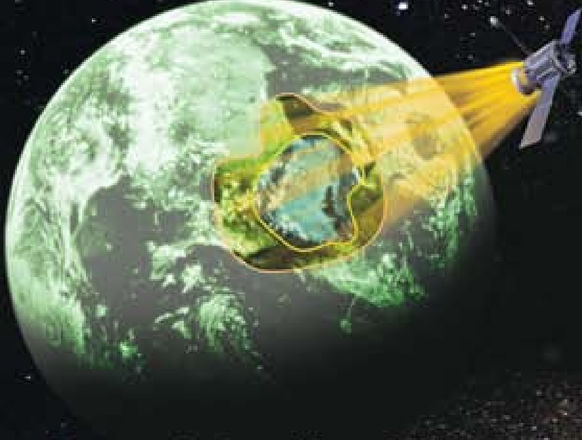

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MILSATCOM FOR THE NEXT DECADE

AUTHOR: CHRIS HAZEEL, ROCKWELL COLLINS

From 25,000 feet in 2 minutes — MILSATCOM in 5 — image courtesy of Rockwell Collins

Communications technologies for the global warfighter are developed and fielded based on military requirements. If the last decade has taught us anything, it is that war is unpredictable and the fight can move anywhere — the tactical edge is expansive and ever-moving, requiring communications solutions that adapt to constantly changing requirements.

Teleports and hub sites for command and control will continue to provide the infrastructure backbone for global SATCOM. In the next decade, the challenge to provide reachback from the edge will revolve around reduced *size, weight and power* (**SWaP**), multi-band capabilities, *Communications On-The-Move* (**COTM**) and the ability to deliver HD imagery over the SATCOM link. All of these challenges are dependent on the availability of appropriate funding to support communications in the government and military arenas. Continued funding is required for industry to engage and address these challenges that must be overcome to assure battlefield superiority and homeland security.

The Race to Reduce SWaP

The nature of the tactical edge requires *Beyond Line of Sight* (**BLOS**) communications. Today, a single soldier may be the system, and the real estate available for communications capability is constrained by what a person can carry and still maneuver effectively. Water, ammunition, weapons and communications equipment all compete for the same real estate.
It is critical to design solutions that require one *Human Machine Interface* (**HMI**) so that controls and outputs of radio, targeting systems, voice, data and video are integrated and easy to access and manipulate with one hand. Integration is crucial to optimizing the package in order for the soldier to access the situational awareness information available at the hub/teleport.

Rockwell Collins has a strong heritage in the integration and design of satellite Earth terminals and communications networks. We have delivered high bandwidth communications for some of the most critical battlefield networks, including:

- ***The U.S. Army's Joint Network Node/Warfighter Information Network- Tactical (WIN-T)***
- ***The U.S. Marine Corps' Support Wide Area Network (SWAN)***
- ***U.S. Central Command's Deployable Ku-band Earth Terminal (DKET) network***
- ***The Defense Information Systems Agency's (DISA) global teleport system***

As military beyond line of sight communication needs have become more tactical, we have

Communications-On-The-Move (COTM)

Above: Rockwell Collin's miSAT-X™ man-portable terminal

also delivered powerful SATCOM solutions with greatly reduced SWaP. These include:

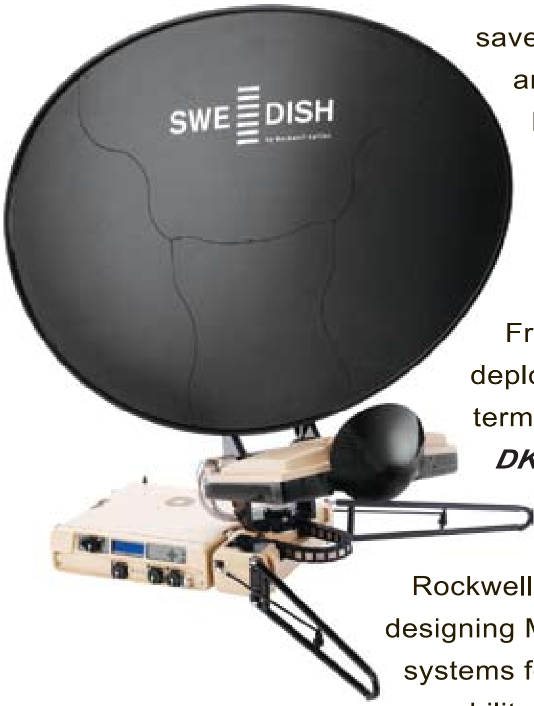
- ***miSAT-X™, a product field-proven in Afghanistan, that provides T1 connectivity in a briefcase-size package, so small it can be stowed in the overhead of an airplane***
- ***SWE-DISH CommuniCase® Technology (CCT) products, which are innovative man-portable earth terminals that accommodate field-interchangeable modems, transceivers and antennas. They can be easily reconfigured to accommodate the mission requirements. For example, CCT components can be readily interchanged between Ku- and X- bands***

These systems are intended for use at the tactical edge. They are designed to enable one person setup, quick-to-air, ease of use and high speed transmission and reception of voice, data and video.

Saturation Of The Ku-band Space Segment

The explosion of bandwidth requirements means that the Ku-band is over subscribed and the demand is greatly increasing for Ka- and X-band satellites, which offer substantial new bandwidth.

The emergence of the newest Ka- satellites means additional capacity, connectivity and control. The narrower beam improves performance of smaller, less powerful terminals, enabling these devices to be worthy at the tactical edge. Particularly in mountainous terrain, Ka- enables customers to maximize and extend their communications networks,



saves money and expands bandwidth to allow IP networking capabilities.

From large fixed deployable Earth terminals, such as ***DKET***, to small man-portable units, Rockwell Collins is designing MILSATCOM systems for tri-band capability, which extends options from the soldier to the commander. These additional bands positively impact capability, availability, and cost.

The convergence of demand for terminals with reduced SWaP and the availability of high-power, high-capacity Ka- and X-band satellites, is resulting in the rapid evolution of next generation terminals that will redefine “value” over the next decade.

Growth + COTM Support

Due to the variable location of the tactical edge, COTM will grow in its importance as the critical connection for real-time situational awareness. Internationally, foreign ministries of defense are testing the COTM concept, performing trials and refining requirements. In the U.S., COTM solutions are moving from the trial stage to low-rate production as a result of the **WIN-T** program of record. Still, there is a large amount of work to be done to make antennas less prominent and implementations more standardized.

The industry needs to do more than upgrade waveforms and antennas. We must also

Network Management System Needs

As the satellite communications industry rises to the challenges of the next decade, what are the implications for the network — the communications backbone that connects people, systems, devices and software?

For military and government networks, availability and reliability are absolutes. The moves to reduce SWaP, manage COTM, and deliver HD quality will, by nature of the solutions, increase the number of deployed devices. The complexity of delivering availability and reliability increases with the proliferation of network assets, device types, and device locations. As they multiply, network operations will require more sophisticated tools to optimize performance.

“Powerful network management and decision-support tools will be required to bolster the next generation of SATCOM networks,” said* Alan Caslavka*, vice president and general manager of* Command, Control, Communications and Intelligence Solutions *for* Rockwell Collins*. “Quality of service will be critical with the need to deliver the maximum amount of content at minimal cost. This means automation is mandatory to streamline service and reduce human intervention and error.”

In addition to monitoring network health status and providing operator control of basic network functions, complex military networks will require a network management system to:

Deployable Ku-band Earth Terminal (DKET)

address security requirements. To meet these challenges, Rockwell Collins is leveraging its expertise and experience in protected MILSATCOM by integrating comprehensive solutions that allow customers to transfer information across the communications spectrum, from *Very Low Frequency and Low Frequency* (VLF/LF) to *Ultra High Frequency* (**UHF**) and *Extremely High Frequency* (**EHF**) communications. These solutions carry voice, video, and data across multiple platforms and protocols, spanning a comprehensive range of technologies including analog and digital, copper, fiber optic, radio, microwave, wireless and satellite-based systems.

The company's ***MobiLink***™ technologies offer several configurations for COTM. They can be deployed on a *Mine Resistant Ambush Protected* (**MRAP**), *High Mobility Multipurpose Wheeled Vehicle* (HMMWV), ***Stryker*** or other vehicle, facilitating connectivity on-the-move at high speed, regardless of the distance from a military base. These solutions have been field-proven, providing continuous connectivity across the satellite throughout long convoys in Iraq. Also provided is a reliable COTM Ku-band solution for the littoral marine market that is gaining customer acceptance.

HD Imagery Over SATCOM

While wars are fought in every corner of the globe, support for them is won or lost in our living rooms, as journalists embedded with the military send video home in real-time.

Broadcasters are starting to demand that military reporting be served in HD quality. This is a bandwidth-rich application that, again, requires the smallest SATCOM terminal possible, which allows journalists to embed with the forward deployed warfighter. The solution demands a modem that is bandwidth capable and tightly coupled with baseband and the HD camera — preferably in a single box. Again, integration is crucial because fewer cables and parts increase ease of use, time to set up and reliability.

Rockwell Collins is solving the issue of HD content delivery by leveraging their ***CommuniCase*** technology to provide quick-to-air, auto acquire HD solutions. Currently, HD CommuniCase solutions are in pre-fielding trials.

What's next? Globalization and multi-force coalitions will continue to drive changes in the way the industry supports military and governmental satellite communication requirements. With the globalization of our industry, the only way to compete in critical national and international projects is to have a capable local presence. Rockwell Collins achieves this by leveraging more than 80 worldwide locations that support the company's core capabilities, while also offering their own indigenous capabilities.

Communications and electronics technology has gone through important development spirals over the last decade as defense and homeland security needs have become central to the national agenda. As budgets are scrutinized, past performance offers living proof of what companies can do to rise to the challenge of delivering quality and capability in an acceptable timeframe at an acceptable price. The company's expertise in secure communications, flight deck avionics, cabin electronics, information management and simulation and training is delivered and supported by nearly 20,000 employees in 27 countries. The global challenges of military and foreign ministries of defense in developing solutions that turn requirements into trusted systems will enhance the safety and security of warfighters worldwide.

About the author

Chris Hazeel is senior director of SATCOM systems at Rockwell Collins, a position he was appointed to in June 2009 when the company acquired DataPath and its subsidiary, SWE-DISH. Since that time, DataPath and SWE-DISH have been integrated into the Rockwell Collins organization, adding SATCOM capabilities that strongly complement the company's existing communications business. Prior to assuming this role, Hazeel, who hails from the United Kingdom, worked for Rockwell Collins in the UK for 10 years, where he was responsible for the FireStorm™ targeting program and the Bowman military GPS program. He spent several weeks a year working on-site with NATO and U.S. coalition forces, participating in trials and development work in preparation for fielding solutions. His interest in SATCOM began in the early 1980s when, as an entrepreneur with an engineering background, he developed SATCOM receive-only terminals and systems and grew a successful business. He has since developed solutions in industrial controls, marine communications and navigation systems.

