SatCom For Net-Centric Warfare October 2011

MilsatMagazine

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The Naval Research Lab celebrates 100 launches... and TacSat-4

This photo captures the "unofficial" symbol of the NRL, the 50-foot dish atop the agency's main administration building at sunset.

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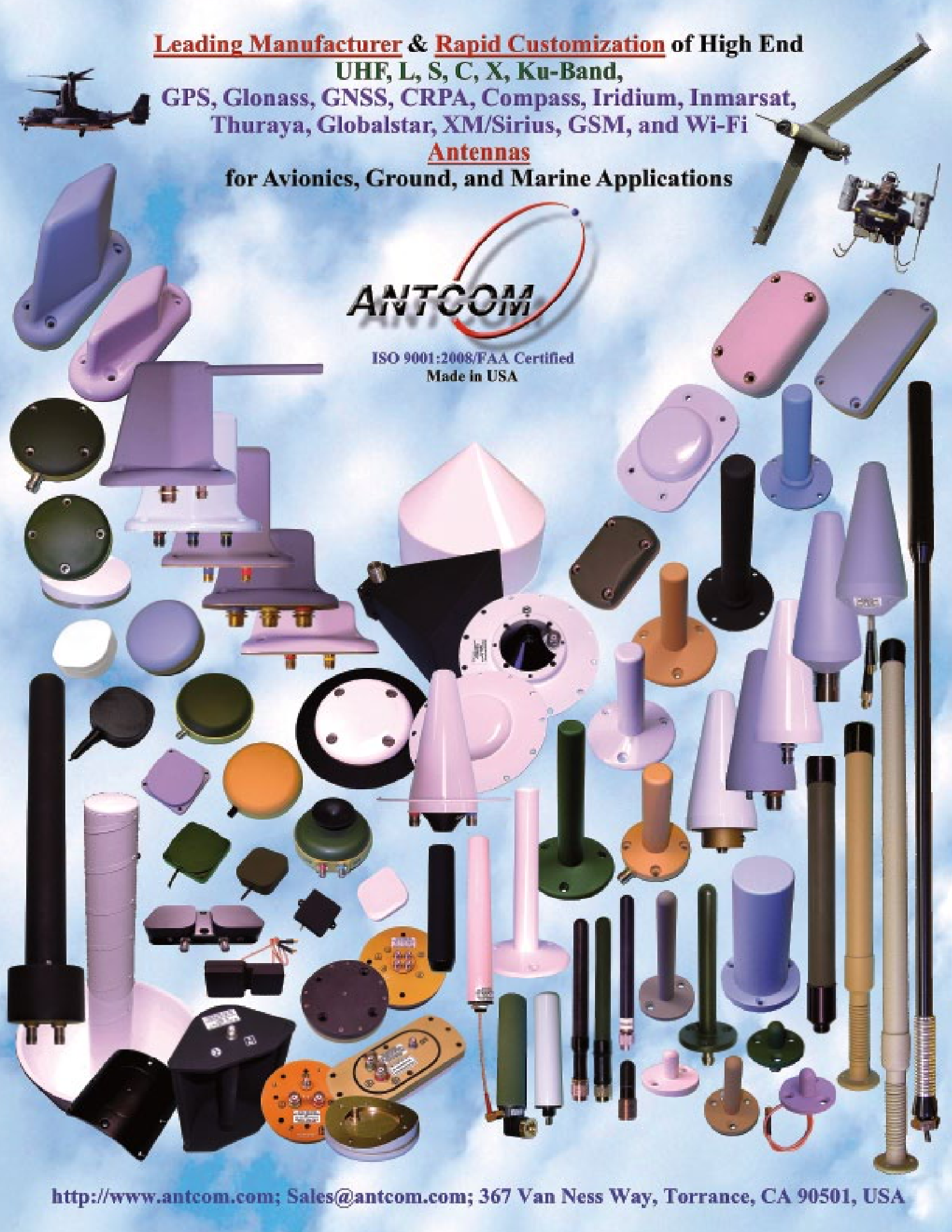
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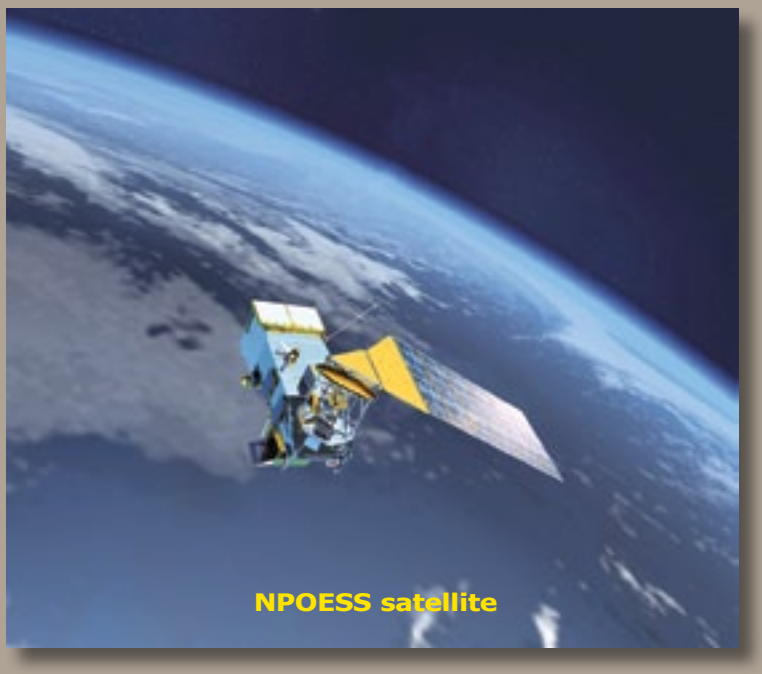

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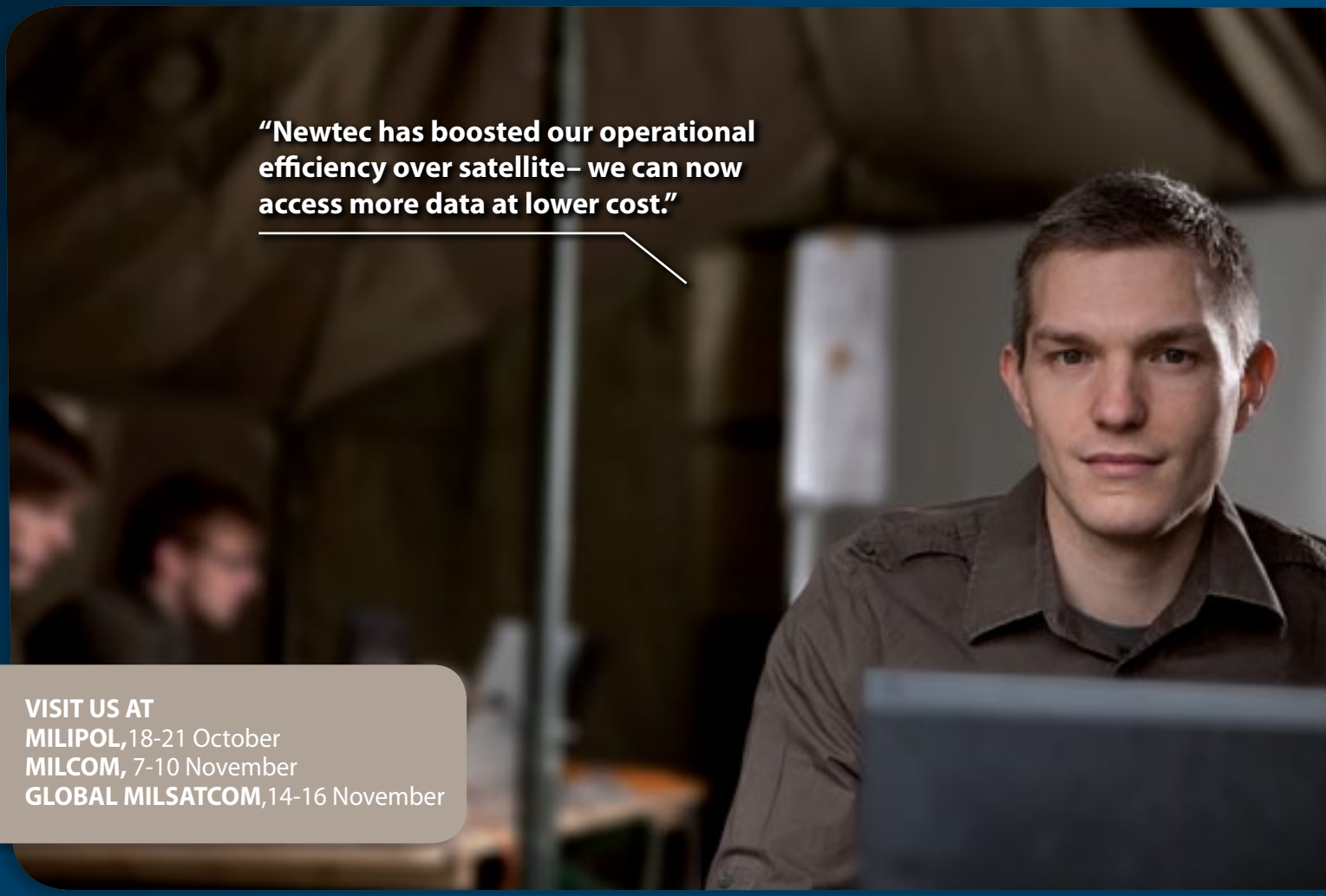
TacSat-4 Makes It's Move

The U.S. Department of the Navy prepared well as they moved toward September 27th, the selected date for the launch of the new, joint tactical satellite, which will bring on-the-go communications to the battlefield. The Tactical Microsatellite (TacSat)-4, funded by the Office of Naval Research (ONR) and developed by the Naval Research Laboratory (NRL), will start transmitting data 30 days after the satellite attains its planned orbit.