Network Management System Needs (cont.)

- ***Increase the number and automation of SATCOM services***
- ***Improve software analytics***
- ***Offer improved network views to simplify management of meganets — the extremely large and complex networks of the future***

Rockwell Collins* MaxView® Network Management System *currently automates SATCOM services for military and government networks around the globe, including:

- ***Carrier monitoring: uses a spectrum analyzer to monitor the health and performance of satellite communications channels***
- ***Uplink Power Control (UPC): monitors a beacon receiver for rain fade, then compensates by adjusting uplink transmit power***
- ***Site diversity switching: performs automated failover from one site to another based on weather/site availability (uses UPC)***
- ***M:N redundancy: provides failover/ redundancy logic based on anything in the network to reduce spares and minimize cost***
- ***Circuit management: monitors chains of devices for better alarm management and reporting***

These services help synchronize the network, reducing complexity and easing the demands on operational staff, who may suffer from turnover and lack of training. Particularly in the SATCOM world, products are at the front lines of conflict providing forward deployed, mission critical communications between

Network Management System Needs (cont.)

the troops in the field and the leadership and support back at base.

To optimize this communications, SATCOM systems and network operations must work in harmony. Software analytics will address this problem by helping operators quickly identify actionable information in their data. For example, customers need awareness of trends in device data (temperature, error rate, etc.) that can indicate problems or the need to take action such as clean, maintain or replace a piece of equipment.

Historically, operators looked for these trends using hand drawn charts or computerized historical reports and, like all manual processes, this is inefficient and error prone. As part of an NMS like MaxView, automated trend detection addresses the need for accurate and faster data analysis and problem detection tools.

With MaxView, it all happens within one system and in real-time. This is a significant advantage over the traditional methods of graphing the maintenance logs or viewing historical reports and manually fitting a trend line to the data. MaxView extrapolates trends in the data to tell a story.

For example, if a component on the network is showing a trend that may cause it to become unstable and the lead time for that component is lengthy, an alert to the operator may trigger a decision to order spares now to avoid lengthy downtime. Networks of the future will rely on trend detection for earlier discovery of problems, better planned maintenance and ultimately higher availability of network assets. Future meganets will also need every advantage to understand and view the entire network.

One breakthrough to improved network management understanding will be the inclusion of geo-mapping into the NMS. This will allow the viewing and control of fixed and increasingly mobile network assets by geographic position/information.

This logical, pictorial view of network topology will be dynamically updated, improving the military's management of mobile assets. Managing network assets geographically is intuitive and, once incorporated, will increase situational awareness.

"Rockwell Collins has years of experience in geospatial applications," adds Caslavka, *"and we are adding geo-mapping as part of our MaxView solution. The bottom line is that the NMS will need to do more heavy-lifting for the network of the future and it will be a central part of a military and government SATCOM solution."*

MaxView™ Datasheet download link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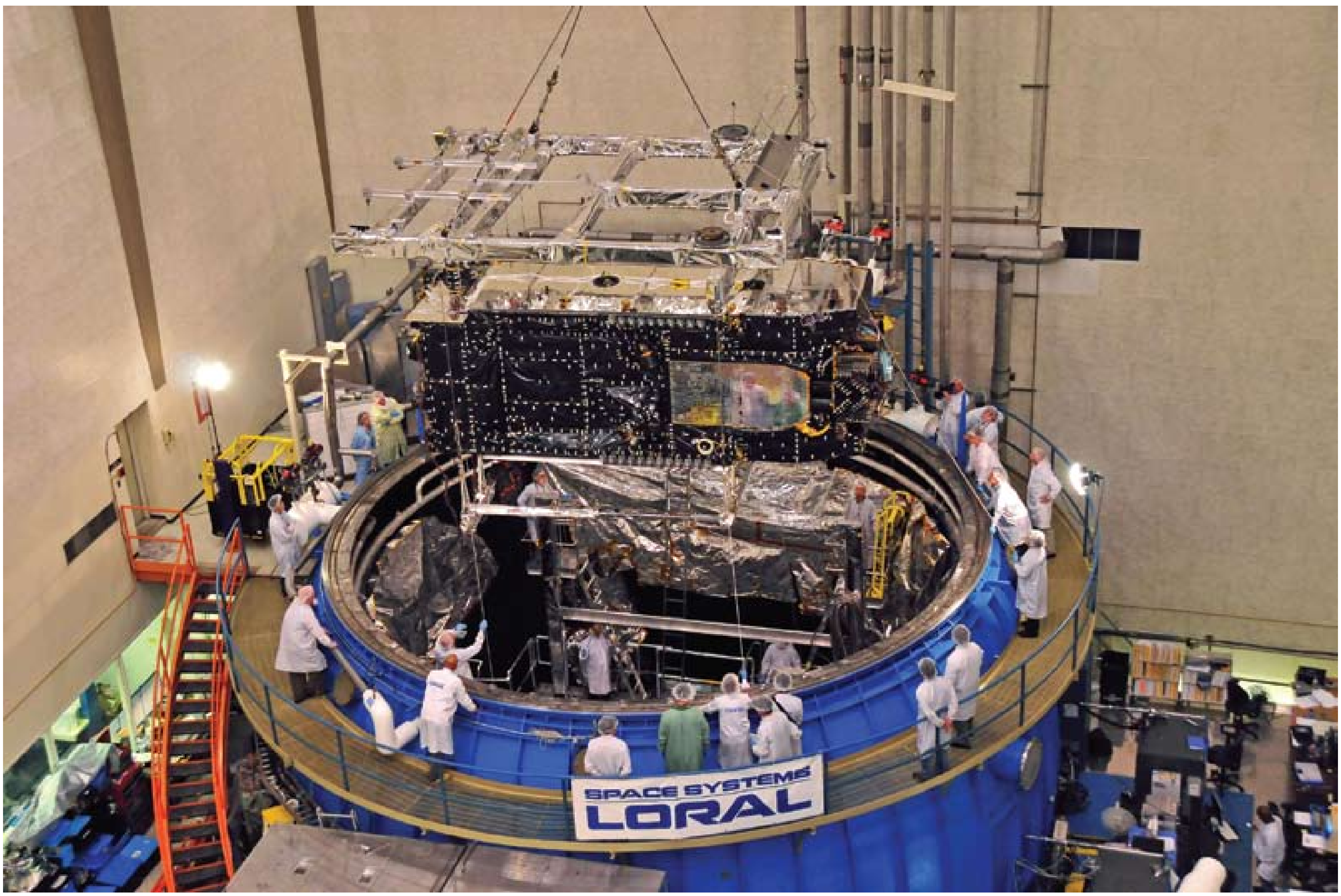
HI-CAP SATELLITES

AUTHOR: BRUCE ROWE, VIASAT



On schedule for an early 2011 launch, the ViaSat-1 high-capacity satellite recently reached a major milestone as it entered Thermal Vacuum Testing at the Space Systems Loral assembly facility.

It's here, that much is certain. A transformation in military satcom (MILSATCOM) is no longer just a vision, but a necessity. The Department of Defense must embrace the change, as there are many forces at work:

- ***An already large — and growing by the day — satellite bandwidth shortfall, publicly acknowledged by U.S. Army Forces Command and Defense Information Systems Agency***
- ***The accelerating "pace of change" for telecoms technology and tightening defense budgets mean that large, funded developments are yesterday's news, e.g., the much-discussed TSAT cancellation***
- ***The need to step up to military networking objectives such as "global cyber dominance" and improving "NETOPS for the next fight", most recently discussed at this summer's LandWarNet conference***
- ***HD video and other new bandwidth hungry apps that simply demand a different kind of network infrastructure***

These realities, trends, and objectives have refocused the challenges for DoD satellite network planners. Now it's about getting as many warfighters as possible onto the network with more and more sophisticated applications.

Such requires more than small bandwidth increases provided by the move from ***DSCS*** and ***Milstar*** to ***Wideband Global Satcom*** and ***AEHF*** — there must also be an order of magnitude increase in bandwidth. It's a disruptive change in focus that requires an equally disruptive new technology to make it happen.

Long-Lead Programs — Not Practical Or Affordable

The last timetable for the ***Transformational Satellite*** system (**TSAT**) projected the first satellite would launch in 2019. If that date was met (and it is increasingly in doubt), a full 15 years will have passed after the U.S. Air Force awarded first study contracts to the two competing primes in January of 2005. And that would have been only the first of six satellites included in the initial plans for this massive project.

The Transformational Satellite Communications System Mission Operations System will provide network management for the TSAT system, providing network-centric interoperability between TSAT and the Department of Defense's Global Information Grid. For the joint warfighter and deployed worldwide users, this means they are one step closer to obtaining network-centric warfare. Image is courtesy of U.S.A.F. Space Command

Imagine waiting a decade and a half for your cell phone carrier to deliver 4G service or your direct-to-home (DTH) television provider to add HD video!

Obviously, the DoD can no longer afford the dollars or time it takes for such long development cycles for new satellite capabilities. The pace of telecommunication technology innovation is simply too fast.