"TacSat-4 fills a Navy and Marine Corps capability gap by enabling 'comms on the move,'" said *Bob McCoy*, an ONR senior scientist. "That is a unique feature of this system — no other Department of Defense [DoD] satellite system can relay information from the satellite all the way down to warfighters' portable communications packs and handheld radios."

It enables warfighters to use a regular handheld radio for mobile communications without having to stop and set up an antenna in the field. This eliminates downtime and maintains connectivity to the base of operations at all times, so one is never out of touch, said *John Moniz,* ONR's program officer for *Expeditionary Warfare Command, Control, Computers*



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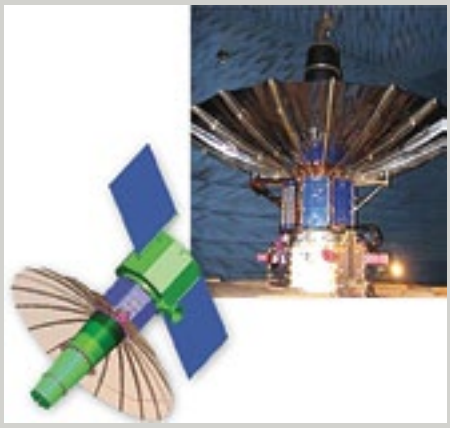

and Communication, whose work could potentially benefit from the TacSat-4 satellite.

The fourth-generation microsatellite, TacSat-4 is a fourth-generation (4G) microsatellite and weighs in at 990 pounds, as opposed to the industry average of approximately 4,300 pounds. The just-launched satellite is less expensive than a conventional system and is designed to support traditional satellite communications, providing two hours of global coverage up to three times per day in multiple theaters within a 24-hour period.

"This gives additional capability and more communications channels to where there's a 'hot spot' in the world," *McCoy* said.

TacSat-4's communication is also flexible and faster, providing dynamic channel assignments within 24 hours during normal operations rather than the typical several days. It offers a smarter, more efficient way of assigning channels.

The satellite carries an ONR-sponsored payload built by NRL on infrastructure funded by the former DoD *Office of Force Transformation* and built by **NRL** and the **Johns Hopkins University Applied Physics Laboratory**. The **Operationally Responsive Space Office** funded the launch, which is managed by the *Space Development and Test Directorate*, a directorate of the **U.S. Air Force Space and Missile Systems Center**, and launched via a ***Minotaur-IV*** rocket built by **Orbital Sciences**.

As of October 3rd, the satellite into its checkout phase and the TacSat-4 spacecraft bus is functioning fully on-orbit. The 12-foot 'umbrella-like' UHF antenna has been deployed and RF tones have successfully been sent through all 10 UHF channels. The X-band downlink is functional as is the advance thermal loop heat pipe system.

ONR provides the science and technology necessary to maintain the **U.S. Navy** and **U.S. Marine Corps**' technological advantage. Through its affiliates, ONR is a leader in science and technology with engagement in 50 states, 70 countries, 1,035 institutions of higher learning, and 914 industry partners. ONR employs approximately 1,400 people who are comprised of uniformed, civilian, and contract personnel, with additional employees at the **Naval Research Lab** in Washington, D.C. The website for the Naval Research Laboratory is ***http://www.nrl.navy.mil/***

The Launch

TacSat-4 successfully launched September 27th aboard an **Orbital Sciences *Minotaur-IV+*** launch vehicle from the **Alaska Aerospace Corporation**'s (**AAC**) **Kodiak Launch Complex**, located on Kodiak Island, Alaska.

The spacecraft augments current geosynchronous satellite communications, having an apogee of 12,050 kilometers in the high latitudes to deliver near, although not continuous, global *communications on-the-move* (**COTM**) to the battlefield and provide access to mountainous regions that have previously proved problematic.

TacSat-4 is a Navy-led joint mission that provides 10 *Ultra High Frequency* (**UHF**) channels and allows forward deployed troops to communicate from obscured regions using existing hand-held radios without the need to stop and point an antenna towards the satellite.

"TacSat-4 supports a critical warfighting requirement: communication," said Chief of Naval Research Rear Adm. *Nevin Carr*. "We've developed a technology that will supplement traditional satellites, giving military personnel on the ground another outlet for data transmission and facilitating 'comms on the move'."

TacSat-4 provides flexible up and down channel assignments, which increase the ability to operate in busy radio-frequency environments and will cover the high latitudes and mountainous areas where users currently cannot access UHF satellite communications.

The NRL **Blossom Point Ground Station** provides the command and control for TacSat-4 and maintains its user *Virtual Mission Operations Center* (**VMOC**) tasking system, allowing dynamic reallocation to different theaters worldwide and enables rapid SATCOM augmentation when unexpected operations or natural events occur.

TacSat-4 is an experimental spacecraft that will test advances in several technologies and SATCOM techniques. It will augment the existing fleet by giving the *SATCOM Support Centers* (**SSC**) an additional space asset to provide communications to otherwise under-served users and areas that either do not have high enough priority, or do not have satellite visibility. The project will potentially provide the option for launching smaller *highly elliptical orbit* (**HEO**) satellites and enabling 24-hour coverage in multiple regions simultaneously, allowing the military to achieve the benefits of a combined HEO and geosynchronous orbit constellation.

The spacecraft bus was built by NRL and Johns Hopkins University Applied Physics Laboratory (APL) to mature ORS bus standards. It was developed by an *Integrated System Engineering Team (*government and industry), known as the the "ISET Team," with active representation from **AeroAstro**, the **U.S. Air Force Research Laboratory**, Johns Hopkins Laboratory APL, **ATK Space**, **Ball Aerospace and Technologies**, **Boeing**, **Design**

Net Engineering, **General Dynamics AIS**, **Microcosm**, **Microsat Systems Inc.**, **Massachusetts Institute of Technology Lincoln Laboratory**, **Orbital Sciences**, **NRL**, **SMC**, **Space Systems/Loral**, and **Raytheon**.

The **Office of Naval Research** (**ONR**) sponsored the development of the payload and funded the first year of operations. The *Office of the Director of Defense Research and Engineering* (**DDR&E**) funded the standardized spacecraft bus. The **Operationally Responsive Space** (**ORS**) **Office** funded the launch that was performed by the **U.S. Air Force Space and Missile Systems Center** (**SMC**).

TacSat-4 is managed by the Naval Research Laboratory, Naval Center for Space Technology and marks NRL's 100th satellite.

The Launch Vehicle

The Minotaur IV Space Launch Vehicle (SLV) leverages the flight-proven heritage of the Minotaur I, Pegasus, and Taurus space launch vehicles to provide an extremely cost-effective and capable space solution for U.S. Government-sponsored spacecraft. It builds on a long background of dependable launch systems with over 50 flights of each core stage. The combination of three government-furnished solid rocket stages, a commercial solid rocket upper stage, and Orbital's flight-proven systems and processes provide an unmatched mix of value and performance. The integration of government motors with commercial boosters and state-of-the-art hardware is one of Orbital's unique strengths from experience spanning several decades, including the use of the Peacekeeper Stage 1 motor on three successful Taurus missions.

For the ***Minotaur IV***, the standard Minotaur-family avionics, flight software, and subsystems are integrated into a *Guidance Control Assembly* (GCA) which also incorporates the Stage 4 solid motor. The baseline Stage 4 motor is the same ***Orion 38*** design used on ***Minotaur I***, ***Pegasus***, ***Taurus***, and other Orbital launch vehicles. An optional ***Star 48V*** motor is available for additional performance in the ***Minotaur IV+*** configuration, which was used to launch the TacSat-4 satellite.

The OSP-2 Minotaur IV SLV combines elements of government-furnished decommissioned ***Peacekeeper*** boosters with technologies from the Company's proven ***Pegasus***®, ***Taurus***® and ***OSP Minotaur*** launch vehicles. The vehicle consists of three Peacekeeper solid rocket stages, a commercial Orion 38 fourth stage motor and subsystems derived from our established space launch boosters. Under a 10-year contract with the U.S. Air Force Space and Missile Systems Center, Orbital will develop and operate the low-cost Minotaur IV vehicle to launch U.S. government-funded satellites into low-Earth orbit.

The Minotaur IV SLV incorporates a standard 92-inch fairing from the Taurus booster and supports dedicated or shared launch missions. Capable of boosting payloads more than 1,750 kg into orbit, the vehicle is compatible with multiple U.S. government and commercial launch sites. The Minotaur IV is designed to provide 18-month mission response including payload integration and launch by Orbital's experienced launch crews.

The Minotaur IV launch vehicle made its debut in 2010, with three successful launches in a six month period in three different configurations. The inaugural launch boosted **DARPA**'s ***Hypersonic Test Vehicle*** on a suborbital trajectory in April 2010. The first Minotaur IV mission to boost a satellite into orbit occurred on September 25, 2010, successfully launching the ***SBSS*** satellite for the U.S. Air Force.