Commercial Sets the Pace

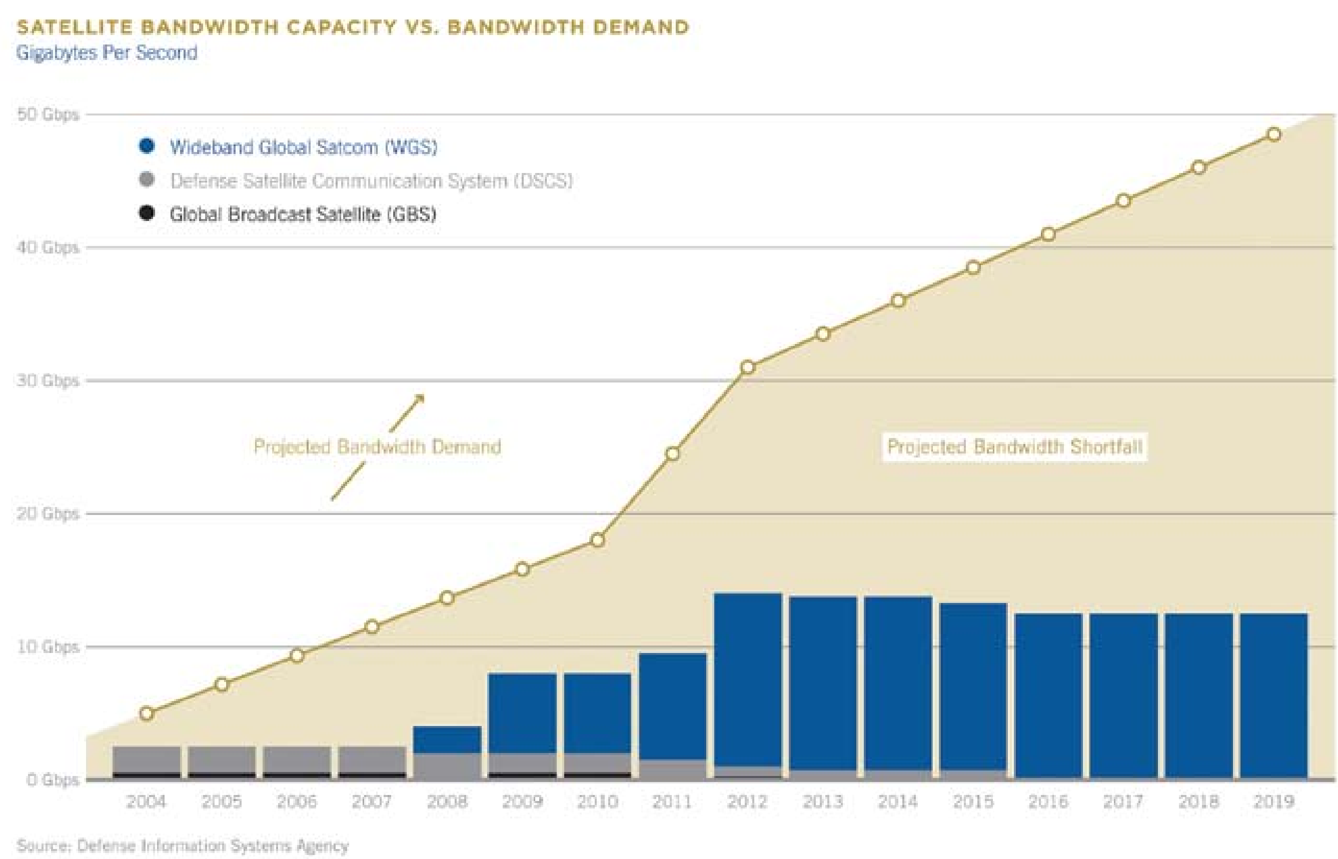
The more sensible approach is to look to *commercial-off-the-shelf* (**COTS**) products and services, driven by wide open competition and innovation needed to satisfy today's consumers. COTS technology enables the DoD to more quickly implement the current advances in speed and bandwidth of the AEHF and WGS constellations they are building and launching now.

COTS technology is already appearing in modems for fixed-site and *comms-on-the-move* (**COTM**) broadband. Many terminals were adapted from commercial modem systems, needing only a matter of months to be made ready for military use, including the **ViaSat *LinkWay*** and **ArcLight** VSAT systems that have been in use for many years by commercial service providers.

Drawing from advanced commercial technology that includes turbo codes, advanced modulation, DVB broadcast and return channel standards, **AES TRANSEC** security, and spread-spectrum *code reuse multiple access* (**CRMA**), these SATCOM systems are already providing efficient and cost-effective connections across much of the Internet protocol (IP) infrastructure for the U.S. DoD.

FSS Satellite Limits Need to Be Overcome

COTS technology is a great first step in accelerating the spread of advanced communications into the hands of more



This chart, based on data compiled by DISA, shows that, even with new military-owned capacity launching, a major shortfall compared to bandwidth needs will remain.

warfighters, yet it's not the full transformation that the military requires. Commercial ground systems can ensure that the Air Force gets the most out of its investments in the space assets it owns now, but they do not address the overwhelming costs of vast amounts of commercial bandwidth leased by the DoD.

The U.S. government is the single largest buyer of commercial Common *Fixed Satellite Services* (**FSS**) capacity in the world. According to DISA figures, leased capacity is providing at least half of total military bandwidth demand this year. The same projection estimates that the figure will rise to 60 percent in 2011, and continue to grow through the next decade.

FSS has shown itself to be a resilient technology. At one time or another, FSS has been used for almost every satellite application: television, long distance telephony, vehicle tracking, position location, credit card validation, corporate networks, mobile phone service, remote village telephony, oil and gas pipeline monitoring, video surveillance, and home Internet access.

FSS pioneered two-way satellite data transmissions and was pretty good at its job when there wasn't much data to be transmitted. Low data rate messaging has been an important means of mililtary communications for years, and it requires only a handful of bits to do it.

The FSS satellite has been so successful that it has practically become viewed as ***the satellite***. As a result of the success of FSS satellites, there has been little incentive to change over the past three decades. Unfortunately, people have settled into a view, even if inaccurate, that the limitations of FSS satellites are inherent in ***all*** satellites.

However, while FSS satellites are relatively good at doing almost everything, they don't do a lot of things really, really well. As a result, a need for specialized satellites has, in some cases, already developed, once FSS applications uncovered demand for some types of services. DTH TV and mobile communications are now carried by spacecraft designed for such work.

It is clear that for broadband applications, "how much" data you deliver is as important as "how fast." **AT&T Wireless** created quite a stir among its customers in the past year — the company didn't alter the speed at which they delivered services, but limited the amount of data subscribers could use on their network.

Bandwidth is the new focus in the disrupted communications landscape — the challenge is to design a whole new system to deliver more of it, and at less cost.

A Constant Focus On Bandwidth

The bandwidth limitations of FSS satellites need not apply to all two-way satellites. Why not focus on designing a new satellite system with the objective of optimizing it in every way to deliver more bandwidth capacity? That could create a much, much larger inventory of bits, available at a far lower cost. The commercial broadband-by-satellite market is proof of the demand and utility for such a system — the same technology can provide the transformational networking capability the DoD requires, as well.

Artistic rendition of the ViaSat-1 satellite, courtesy of Space Systems/Loral

This next generation system, called ***high-throughput*** (**HTS**), or ***high-capacity satellite*** (**HCS**), is under construction right now by **ViaSat** and other satellite operators. The first ViaSat satellite is known as ***ViaSat-1***. The system design encompasses several techniques and technologies to maximize available bandwidth as well as the number of subscribers that can be served and the level of service each user of the network will experience...

- ***All Ka-band frequencies***
- ***Many narrow "spot beams", similar to mobile phone cells, to reuse frequency spectrum***
- ***A matching advanced ground system that can easily and efficiently provision and manage bandwidth among subscribers***
- ***Network + application acceleration***
- ***Ability to deliver more bandwidth volume, not just more speed***

While ViaSat-1 is designed to send and receive data faster than any other commercial broadband satellite, it is the quantum jump in total capacity that is so revolutionary. The total throughput for ViaSat-1 is expected to be well above **100 gigabits per second (Gbps)**. That compares to about 1 to 2 Gbps for a conventional FSS satellite, and about 10 Gbps for the best broadband satellites serving the United States today.

A number of demonstrations of the HCS system, at both Ku-and Ka-band, have shown the satellite can provide a 10X jump in level of service. Video is perhaps the application where the performance gain is most noticeable. In side-to-side comparisons, high-capacity satellite delivers smooth, *full-motion video* (**FMV**) in *high-definition* (**HD**), compared to jittery, halting video that is, basically, totally unusable.

All of this performance comes at a cost of about $250 million for the satellite alone, a price comparable to standard FSS satellites. That makes the transmission cost per Gbps of communicating over a high-capacity satellite just a fraction of what it would cost over any other satellite.

Also, compare that cost to the 28-30 Gbps throughput total estimated for all six TSAT birds, at a cost of $12-15 billion or more. Granted, TSAT had additional mission components, such as built-in security and system continuity, but for pure cost-per-bit, there is no comparison.

How HCS Fits The DoD Network Objective

Let's examine the need to obtain more network capacity over DoD areas of operations, and to do so quickly. The U.S. government, with its huge appetite for commercial FSS capacity, leases a significant portion of that bandwidth over the United States, where ViaSat-1 will offer coverage. By cooperating with ViaSat's international, high-capacity broadband partners — **Barrett** in Canada, **Eutelsat** over Europe, and **Yahsat** in the Middle East — the benefits of high-capacity satellite will soon extend to most of the operational areas where the United States purchases FSS capacity. Within six to nine months, the first two HCS satellites are scheduled to launch over Europe and the U.S. Then there is the need to move satellite communications capablities deeper and deeper into the military organization — virtually every warfighter would gain access to the services. As outlined in the previous paragraph, the coverage is going to quickly blossom in the next year. As a complement to the coming Ka-band capacity, ViaSat and **KVH Industries** have built a mobile broadband network that now encircles the globe with Ku-band capacity. Terminal technology that would operate on both frequencies is in design, again leveraging already proven and widely used commercial systems and services. All that is left is for the DoD to do is to tap into this seamless network for global roaming between high-throughput Ku- and Ka-band, similar in practice as how consumer roam from 3G to 4G networks with mobile phones.

Another advantage of Ka-band SATCOM is that it requires smaller antennas and RF transceivers. That is a major advantage to placing SATCOM into the hands of individual warfighters at the edge of crucial operations.

With next-generation Ka-band, the cost per bit will make it not just technically possible, but also economical in providing more bandwidth to more users.

Not A Replacement—A Low-Cost Addition To MILSATCOM

In the near term, high-capacity satellite technology is not a replacement for military-owned and operated systems such as AEHF and WGS. Rather, high-capacity satellite technology can be part of the MILSATCOM transformation, addressing the obvious bandwidth shortfall the military faces in leased, commercial bandwidth capacity. In the future, this satellite communications technology could be incorporated into either hosted military payloads or new satellites constructed specifically for military use. These next-generation satellites deliver the same benefits in any application:

- ***Primary, military enterprise communications infrastructure***
- ***In blended networks, such as high-volume backhaul for cellular smart phones as they become a bigger part of battlefield communications***
- ***Mobile broadband for airborne, vehicle, or dismounted COTM/SOTM***
- ***High-speed delivery of high-definition video from unmanned systems***
- ***First responder and civil emergency communications***

The first turnkey high-capacity systems — gateways, ground terminals, satellites, and services — will soon be carrying fixed and mobile satellite networking to commercial customers. The low-cost bandwidth delivered by these next generation satellites can be a strategic advantage for the U.S. military, as well, helping to overcome the bandwidth gap that challenges warfighters with their current — and future — missions.

About the author

Bruce Rowe is director of public relations for ViaSat Inc. He is a former business reporter who has worked in corporate marketing communications for over 25 years, writing articles, press releases, white papers, brochures, and web site content. His experience includes 22 years in satellite and defense communications, first with ComStream Corp. and then for the past 14 years with ViaSat. Bruce is a graduate of the business school at San Diego State University.

THE FIRST LINE OF DEFENSE

AUTHOR: ANGIE CHAMPSAUR, ENCOMPASS DIGITAL MEDIA

Encompass Digital Media, which operates two of the largest, independent transmission facilities in the U.S. in Los Angeles and Atlanta, has built a reputation among military and civilian clients for its reliable performance during emergency response operations.

With extensive connectivity, to ever-expanding fiber networks and multiple satellite footprints, the company offers a variety of turnkey disaster recovery solutions for SATCOM, including *single channel per carrier* (**SCPC**), *digital video broadcasting* (**DVB**), and hub solutions.