The Minotaur family of launch vehicles are provided via the *Orbital/Suborbital Program 2* (**OSP-2**) and managed by the **U.S. Air Force Space and Missile Systems Center** (**SMC**), **Space Development and Test Wing**'s (**SDTW**) *Launch Test Squadron* (LTS) located at **Kirtland AFB**, New Mexico. — information courtesy of **Orbital Sciences**. Additional details are available at ***http://www.orbital.com/SpaceLaunch/Minotaur/IV/.***

The Launch Facility

Kodiak Launch Complex (KLC) was the nation's first commercial spaceport *not* collocated on a federal range. Situated approximately 44 road miles south of the city of *Kodiak* at *Narrow Cape* on *Kodiak Island*, the spaceport is a state-of-the-industry launch facility. Vigilance, regularly scheduled maintenance, and periodic upgrades govern day-to-day activity. KLC is situated on 3,717 acres of state owned land, and AAC has authority during launch missions to limit public access to an additional 7,000 acres to assure public safety and security.

KLC is the nation's only high latitude full service spaceport. It features all indoor, all weather, processing and was designed specifically to provide optimal support for space launches to polar orbit, including circular and highly elliptical Molniya and Tundra orbits.

KLC offers unrestricted down range launch azimuths ranging from 110 to 220 degrees, and is the only U.S. facility that can launch high inclination (63.4 degree) missions without land over-flight and the requirement to resort to energy consuming dogleg flight segments. The spaceport, like all U.S. west coast facilities, sits on the seismically active Pacific Rim, and all structures and components are designed to exceed applicable design criteria for seismically active zones.

Rocket motors and payloads come to KLC via sea and air, depending on dsize and customer needs. AAC can provide complete logistics services from the other 49 states or overseas to KLC through its subcontractors, or the customer can arrange for logistics directly.

Ports of entry include the regional airport, which is collocated with the **U.S. Coast Guard Base** near the town of Kodiak, and the **LASH Dock**, a marine terminal located adjacent to the U.S. Coast Guard Base. Transport from the port of entry is by all-weather paved highway to KLC. A typical motor convoy to KLC includes a pilot and trail car, State Trooper escort, and crew vehicles. In winter, the convoys are augmented with road graders and sanders. — information courtesy of Alaska Aerospace Corporation. For further details, access ***http://www.akaerospace.com***. ❖

Better Late Than Never…

The first Advanced Extremely High Frequency space vehicle will arrive at its orbital slot in late October, instead of October 3, as projected in June

In August of 2010, when ***AEHF-1*** was launched, it experienced lower-than-expected thrust from its main bi-propellant engine (Liquid Apogee Engine). A team of **United States Air Force** military, federal civilian, **Lockheed Martin** and **Aerospace Corporation** engineers at the **Space and Missile Systems Center**'s *Military Satellite Communications Systems Directorate* revised the AEHF-1 orbit-raising profile to use **Hall Current Thrusters** to raise the spacecraft to its intended operational orbit while maintaining the safety of the vehicle and conserving on-board fuel. The decision to slow down the orbit-raising plan was made to balance operational needs, space environmental factors and vehicle conditions.

"As we go forward, we're careful to understand the use of those thrusters and are monitoring closely the amount of fuel we're using in order to continue to optimize overall satellite performance," said Mr. *Dave Madden*, director of SMC's *MILSATCOM Systems Directorate*. "Currently, there are no changes to the previously anticipated mission capabilities at the completion of orbit transfer.

AEHF is a joint service satellite communications system that will provide survivable, global, secure, protected, and jam-resistant communications for high-priority military ground, sea and air assets. The AEHF System is the follow-on to the ***Milstar*** system, augmenting, improving and expanding the MILSATCOM architecture. The satellite remains stable and under Air Force control and is projected to meet its required 14 years of mission life. AEHF is developed by the MILSATCOM Systems Directorate at Los Angeles AFB, California.

The MILSATCOM Systems Directorate plans, acquires and sustains space-based global communications in support of the president, secretary of defense and combat forces. The MILSATCOM enterprise consists of satellites, terminals and control stations and provides communications for more than 16,000 air, land and sea platforms. ❖

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A Most Admirable Award

Lockheed Martin [NYSE : LMT] congratulates the U.S. Air Force and the *Global Positioning System* (GPS) community for receiving the *International Astronautical Federation*'s (IAF) *60th Anniversary Award* for outstanding achievement in the area of space applications for human benefit.