Encompass has also partnered with the **DoD**, **NASA**, **NOAA** and the **CDC,** as well as major broadcasters, to support and restore communications during unexpected events. From the aftermath of *Hurricane Katrina*, the Haitian and Pakistan earthquakes, the tsunami in Southeast Asia to the recent BP oil rig explosion, the company has been called on by its clients to supply a wide range of transmission services.

The company's integrated solutions have included the provisioning of remote equipment such as mobile units (C-, Ku-band and hybrid); flyaway systems; occasional-use and full-time temporary satellite capacity; and Teleport services.

When the story broke regarding the oil spill in the Gulf of Mexico, Encompass immediately responded with logistical support and positioned its satellite uplink trucks to facilitate broadcast needs within the region. As the demand for coverage increased, the company created an on-site broadcast solution which cut costs and added stability for clients requiring full-time temporary uplink services and production.

The Deep Horizon rig explosion — the start of the Gulf of Mexico oil spill.

"You never know when a disaster is going to strike, and it's imperative that we as a company are always at-the-ready," said Encompass' VP of Transportables and Production Services, *Greg Jennings*. "We take a very proactive approach to strategically placing our assets for quick and easy deployment."

Encompass stationed engineers in **Gulf Shores**, Alabama, to oversee and initiate remote services which included Internet access, work space, live shots and technical support. The company used one of its Ku-band trucks for Internet and four simultaneous transmissions, plus one HD path for international video distribution. This unit was situated at Encompass' fixed, beachfront location with HD/SD cameras for live shots. Encompass used another Ku-band unit as a roving platform for transmission and hot spot access.

"Our setup allowed us to be ready at a moment's notice for anyone that came through the door," said *Jennings*. "We held client meetings on a daily basis which gave us instant feedback, so we could tailor our services down to the hour. This was a global story that had global impact, and our approach to the situation strengthened our relationship with our clients."

Encompass' full-time temporary uplink services are also used for *Continuity of Operations Planning* (**COOP**) requirements. The company's 24/7/365 scheduling and operations

Gulf Shores, Alabama, before Hurricane Katrina staffs are able to acquire and access both occasional-use and full-time temporary satellite capacity, fiber connectivity and ground services immediately and with very little lead time.

Booking windows, as small as 15 minutes, can be accessed on a global basis. Encompass serves as a data and video network hub, enabling transmissions from remote locations back to the States.

"With our data trailers, we can establish media or baseline communications rapidly — whether it's a television network capturing footage or government agencies securing communication lines such as phone or Internet," said Encompass National Account Manager, *Robyn Godfrey*.

Governmental SATCOM continues to be a huge focus for Encompass through its **DVIDS** (*Defense Video and Imagery Distribution System*) project that provides a reliable connection between global media and the U.S. military. The joint operation between Encompass and the military has supported more than 700 public affairs teams from all branches of the Armed Services, fulfilling more than 80,000 media requests worldwide in 2009.

Through a network of portable Ku-band satellite transmitters collocated with military units, and a distribution hub at Encompass in Atlanta, DVIDS provides real-time broadcast-quality video, still images, and print products,

as well as immediate interview opportunities with service members, commanders and subject matter experts.

Since 2007, DVIDS has won six *Telly Awards* for the program *In the Fight,* plus three more for its website, live event coverage, and DVIDS commercial. DVIDS received of four *Emmys* for its participation during *Freedom Week/ Operation Home Base* and the *Minnesota Hockey Day* program; **WAGA-TV**'s coverage of Atlanta's *Peachtree Road Race*; and *This One's For You* broadcast on **FSN Midwest**. The events featured live satellite feeds from Iraq, Kuwait and Afghanistan.

About Encompass Digital Media, Inc.

Encompass owns and operates two of the largest, independent broadcast facilities in the U.S. in Los Angeles and Atlanta. Total media solutions include network origination; cable neighborhood platforms (***G-13***, ***G-17***, ***G-23***, ***AMC-10*** and ***-18***); centralcasting; disaster recovery; satellite and fiber transmissions (full time and occasional use); a fleet of satellite uplink trucks; digital media encoding services; digital file transfers via satellite, fiber and IP; emergency communications; governmental SATCOM; production studios; and video production services.

The company is also a service provider to major networks and broadcasters as well as sports leagues and general entertainment cable channels including ABC, CBS, FOX and NBC Universal; DIRECTV Sports Networks, ESPN, GolTV, MLB, NASCAR Media Group, NBA, NFL Network, Tennis Channel and Universal Sports Network; Hallmark, Game Show Network, MGM HD, Sony HD/3D and TV Guide. In addition, Encompass performs international services for Alterna'TV, Fox Latin American Channels, Latin American Pay Television (LAPTV), MGM Networks Latin America and SkyVision as well as disaster recovery for BET, Discovery Communications, Scripps Networks and The Weather Channel.

For additional information, visit http://www.encompass-m.com.

BRIG. GENERAL ROBERT T. OSTERTHALER (U.S.A.F. RET.) CEO SES WORLD SKIES U.S. GOVERNMENT SOLUTIONS (USG)

Mr. Robert Tipton (Tip) Osterthaler joined the SES family in December 2006 when he became the President and CEO of AMERICOM Government Services. Since then, the independent corporation and wholly-owned subsidiary of SES WORLD SKIES has grown and integrated with other USG business elements within SES to become SES WORLD SKIES, U.S. Government Solutions. During his tenure at SES, the U.S. Government business transformed from a product oriented sales channel into an end-to-end satellite solutions company, and now to an entity that is directly aligned with the global assets and resources available on the SES fleet of 44 communications satellites.

From 1998 until 2006, Tip was a Senior Vice President at Science Applications International Corporation (SAIC), a large systems, solutions and technical services company serving the needs of the US government. His last assignment at SAIC was Deputy General Manager of the Strategies, Simulation and Training Business Unit, a 2,300 person organization that provides government and commercial clients with advanced modeling, simulation and training solutions.

Prior to joining SAIC, Tip served in the U.S. Air Force for 28 years, retiring as a Brigadier General and Deputy Assistant Secretary of Defense for European and NATO Policy. Earlier assignments included Vice Commander of the Air Intelligence Agency, NATO Staff Officer, and numerous command and senior staff assignments. Mr. Osterthaler is a Command Pilot, having accumulated over 3,200 hours of flying time in fighter aircraft including multiple models of the F-4 Phantom II and the F-15 Eagle. He holds a BS in Economics from the U.S.A.F. Academy and an MBA from Texas A&M University, is a graduate of Harvard University's Senior Executives in National Security Program as well as their National and International Security Management course, the Royal College of Defense Studies in the U.K., the Air War College, and the U.S.M.C. Command and Staff College.

MilsatMagazine (MSM)

Mr. Osterthaler, how did your career with the U.S.A.F. prepare you for your leadership position with SES WORLD SKIES, U.S. Government Solutions?

Robert Osterthaler

Government organizations and the private sector use different metrics to measure success, but every leader in either the public or private sector is ultimately accountable for the success of his or her organization. What I found when I joined the private sector is that accountability is as absolute in the business world as it is for command positions in the military, and while it took some time to understand how to drive a different set of metrics, the people and organizational dynamics are no different in the two worlds.

MSM

Why did you select SES after your foray with private companies with SAIC? How do you see your experience helping this company?

Robert Osterthaler

The US Government and particularly the DoD are big users of commercial satellite capacity, but none of the major operators of geosynchronous communications satellites are US companies. For me, SES presented an opportunity to bring to SES many years of experience working in the government and for the government as a contractor, and also to leverage the understanding and insights I gained while living and working in Europe.

MSM

What does SES WORLD SKIES USG Solutions bring to the playing field as far as technologies and capabilities are concerned?

Robert Osterthaler

SES WORLD SKIES, USG Solutions, brings the capabilities of the strongest satellite company in the world. We have the newest and fastest growing global fleet of satellites, and we are in business to serve the long term needs of our customers and investors. Our financial strength and stability enable us to innovate and focus on quality, creating long term value for both groups.

MSM

The integration of AMERICOM GS with SES must have offered a number of challenges for you and the company... what are the most significant advantages resultant of this blending of talent and technologies?

Robert Osterthaler

The integration of SES AMERICOM and SES NEW SKIES enabled us to consolidate our USG business and make it more efficient. It also simplified our customer interactions and helped us to sharpen our strategy. Maybe the most important benefit is that the consolidation brought together the best resources and practices of two highly successful companies and created a single organization that is more than just the sum of its parts.

Organizational changes always create challenges, but SES WORLD SKIES had the courage to take on those challenges, and our customers are already seeing the benefits of the integration.

MSM

With satellite capacity seemingly a constant issue, how does SES WORLD SKIES USG Solutions capture transponders for your clients' use when SES itself has many capacity needs as well? How is priority determined?

Robert Osterthaler

WORLD SKIES USGS is in the business of providing SES satellite capacity to satisfy the needs of the US Government. Because the Government decides what is going to buy and how it is going to buy, we must be capable of responding to their needs either directly or indirectly.

If we have capacity available, we will always support the bids of other companies who are pursuing USG business. Under some circumstances, the US Government makes it clear that they expect companies such as ours to respond directly to them, and in such cases we might put together our own offerings. Although this seems to be an odd notion within the commercial satellite industry, it is actually the prevailing practice within the USG market.

MSM

Has your command military career been an asset in helping you to deal with the intricacies of agency and military procedures for capturing MILSATCOM projects? If so, how?

Robert Osterthaler

During my years of military service, I gained an appreciation for the essential contributions of the private sector and I learned a lot about how the government buys goods and services. Those experiences have clearly been helpful.

MSM

Hosted payloads offer commercial communication capacity to the military, agencies and governments —is this environment working for both sides of the equation?