The prestigious IAF award, presented to the GPS program on October 4th in Cape Town, South Africa, recognizes the program for having the **greatest measurable benefit to humanity in the history of space programs**. The IAF noted that while there have been numerous scientific and technical achievements spawned from human and robotic spaceflight, satellite communications, weather satellites, remote sensing and more — the GPS program provides the greatest measurable benefits every day to billions of people around the globe.

Similar to the Internet, GPS is an essential element of the global information infrastructure. GPS technology is found in everything from cell phones and wristwatches to shipping containers, and ATM's. The system boosts productivity across a wide swath of the economy, to include farming, construction, mining, surveying, supply chain management and more. Major communications networks, banking systems, financial markets, and power grids depend on GPS and the technology is embedded in virtually every U.S. military asset making armed forces safer and more effective.

"The far-reaching applications of GPS today extend beyond anyone's imagination when the program was conceived almost 40 years ago. We congratulate the U.S. Air Force and the entire GPS community for their remarkable vision and unrelenting diligence in building and operating a true global utility that improves the welfare of billions around the world every day," said *Joe Trench*, vice president of Navigation Systems for **Lockheed Martin Space Systems Company**. "We take great pride in our partnership with the Air Force on its GPS program and we are steadfastly committed to providing even better GPS capabilities in the future."

Lockheed Martin designed and built 21 ***GPS IIR*** satellites for the U.S. Air Force and subsequently modernized eight of those spacecraft, designated ***GPS IIR-M***, to enhance operations and navigation signal performance. The fleet of Lockheed Martin-built GPS IIR and IIR-M satellites makes up the majority of the operational GPS constellation. The satellites have exceeded 140 cumulative operational years on-orbit with a reliability record of better than 99.9 percent, an unmatched record of exceptional performance, and reliability for GPS users around the globe. Lockheed Martin heritage also dates back to the production of the ***Oscar*** and ***Nova*** satellites, the original navigation programs that paved the way to the current GPS system.

As GPS becomes increasingly vital to modern civilization, the U.S. Air Force and Lockheed Martin are developing the next generation system, known as ***GPS III***. GPS III will be a catalyst for profound new applications as it brings on significant capabilities including increased accuracy, availability, anti-jam power, integrity and reliability. The satellites will also add a fourth civil signal that will be interoperable with *International Global Navigation Satellite Systems*, providing even better precision and increased Earth coverage. With first launch in 2014, GPS III is the lowest risk solution to constellation sustainment and the most affordable path to meet the needs of military, commercial and civilian users worldwide. Learn more about the history and future of GPS at **http://www.lockheedmartin.com/gps.** ❖

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A Great Air Force Base The World Has Never Seen…

Commentary by Col. John Shaw
50th Operations Group commander
Schriever Air Force Base, Colorado

There's Langley Air Force Base, home of the Air Combat Command and the 1st Fighter Wing. Then there is Nellis Air Force Base, the Las-Vegas-based host of *Red Flag* and countless other special flying activities in the vast Nevada desert. There is also Edwards Air Force Base, known as the center for flight test programs from the 1950s to the present. It seems as though everyone has heard of these special places and knows where these Air Force bases are located. Their fame is well-deserved.

However, what about this base called **Schriever**? Where is it, exactly? And what do they do there? Who really knows?

Imagine *Alex Trebek* reading this on the next *Jeopardy* game show (perhaps under the category "*Places Named for Great Generals*"): "What is *The Global Positioning System*, with billions of users around the world, that is deeply integrated into the fabric of human society, and is operated from this Air Force Base?" How would the contestants fare on that one?

The truth is, our warfighters, our nation's security, and, yes, even human society — all depend greatly upon the activities performed day in and day out within this 21st century fort at this special place where the Great Plains meet the Rocky Mountains, about eight miles east of Colorado Springs, Colorado.

It's not just GPS. Airmen at Schriever also operate the nation's military satellite communications systems, providing a central nervous system for our military as well as our national leadership. There are also new cutting-edge forms of space-borne *Intelligence, Surveillance and Reconnaissance* (ISR) receiving their guidance from Schriever, including the all new Space-based Space Surveillance System, poised to revolutionize how we maintain awareness within the space domain.

Schriever is also a place where the vast domains of space and cyberspace converge. The *Air Force Satellite Control Network* is one branch of this confluence and has been the backbone of information flow to and from space for decades, supporting nearly all military, intelligence and manned space-flight activities.

Of course, there are the **50th Space Wing**'s mission partners here, as well, including the *Space Innovation and Development Center*, key elements of the **Missile Defense Agency**, Strategic Command's *Joint Functional Component Command for Integrated Missile Defense*, and others. Together, these organizations are probing new frontiers in technology, taking the nation to the next level in space and defense capabilities.

Let us not forget our Total Force teammates in the **310th Space Wing** who are leading the charge in defining and growing Air Force Reserve space expertise for the Air Force. Many members of the 310th work directly alongside their active duty counterparts across the full spectrum of mission activities at Schriever.

There you have it — the Greatest Air Force Base the world has never seen. Let's face it, Schriever Air Force Base may not be on the front pages of newspapers around the world, or featured prominently in today's history books. It may not be near the top of the list of places to visit on a vacation to Colorado, though it seems tours to the base are on the increase. Your average person on the street could not tell you where Schriever Air Force Base is, let alone what goes on there.

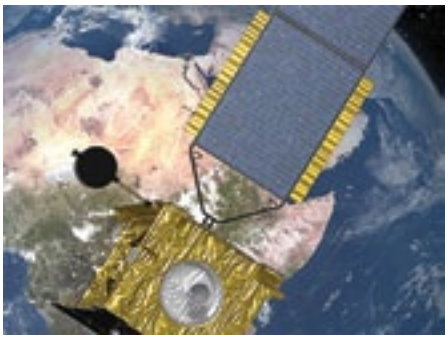
However, those who serve at Schriever know they are, without fanfare, quietly and surely, making a tremendous difference across the globe. For them, that's good enough. ❖

New Satellite = Better Afghan Communications

U.K. troops in Afghanistan have begun operating a satellite secured from NATO at no extra cost to the MOD which is providing extra communications channels for commanders on the front line.

The NATO satellite will be used to provide two extra ***Ultra High Frequency*** (UHF)

Captain Rob Durling, 79 (Kirkee) Battery, 29 Commando Regiment Royal Artillery, uses satellite technology to establish out-of-line-of-sight communications to request air support in his role as a Forward Air Controller, attachedto D Squadron, The Royal Scots Dragoon Guards
[Picture: Corporal Andy Reddy RLC, Crown Copyright/MOD 2011]



tactical communications channels that can be used in Afghanistan. This additional satellite adds to the MOD's three existing ***Skynet 5*** series satellites, which provide a worldwide satellite communications service.

Satellite technology gives commanders on the ground an efficient and secure means of communication, including with operations centres that co-ordinate vital air support, as well as with other units.

Flight Lieutenant *Damien Handley* is a *Joint Tactical Air Controller* in Afghanistan. He uses satellite communications on the front line in his role co-ordinating air support for ground troops. He said, "I can use these satellite communications to talk from Afghanistan directly to operations centres and headquarters around the world. They are vital in the fight against insurgents, particularly to task aircraft in support of our front line troops. In the thick of battle we rely on good communications and more satellite channels will be a great boost."

Following an agreement with NATO, the MOD's *Defence Equipment and Support* organisation secured ownership of the satellite earlier this year at no extra cost to the MOD.

Control of the satellite and running of the two UHF channels has been incorporated into the MOD's Skynet 5 *Private Finance Initiative* contract and is managed by communications company **Paradigm**.

Commander *Andy Titcomb*, from the MOD's Defence Equipment and Support organisation, explained, "Ultra High Frequency satellite communications are a valuable resource and when it became known that NATO was about to fire this satellite into a graveyard orbit, we jumped at the chance to see whether we could take ownership of this valuable asset and use it to support our troops in Afghanistan. This is an example of MOD personnel identifying and seizing an opportunity to deliver an additional vital resource to our troops on the ground at zero capital cost." ❖

(***Continued on Page 56***)

One Hundred Launches... And Counting...

Naval Research Laboratory

Celebrating the launch of the 100th satellite into orbit with the launch of *TacSat-4*, September 27th, the U.S. Naval Research Laboratory's *Naval Center for Space Technology* commemorates a pioneering and fruitful space-based research program that got its start some 65 years earlier.

After World War II, captured German V-2 rockets were brought to the U.S. Army's White Sands Missile Range, New Mexico, where they were reassembled for research and experimentation by government agencies and universities as a means for sending scientific instruments above the bulk of the Earth's atmosphere, which absorbs ultraviolet (UV) radiation.

In 1946, the ***U.S. Naval Research Laboratory*** (**NRL**) in Washington D.C., was invited to participate in the Army's **V-2** rocket program. As an established group ready to carry out upper atmospheric research, the newly formed *NRL Rocket Sonde Branch*, led by physicist *Ernst Krause*, elicited research physicist *Richard Tousey*, head of the *Instruments Branch*, to design a rugged, V-2 capable, solar spectrograph to study the nature of atmospheric absorption, and to examine the ultraviolet portion of the solar spectrum.

The first launch occurred on June 28th in an effort to place an ultraviolet spectrograph over 160 km [nearly 100 miles] above the desert floor to record the intensity of high-energy radiation emitted from the Sun. Although this spectrograph tape was never recovered, the Laboratory became the prime agency for developing the technology and carrying-out the missions of the V-2 rocket-sounding program.