Robert Osterthaler

Hosted payloads are not the solution to every problem, but I believe they will be a useful addition to the list of options available to the

SES-2 with CHIRP onboard

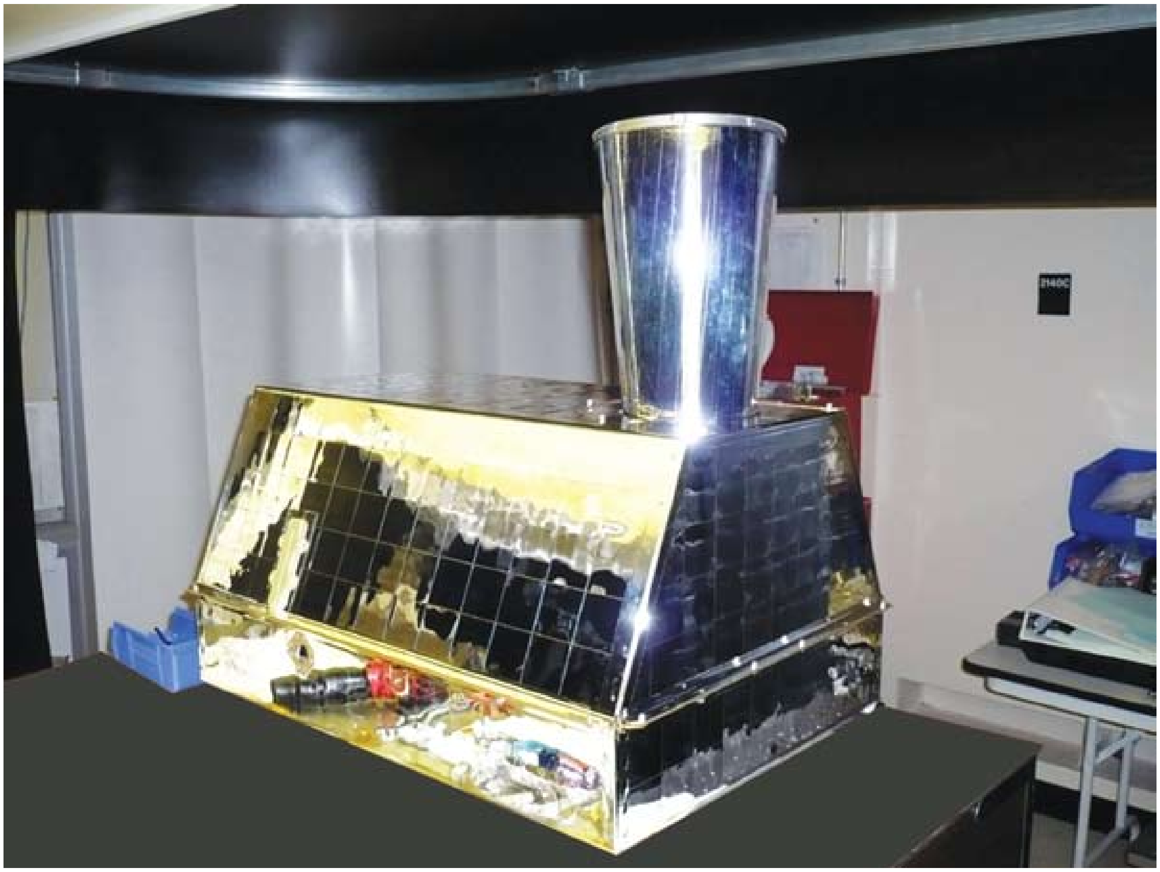
USG as it strives to meet a growing list of needs, many of which will be unaffordable using traditional approaches. For example, our current ***Commercially Hosted IR Payload*** (**CHIRP**) flight demonstration project will enable the Air Force to complete about 85 percent of an exhaustive list of hundreds of desired test objectives for about 15 percent of the cost of a dedicated government spacecraft program.

MSM

With the warfighgter on the far side of capacity use, have hosted payloads projects actually improved communications for those involved in hostile encounters?

Robert Osterthaler

Today's warfighters generally use the same capacity we provide to our commercial customers. Having said that, we work very closely with the US Government to identify things we might do to make our spacecraft even more suitable for USG use. For example, we routinely install special USG-certified security hardware on our satellites, design beam coverage patterns optimized for USG users, develop spectrum of interest to war fighters, and even reposition spacecraft based on USG needs. In the future, we foresee opportunities to provide increasingly specialized capabilities in the form of hosted payloads to support our USG customers.



The CHIRP sensor

MSM

Financially speaking, are hosted payloads feasible for the government and for the commercial company?

Robert Osterthaler

From the perspective of the cost savings offered to the government, the answer is an emphatic yes. Hosted payloads share many of the resources of a satellite that is already being built and is going to be launched. The incremental costs to add the capabilities of the hosted payload are a small percentage compared to building a dedicated spacecraft and paying the total cost for the launcher.

From a commercial perspective, we are in the business to provide capability to our customer and to deliver appropriate levels of return on our investments. When we work together with our government customers to design a program and a contractual arrangement that is a fit, we find that hosted payloads are not only feasible, but they are a mutually-beneficial way to do business.

MSM

How does one educate the supplier and the user as to the benefits of hosted payloads? Is CHIRP going to greatly assist in this area?

Robert Osterthaler

Both the user and supplier are educated through open and continuous dialogue. It is important for the government to understand the constraints that commercial industry faces in meeting schedule and cost requirements, and it is equally important for commercial operators to understand the limitations of government funding and procurement practices.

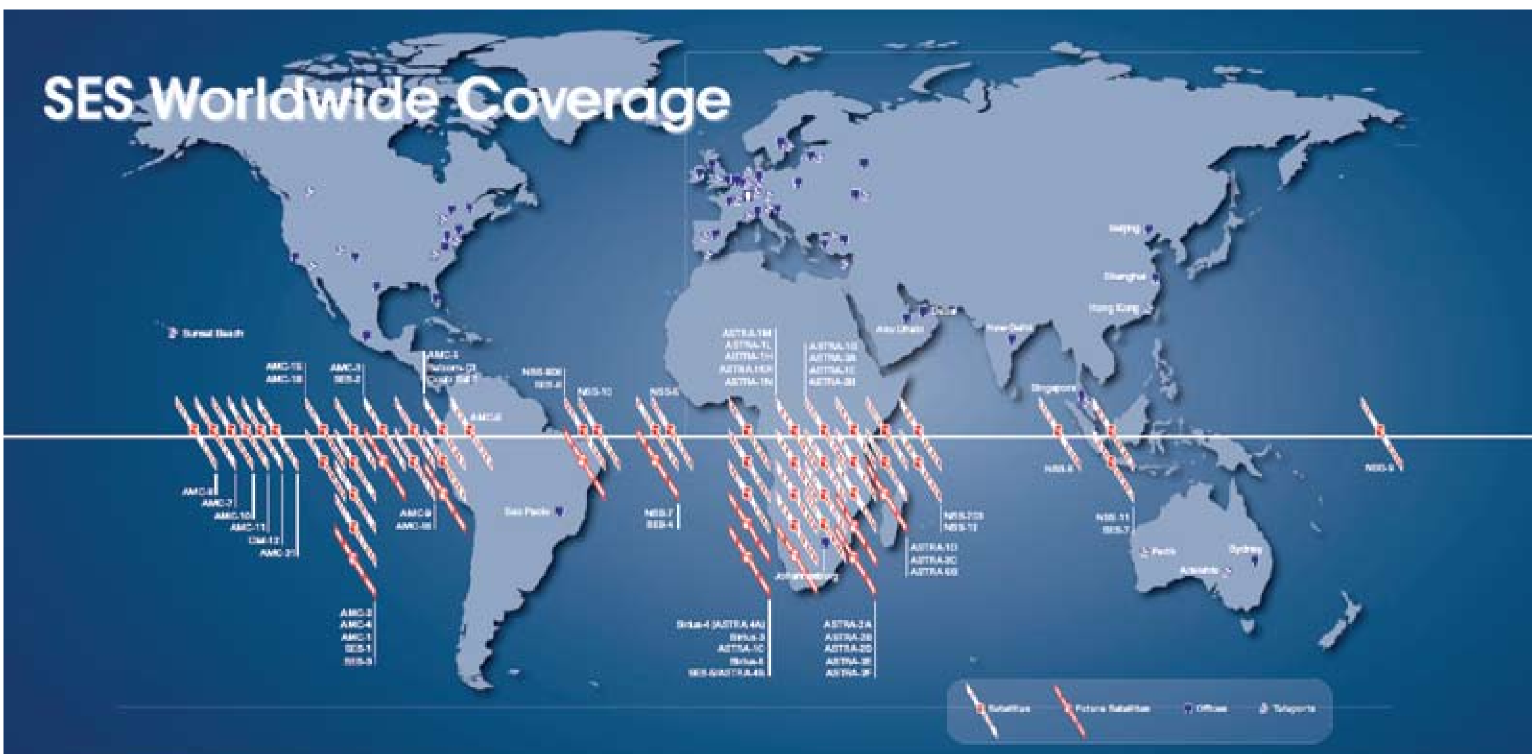
CHIRP is a pathfinder for contracting practices between the government and commercial operators. The framework of the contract ensured that the government interests were protected without exposing the operator to excessive risks.

MSM

What technologies, in addition to IR, does CHIRP demonstrate?

Robert Osterthaler

CHIRP also demonstrates the ability to interface the command and control of a payload with the commercial communications capability of the spacecraft. The *Secondary Payload Interface* (**SPI**) enables encrypted communications to the sensor and encrypts the data before transmitting it over the commercial transponder. Transmitting encrypted data at rates as high as 70 Mbs was challenging but the CHIRP team designed and implemented the SPI in less than 12 months.



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THE ORBITING VEHICLES SERIES — OV1 —

AUTHOR: JOS HEYMAN, FBIS, TIROS SPACE INFORMATION

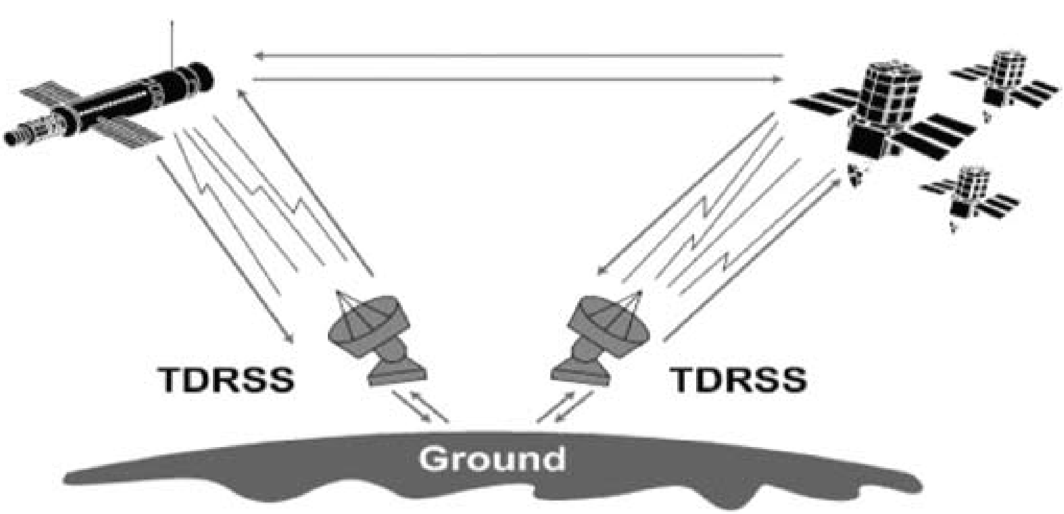
During the late sixties and early seventies the U.S. Air Force launched a series of satellites in what was known as the ***Orbiting Vehicle*** (**OV**) series. The satellites were essentially of a scientific and technology nature and demonstrated the use of a standard platform. The series came in five sub-series.

OV1

The ***Orbiting Vehicle (OV) 1*** series was built by **Convair** (**General Dynamics**) as a multi-purpose spacecraft to be used in conjunction with the ***Atlas*** launch vehicle (although it was also used with other launch vehicles). The basic satellite was a cylinder of 1.40 m long and 0.69 m in diameter with a small globe on one or both ends. It included a jettisonable propulsion module with an Altair 2 (X258) solid fuelled motor. Normally the satellite was mounted in the nose cone but in several cases (***OV1-1***, ***OV1-3*** and ***OV1-86***) the structure was side-mounted.

OV1 Satellites

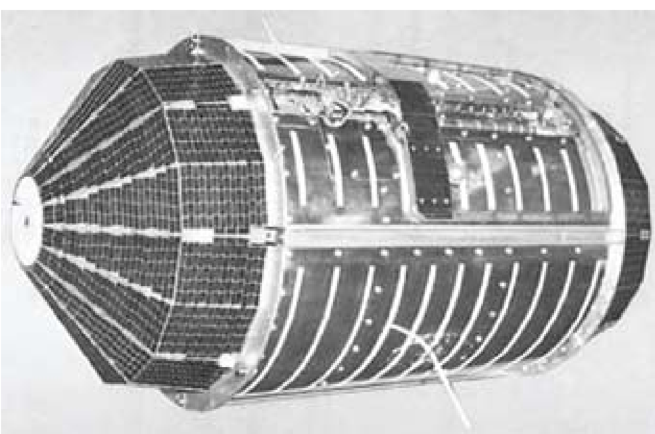
The purpose of ***OV1-1***, which was launched on January 21, 1965, on an ***Atlas D*** vehicle, was carried in a side-pod on a test flight of the ***Atlas Advanced Ballistic Re-entry System*** (**Abres**), was to study trapped radiation. The 85 kg satellite carried an omni-directional proton spectrometer, a micrometeorite detector, an infrared/ultraviolet radiometer, an aspect magnetometer, a solar aspect sensor, a radio noise radiometer and an ion density impedance probe.



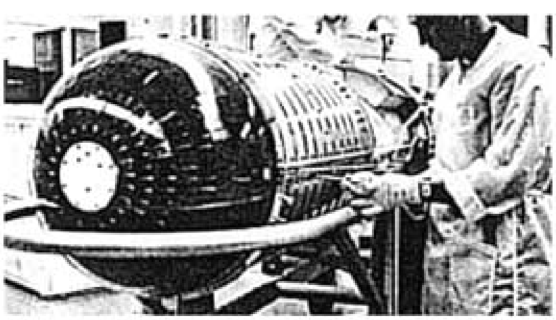
OV-1 high level operational concept diagram

The satellite was intended to be placed in a 560 x 2400 km orbit, but the separation mechanism failed to release the satellite from the launch vehicle. ***OV1-2*** launched on October 5, 1965, had a mass of 88 kg, conducted radiation studies to measure the impact of radiation on humans. It also tested the back-to-back launch configuration of the OV1 series but with a single satellite mounted. The payload consisted of proton and electron dosimeters and spectrometers, an X-ray detector, a magnetometer, two tissue equivalent ion chambers, and a shielded proton/electron dosimeter.

The 92 kg ***OV1-3*** payload, which was carried in a side pod, was to evaluate the biological hazards of trapped radiation and carried a tissue equivalent plexiglass human torso which was implanted with an ion chamber, spectrometer and linear energy transfer device. The launch vehicle exploded after two minutes of flight on May 27, 1965.



OV1 14 [USAF]



On March 30, 1966, an ***Atlas D*** launched two satellites simultaneously. ***OV1-4*** satellite conducted thermal control experiments with wafers of various materials and coatings. It also performed zero-gravity experiments on chlorella algea and multi-cell duck weed and exposed these specimens to alternate 12 hour periods of light and darkness as photo cells measured the cell division of the organisms. The mass of the satellite was 87.5 kg.

The ***OV1-5*** satellite, which had a mass of 114 kg,m measured the optical background of the Earth as well as the background of space to provide a basis for military surveillance techniques. Called the *Background Optical Radiation* experiment, it used five optical sensors, of which three pointed to the Earth and two away from the Earth. The sensors operated in the ultraviolet, infrared, and visible bands of the spectrum. In addition, the satellite tested the varistat gravity gradient stabilization system.

Atlas D launch vehicle

The 202 kg ***OV1-6*** satellite, which was launched on November 3, 1969, on a ***Titan IIIC*** along with several other satellites, carried several balloons which were ejected and served as optical targets which were subject to radiometer measurements and ground observations.

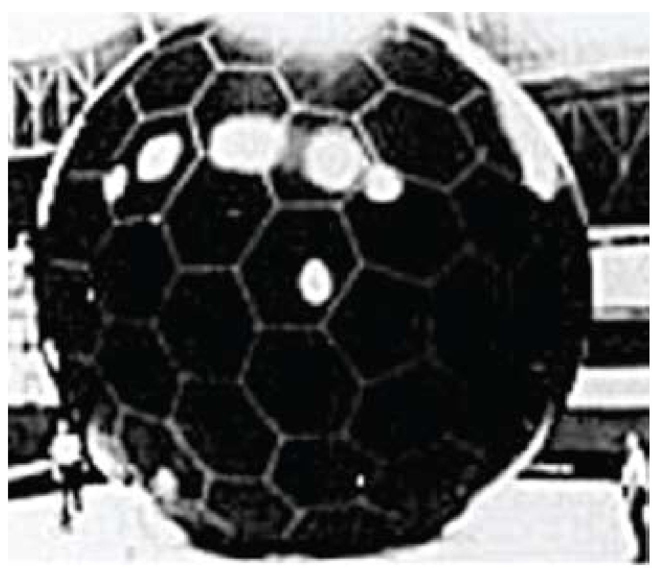
The ***OV1-7*** and ***OV-1-8*** were launched together on an Atlas D on July 14, 1966. OV1-7 was to investigate the night airglow, the molecular oxygen distribution, solar x-rays, cosmic rays, charged particles and electric fields of the upper atmosphere. The instruments carried were a solar X-ray monitor, a nightglow photometer, an electric field detector, a charged particle detector and several radio beacons. The 117 kg satellite failed to orbit, as the door of the payload bay of the launch vehicle, which were of the same design as for OV1-8, did not open quickly enough. It has also been stated the satellite injection motor failed.

Titan IIIC launch vehicle

The OV1-8 had a mass of 3.2 kg and consisted of a 9.14 m diameter wire mesh sphere with a balloon inside. The satellite was used for passive communications tests and to demonstrate the feasibility of the erection of an open gird structure in space. Also referred to as ***PasComSat***, the balloon decomposed, as planned, after a few orbits due to the intense solar ultraviolet radiation.

A number of radiation experiments were carried on ***OV1-9***, that was launched on December 11, 1966, including an electrostatic analyzer for the study of electrons and protons, a magnetic analyzer, and scintillation spectrometer for electrons, two solid state spectrometers and range energy spectrometer for the measurement of protons, a low-frequency antenna and amplifier to study exospheric radiation, plus three tissue-equivalent ion chambers to determine the space radiation hazard to man.

The same launch also carried ***OV1-10,*** which conducted further studies of space radiation with an all-sky *Lyman-alpha photometer* to measure hydrogen radiation, a scanning monochromator for ultraviolet day-glow photometry, a monochromator and *Geiger-*



OV1-8

Mueller counters for day-glow photometry, a crystal spectrometer to measure solar X-rays, a heavy primary cosmic ray telescope and a dual rubidium vapor magnetometer.

OV1-11, which was launched on July 27, 1967, was equipped with eight experiments to measure solar emissions, altitude distribution of atmospheric oxygen and ozone, and charged particles. The instruments included a solar X-ray spectrometer and monitor, a plasma wave detector, a night-glow probe, an ultraviolet radiance spectrometer and instruments to measure electron and proton flux. The satellite failed to separate from the launch vehicle.

The same launch vehicle also carrier the ***OV1-86*** which consisted of a satellite similar to the OV1-8, mated with a propulsion module as used on OV1-6. The objective of the flight was to measure the change over time in energy of cosmic rays, as well as the isotrophy of those rays. It was also to determine the emission properties of the Earth's oxygen mantle and to determine the radiometric temperature of the Earth's atmosphere. The instruments carried consisted of a cosmic ray telescope, a 60GC radiometer, a 1-14B interferometer and a WW-4 radiometer. As the 105 kg satellite tumbled, only partial data was gathered.

Finally, the launch on July 27, 1967, placed the 140 kg ***OV1-12*** satellite in orbit. It made biophysical and physical measurements of the space environment during solar flare activity as part of an overall programme to assess the effect of space radiation on humans. The experiments, which were collectively known as ***WL701 Flare Activated Radio-biological Observatory*** (**FARO**), were a *Tissue Equilibrium Ion Chamber*, a *Linear Energy Transfer Spectrometer*, a 20 to 40 *MeV Proton Detector*, a 45 to 110 *MeV Proton Detector*, a 3.5 to 5.0 *MeV Electron Spectrometer*, a *Solar Flare Detector*, a *X-Ray Scintillator*, a *Solid State Radiation Monitor*, a *High Energy Particle Detector*, a *Dose Spectrometer* and an *Omnidirectional Proton/Electron Spectrometer*.

An ***Atlas F*** placed the OV1-13 and OV1-14 satellites in orbit on 6 April 1968.
The 107 kg OV1-13 was to measure radiation at altitudes below 8000 km, evaluate the space environment's effects on bearings and on friction between various material combinations as well as evaluate flexible cadmium sulphide solar cells. The payload consisted of a Geiger-Mueller counter, four spectrometers, a magnetic analyser, an electrostatic analyser, various material combinations for the friction and wear experiment and experimental cadmium sulphide solar cells.

The 100 kg OV1-14 was to measure solar Lyman-alpha radiation and VLF and LF radiation in the Van Allen belts. The payload consisted of particle detectors to measure proton fluxes, proton spectra, electron spectra

Atlas F launch vehicle

and the time dependence of particles **dE/dX** telescopes and a Lyman-alpha experiment. Due to a power failure the satellite ceased transmitting data after one week in service.

OV1-15 was launched on July 11, 1968, to identify the cause of large and sudden fluctuations encountered in satellite trajectories, with the ultimate goal of being able to predict these fluctuations and their magnitude. The satellite investigated the upper atmosphere with an array of instruments, which included a microphone density gauge, ion gauges, mass spectrometers, energetic particle detectors, solar X-ray and ultraviolet flux monitors, an ionosphere monitor and a triaxial accelerometer. In addition ground based measurements were made. The satellite was also known as ***Solar Perturbation of Atmospheric Density Experiment*** (**Spades**).

The same Atlas F launch vehicle also carried ***OV1-16,*** which measured the time and space variations of atmospheric density at altitudes as low as 120 km. Also referred to as ***Cannonball-1*** or ***Low Altitude Density Satellite*** (**Loads**)***-1***, the satellite was a brass sphere with a diameter of 58 cm and a mass of 272 kg giving it a density equal to 690.5 kg/cubic meter, required to ensure the satellite would not immediately decay. It carried a tri-axial accelerometer.

On March 18, 1969, an Atlas F placed four OV1 series satellites into orbit. ***OV1-17*** measured the incoming solar electromagnetic radiation and the interaction of this radiation with the Earth's outer atmosphere. The 12 experiments measured the horizon day-glow and night-glow, solar x-rays, particles, electric fields, and extreme low-frequency propagation. It also tested cadmium-sulphide solar cells and thermal coatings. The satellite, which had a mass of 142 kg, was not correctly stabilzsed and spinned, resulting in four experiments that required proper stabilization returning useless data. The combined payloads on this flight have also been referred to as ***P69-1***.

OV1-17A, also known as ***Orbis Cal-2***, studied the unusual transmission of radiowaves through the ionosphere by monitoring the satellite with several ground stations. The 221 kg satellite consisted of the propulsion module of OV1-17 which was fitted with two radio beacons operating at 8.98 and 13.25 MHz. The ***OV1-18*** studied the ionosphere as it affects radiowave propagation. The payload consisted of 16 instruments to measure radio interference, electric fields, horizontal ion density gradients and gamma rays. The gravity gradient booms did not deploy and the satellite, which had a mass of 125 kg, was unstable giving meaningless data. The final satellite on this launch, ***OV1-19***, made detailed studies of the events causing and sustaining the trapped radiation in the **Van Allen** belts and studied the hazards to a human of incoming and trapped radiation. It carried seven instruments to study the trapped radiation and five instruments to study radiation hazards. The satellite's mass was 124 kg.

The final two satellites in the OV1 series were launched by an Atlas F on August 7, 1971. ***OV1-20*** and ***OV1-21*** carried experiments to investigate the properties of the near-Earth environment. The first satellite ejected a further satellite known as ***OAR-901***, ***Low Altitude Density Satellite II*** or ***Cannonball-2***. This was a brass sphere which made air density measurements in the fringes of the Earth's atmosphere. OV1-20 itself carried an energetic proton analyzer to measure the spatial energy dependency of trapped proton flux, as well as a particle and flux thermal detector to measure the electron density and temperature in the upper atmosphere.

OV1-21 was equipped with an experiment to determine the non-linear impedance and non-linear plasma effects of a long electric dipole antenna, an experiment to measure the atomic oxygen density and the variations in this density during geomagnetic activity as well as an instrument to measure the solar flux and atmospheric composition. Furthermore the satellite released six sub-satellites: the *Radar Tracking Density Satellite*, ***OAR-907*** or ***Musketball***, which carried a C-band transponder to make air density measurements in the fringes of the Earth's atmosphere; a 112 cm diameter rigid sphere (***AVL-802*** or ***Rigid Sphere-2***); three inflatable spheres with a diameter of 213 cm (identified as ***Grid Sphere-1*** and ***-2*** and ***Mylar Balloon***), which were used to determine the ballistic coefficient of spheres and measure the change in this coefficient with the changing altitude; and the ***Lincoln Calibration Sphere*** (**LCS**)***-4***, a radar calibration satellite also known as ***Rigid Sphere-1***.

In their day, the **Orbiting Vehicle** series of satellites were remarkable in that details of the experiments were published, unlike other US Air Force satellites which were classified and remain so – in most instances – today. We will probably never know the extent to which these small satellites were associated with the classified programs. In a future issue of *MilsatMagazine*, *Jos Heyman* will continue the OV satellite series.

About the author

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

OV1 Series

Name	Launch	Re-entry	Notes
OV1-1	21-Jan-1965	---	Failed to orbit
OV1-2	5-Oct-1965		Radiation studies
OV1-3	27-May-1965	---	Failed to orbit
OV1-4	30-Mar-1966		Thermal control experiments
OV1-5	30-Mar-1966		Optical radiation test
OV1-6	3-Nov-1966	31-Dec-1966	Inflatable decoy
OV1-7	14-Jul-1966	---	Failed to orbit
OV1-8	14-Jul-1966	4-Jan-1978	Communications experiment
OV1-9	11-Dec-1966		Radiation studies
OV1-10	11-Dec-1966	30-Nov-2002	Radiation studies
OV1-11	27-Jul-1967	---	Failed to orbit
OV1-86	27-Jul-1967	22-Feb-1972	Cosmic ray telescope
OV1-12	27-Jul-1967	22-Jul-1980	Radiation studies; also known as Flare Activated Radio-biological Observatory (Faro)
OV1-13	6-Apr-1968		Radiation studies
OV1-14	6-Apr-1968		Radiation studies
OV1-15	11-Jul-1968	6-Nov-1968	Air density, solar studies; known as Solar Perturbation of Atmospheric Density Experiments Satellite (Spades)
OV1-16	11-Jul-1968	19-Aug-1968	Ionospheric drag experiment; also known as Cannonball-1
OV1-17	18-Mar-1969	5-Mar-1970	Solar studies
OV1-17A	18-Mar-1969	24-Mar-1969	Ionospheric studies; also known as Orbis Cal-2
OV1-18	18-Mar-1969	27-Aug-1972	Ionospheric studies
OV1-19	18-Mar-1969		Radiation studies
OV1-20	7-Aug-1971	28-Aug-1971	Radar calibration, radiation studies
OV1-21	7-Aug-1971		Radar calibration, air density studies

MILSATCOM IN HARSH CONDITIONS

"Incoming!"

This is not the kind of cry that a loving wife expects to hear in the background whilst talking to her husband on the telephone. But when **Danish Army Sergeant First Class**, *Flemming Ulrich* thought he would check in with his family at home using his ***Explorer 500***, he was not expecting it to start raining rockets. Fortunately, *Flemming* and his unit made it through the barrage unscathed and he was soon able to call his wife back and let her know they were all safe.

Flemming Ulrich's job as a Sergeant First Class and as a military technician was to make sure all the vehicles, weapons, and communication systems worked as well as possible. With this commitment in mind, he organized with **Thrane & Thrane** to field trial a ***BGAN*** system during his tour in Afghanistan, to find out if such a system could work for the military.

A Vital Need... Communication

"If a vehicle breaks down in Afghanistan, the squadron comes to a stop and that can stop the whole battalion. And the vehicles break down very often in this harsh terrain. The Danish units are organized differently from the British. As we are fewer troops, we need to be more self-sufficient. Therefore, we brought big trucks to the desert with ammunition, water and food rations, etc.," explains *Flemming*.

"Obviously in these conditions communication is very important so just before I left, I met with Mr. Anders Pjetursson of Thrane & Thrane. We discussed satellite communication and it ended up with me taking an EXPLORER 500 to the desert to make a field-test under the hardest conditions you can think of."

The Ultimate Test

The ***EXPLORER 500*** is built to last. The system is designed for use in extremely harsh

conditions by engineers, government, and NGO workers, disaster relief organizations, and the military, to name but a few. The war in Afghanistan, though, is truly the ultimate test for the system. According to *Flemming*, it held it's own in conditions that most of us would find it hard to imagine.

"As we patrolled the desert for long periods, it (Explorer 500) was our only means of Internet communications. That meant that I could communicate with my family at home. It also meant that my wife could write me emails and that I could send her updates — non military, of course — and let her know that I was okay after our many battles with the Taliban," said *Flemming*.

Flemming's experiences in the desert reflect the user-friendly design that is the heart of the EXPLORER. "The EXPLORER was quite easy to use. I used it in thunderstorms, sandstorms and in wild rainstorms with no problems. I could always get a connection with the satellite. Even temperatures of 55 degrees in the shadow were no problem. The computer would pass out before the Explorer ," said *Flemming*.

Under Fire

"One particular episode was out of the ordinary. It was when we were in a joint operation with British and American forces to take the city of Sangin. Normally I wouldn't make calls during operations, but this was a very long operation and nothing really happened in our sector, so I called my wife to tell her, that everything was fine. She had just answered the call, when the first Taliban rocket hit the ground a few hundred meters away. She heard the detonation and people yelling "incoming". I dropped down and told her, I was busy, and that I would call later. After about 30 minutes I was able to call her again.

"My wife had just picked up the phone once more, when another rocket hit the ground a kilometer away and my colleagues yelled 'incoming'. I dropped down again, told my wife that I was still busy, and that I would call again later. It took more than two hours before we had finally defeated the Taliban and I could call her on the satellite phone."

Tough Conditions

Flemming's experiences in Afghanistan show that EXPLORER 500 will withstand the harshest conditions and just how important communication with loved ones can be for the troops on the ground. From a military perspective, *Flemming*'s commanding officers are very interested in getting the EXPLORER for operative use, but it can take a while before the military command are convinced, especially as the signal encryption is a specialized job in times of war. In addition to being a moral boost for the soldiers, EXPLORER could one day play an important operational role in future conflicts.
"The war in Afghanistan, though, is truly the ultimate test for the system and it held it's own in conditions most of us would find hard to imagine."

Voice and broadband available anywhere on the planet — the Explorer 500 harnesses the power of **Inmarsat**'s ***BGAN***, or *Broadband Global Area Network*, which provides broadband quality and speed, almost anywhere on the planet. BGAN is the world's first mobile communications service to provide voice and broadband data simultaneously through a single, portable device on a global basis — that's why it is used by professionals whose job depends on them being out in the field, often miles from civilization.

Explorer 500

INDIA'S MISSILE DEFENSE/ANTI-SATELLITE NEXUS

AUTHOR: VICTORIA SAMSON, SECURE WORLD FOUNDATION

While China's 2007 anti-satellite (ASAT) test and its missile defense intercept test earlier this year have attracted much attention and concern, another emerging space power has also been expressing its interest in developing those capabilities yet attracting very little notice: India.

Given enthusiastic statements by Indian officials about what they see as the need for ASATs and the country's continued missile defense efforts, this could be worrisome. Though most of the rhetoric can be chalked up to regional rivalry, and much of the grandstanding downplays the level of technical capacity that still needs to be developed, India's plans for missile defense and their relationship to space security bear further monitoring.

India's Plans

India has been working on a missile defense system that is primarily indigenously built for several decades, but it wasn't until relatively recently that successes were repeated during testing. India held missile defense intercept attempts in November 2006 (a test where the intercept occurred outside the Earth's atmosphere, or was exoatmospheric), December 2007 (a test where Indian officials claimed that the intercept occurred inside the Earth's atmosphere, or was endoatmospheric, despite video footage implying that the interceptor missed the target), March 2009 (an exoatmospheric test), and March 2010.[1]

During the last test, the modified **Prithvi** target missile did not follow its scheduled flight path and thus the interceptor missile, called the ***Advanced Air Defense*** (**AAD**) missile, was not launched.[2] Indian officials have indicated that they want to deploy a working missile defense system by 2012. *Defense Research and Development Organization* Director General *V.K. Saraswat* stated last October that the "[o]nly part that remains to be developed is the interceptor missile;"3 the US Missile Defense Agency's experience in developing interceptors might demonstrate to him how much work India might have ahead of itself. Per Saraswat, there are two phases to India's intended ballistic missile program: the first phase is planned to intercept target missiles with ranges of up to 2,000 kilometers via "exo-atmospheric, endo-atmospheric and high-altitude interceptions," while in the second phase, India will strive to be able to intercept target missiles with ranges of 5,000 kilometers, which potentially could give India the ability to intercept intercontinental ballistic missiles.[4] *Saraswat* also proudly noted after China held its first missile defense intercept test attempt in January 2010, "This is one area where we are senior to China."[5]

Prithvi target missile

Dr. *K. Kasturirangan*, former head of the ***India Space Research Organization*** (**ISRO**), said in September 2009, "China's ASAT capabilities displayed a few years ago was to show to the world that they too can do it. That China can do what it wants to do and demonstrate that it can do even more… to supersede the best of the world, that is the US."[6] He also stated, "Obviously we start worrying. We cannot overlook this aspect."[7] *Kasturirangan*, sounding very similar to some parts of the US national space community, asserted that "India has spent a huge sum to develop its capabilities and place assets in space. Hence, it becomes necessary to protect them from adversaries. There is a need to look at means of securing these."[8]

In January 2010, *Saraswat* tipped India's hand further when he told reporters, "India is putting together building blocks of technology that could be used to neutralize enemy satellites," and that "We are working to ensure space security and protect our satellites. At the same time we are also working on how to deny the enemy access to its space assets."[9]

This last part is very similar to statements made by some US officials charged with protecting US space assets. *Saraswat* did acknowledge, "Basically, these are deterrence technologies and quite certainly many of these technologies will not be used."[10] If that last part is true, it does raise the question of how much of a deterrent these technologies may actually provide, since the Indian government claims not to intend to use them.

Air Chief Marshal *P.V. Naik* gave in February 2010 perhaps the real reason why India has expressed any interest in an ASAT program in his explanation, "Our satellites are vulnerable to ASAT weapon systems because our neighborhood possesses one."[11]

Our satellites are vulnerable to ASAT weapon systems because our neighborhood possesses one."
Air Chief Marshal P.V. Naik

Clarifying his statements from the previous month, *Saraswat* announced in February 2010, "In Agni-III [*see introductory photo at the start of this article-Ed.*], we have the building blocks and the capability to hit a satellite but we don't have to hit a satellite… If you hit a satellite, the repercussions are that we will have debris and they will be detrimental to objects in space and it will remain in there for many years."[12]

This was a welcome acknowledgement by an Indian military official of some of the negative consequences of actively testing an ASAT program. Instead, *Saraswat* said that India "will validate the anti-satellite capability on the ground through simulation," emphasizing that "there is no program to do a direct hit to the satellite."[13] Conflating India's successes thus far with its ballistic missile arsenal development and its plans for a ballistic missile defense system, he went on to say, "With the kill vehicle available and with the propulsion system of Agni III, that can carry the missile up to 1,000 kilometers altitude, we can reach the orbit in which the satellite is and it is well within our capability."[14]

Part of why India may be interested in developing an ASAT capability is that it wishes to use it as a way to enhance its missile defense program and, to a lesser extent, its domestic science and technology skills. This is latter is seen even in the United States, which has a much longer history of space activities, where some of the strongest proponents for continuing with space exploration (for example) couch their arguments in the need to maintain and expand an intellectual industrial base for space technology know-how.

An ASAT capability requires, if one is using kinetic kill vehicles and not relying on the destruction from an electromagnetic pulse or a nuclear-tipped warhead, very solid and reliable hit-to-kill capabilities. India has explicitly expressed its interest in developing more or less indigenously its own missile defense system and has been working assiduously on such a program for some time; thus, an ASAT program, as it were, would also be a technology demonstration program for a missile defense system.

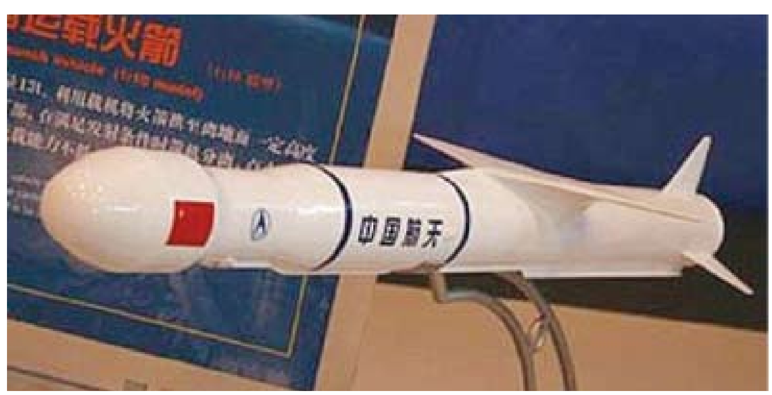
This highlights the similarities between missile defense and ASATs. Interestingly enough, India seemed a few years ago like it was more interested in purchasing parts of the **Arrow Weapon System**, a missile defense system co-developed by the United States and Israel. It apparently has since decided that it would rather build its own and gain the skill set such a system would require.

But primarily, as can be seen by statements by Indian officials, not ceding ground to its political regional rival, China, is mostly grandstanding by India. The Indians see China as their main competitor and nation of concern (regarding space capabilities) in the region. These statements by Indian officials partially can be explained as bombast to assure domestic audiences that India is a peer of China or even ahead of it.

However, there is another explanation: these statements indicate that India is interested in being able to reach China. The Indians may have decided that they should be able to cover all contingencies for future conflicts. The Pakistanis are already well within range of Indian ballistic missiles, and by developing this long-range missile capability, the Indians will be able to counter China as well. They can point to the 2007 Chinese ASAT test as an example of the pressing need for reciprocal capability; again, this mirrors some of the debate within the United States for why American space assets may be endangered. And as China reportedly held its own hit-to-kill missile defense test in January 2010, this just adds more justification to those who feel that India must have a missile defense system in order to keep up with regional capabilities.

There are lessons learned from previous arms control debates that have probably affected India's decision to seek a missile defense/ASAT capability. One strong one is that Indians remember well that the 1*968 Nuclear Non-Proliferation Treaty* (**NPT**) made a concrete division between the nuclear haves and the have-nots. This partition was largely based on who had held a nuclear test prior to

U.S. ASM-135 ASAT missile



Chinese ASAT missile

the treaty's creation. India missed becoming an official nuclear weapon state by six years by having its first nuclear test—or, as India termed it, a "peaceful nuclear explosion — in 1974. There are some within India who have taken that lesson to heart and want India to develop an ASAT capability so that India would be grandfathered in, should any future treaty or international agreement ban ASATs. This is probably to gain the prestige of being one of a select few states and the wish to avoid being hemmed in, should future Indian military officials decide that an ASAT capability is needed for their national security needs. India's ASAT plans are worrisome because, in the Indians' anxiety to keep up with China, they may unexpectedly create the exact thing that they are trying to avoid: a conflict in or about space.

AEGIS-BMD: CG-70 launches SM-3

India's interest in developing this missile defense/ASAT capability also could be seen as an unintended consequence from the October 2008 US-India nuclear deal. In it, the United States agreed to lift its ban on nuclear trade with India, despite India's not having signed the NPT and actively flouting the spirit of that treaty by holding nuclear weapon tests. The nuclear deal put India in a unique position relative to other non-conforming states to the NPT, thanks to its now special relationship with the United States; India may think that its benefactor will quietly look the other way while it develops ASATs. Furthermore, as noted earlier, many of India's justifications for pursuing ASATs are quite familiar to those following the debate being held in the United States about how best to protect US space assets.

Along those same lines, while there was much criticism of the debris created by China's 2007 ASAT test, international approbation was about all that China was subjected to. There were not any military responses, economic embargoes, or even technological limitations (beyond what the export controls that the United States already had in place). Japanese Prime Minister Shinzo Abe very delicately called the test illegal with this statement to the Japanese Diet: "I believe it would not be in compliance with basic international rules such as the *Outer Space Treaty*."[15] (Article IX of the 1967 OST calls for prior international consultation if a state believes its planned space activities may be harmful to others.)[16] Perhaps India figures that despite the unpopularity of developing ASATs, there are not going to be any tangible consequences to doing so.

Now, if India were to actually test an ASAT, that might prove to be a different story, but as can be seen by the Indian officials quoted above, they probably realize that as well and have opted not to cross that line. Also, perhaps

India's ASAT plans are worrisome because in the Indians' anxiety to keep up with China, they may unexpectedly create the exact thing that they are trying to avoid: a conflict in or about space. If their statements are misunderstood or if they ratchet up the rhetoric, they may thrust India into the position of having to hope that its missile defense interceptors do, indeed, serve as able ASATs.

maintaining ambiguity around its ASAT plans serve India better than holding an actual test and removing all doubt as to whether it actually has that capability.

Finally, it is important to put India's missile defense/ASAT ambitions within the proper context. India does not have the indigenous space situational awareness capability needed for an ASAT system. India is working to improve this but, as the US missile defense systems' trials and tribulations have shown, it is not something that can be developed rapidly, even if given great leeway in its development and a relatively blank check.

While a dedicated satellite network is not a necessity, it does raise the question of how India intends to be able to detect and track missile launches. The United States' experience in shooting down the de-orbiting satellite ***USA 193*** in February 2008 with a modified ***Aegis Ballistic Missile Defense*** (**BMD**) interceptor demonstrated that missile defense radars often do not have the capacity to keep up with a satellite target, since the Aegis system's radars were unable to track at the very fast speed that the satellite was travelling.

Finally, while it is true that, generally speaking, a ballistic missile is expected to be able to reach an altitude of about half its range, this does not mean that this automatically translates into being able to reach that altitude while simultaneously serving as a missile defense interceptor. The ***Agni-III*** or ***-V*** may be powerful ballistic missiles, but they cannot be scaled down and just swapped into the Indian missile defense network in order to have a missile defense capacity; thus claims about their effectiveness equaling an enhanced ASAT or missile defense capability should be taken with a grain of salt.

About the author

Victoria Samson is the Washington Office Director for Secure World Foundation, where she engages Congressional staffers and agency officials on matters related to space security and governance. Previously, she was a Senior Analyst with the Center for Defense Information (CDI), where her areas of interest included missile defense, nuclear reductions, and space security issues. Prior to her time at CDI, Samson was the Senior Policy Associate at the Coalition to Reduce Nuclear Dangers, a consortium of arms control groups in the Washington, D.C., area. She previously worked as a subcontractor on war-gaming scenarios for the Missile Defense Agency's Directorate of Intelligence. Samson is the author of numerous op-eds, analytical pieces, journal articles, and electronic updates on missile defense and space security matters. She has an M.A. in international relations from the Johns Hopkins School of Advanced International Studies, and holds a B.A. in political science with a specialization in international relations from UCLA.

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