The Army set to work with V-2 rockets at the White Sands Missile Range in 1946 and scientific users were invited to fill the space of the 2000-pound warhead with instruments. *E.O. Hulbert* at the NRL Optics Division jumped at the chance.

Between 1946 and 1951, 80 experiments were performed providing new and valuable information about the nature of Earth's upper atmosphere and ionosphere, the first being the successful launch, October 10, 1946, that delivered the first recorded solar spectrum of the Sun from above Earth's atmosphere.

NRL also directed the development of a new sounding rocket called ***Viking***. From 1949 to 1954, 12 Viking rockets were launched, providing NRL the first measurements of temperature, pressure, and winds in the upper atmosphere and electron density in the ionosphere, and record of the ultraviolet spectra of the Sun. On October 5, 1954, a Viking rocket carrying a movie camera captured the first high-altitude images of a tropical storm over the Gulf of Mexico, sparking the interest of the **U.S. Weather Bureau** and the future of high-altitude weather reconnaissance.

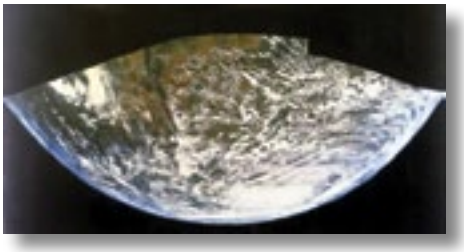
Starting in 1957, NRL turned to newly developed Nike rockets having several different second-stage rockets, to study the Sun during the *International Geophysical Year*, July 1957 to December 1958. During these studies, NRL scientists recorded the first measurements of ultraviolet and X-ray emissions during a solar flare.

***Roger Easton* (left) supervising the placement of the Vanguard-1 satellite atop the Viking launch vehicle.**

Between 1955 and 1959, NRL conducted the first American satellite program named ***Project Vanguard***, which became the prototype for much of what became the U.S. space program. On March 17, 1958, the ***Vanguard I*** satellite was successfully launched into Earth orbit. Although communication with the satellite was lost in 1964, Vanguard I was the second artificial satellite successfully placed in Earth orbit by the United States and ***remains the oldest man-made satellite in orbit today*** and the first to use solar cells. The first U.S. satellite, ***Explorer I,*** was launched February 1958 by the U.S. Army, but similar to the Soviet satellites ***Sputnik I*** and ***II***, Explorer I has long since fallen out of orbit.

When the **National Aeronautics and Space Administration** (**NASA**) was established on July 29, 1958, the **NRL Vanguard** group, comprised of approximately 200 scientists and engineers, became the core of its spaceflight activities. The group remained housed at NRL until the new facilities at the **Goddard Space Flight Center** at Beltsville, Maryland., became available in September 1960. The exodus created by the newly formed space agency did not, however, signal an end to NRL satellite and space-based research. Through the advocacy of *Martin Votaw*, who believed the Navy had an important role to play in space, a small contingent of remaining NRL rocket scientists and technicians regrouped to form the *Satellite Techniques Branch* headed by *Votaw*.

The Satellite Techniques Branch staff concentrated on the engineering hardware of what was referred to as the satellite bus and was responsible for the structure, power supply, command, telemetry and the coordination of the satellite, along with its interface with the booster. Additionally, they handled any special circuitry needed to support the satellite payload.



Mosaic Compilation - Taken from a Viking rocket from an altitude of 100 miles, NRL scientists capture the first image of a tropical storm (bottom-right), Oct. 1954, swirling in the Gulf of Mexico.

The group's first post-Vanguard success was in June of 1960 with the launch of the world's first orbiting astronomical observatory to study the Sun's effects on the Earth. Piggybacked on the ***Transit IIA*** satellite, a larger U.S. Navy satellite, the first solar radiation satellite, ***SOLRAD-I***, was equipped with both X-ray and Lyman-alpha sensors. Determining that radio 'fade-outs' were caused by solar X-ray emissions, SOLRAD-I had an immediate scientific impact — verifying a theory held by NRL research physicist, Dr. *Herbert Friedman* of the direct relationship between solar X-ray variability and the strength of the Earth's ionosphere.

Shrouded in secrecy for nearly 40 years, SOLRAD-I also shared the first U.S. Navy *electronic intelligence* (**ELINT**) instrumentation for Cold War reconnaissance. The project was originally called "*Tattletale*," but was renamed the ***Galactic Radiation and Background*** satellite system, or **GRAB**, to conceal its purpose from the Soviets. Having successfully developed and installed radar detectors on submarine periscopes, NRL scientist *Reid Meyo* of the *Countermeasures Branch* developed the idea that the success of his submarine periscope antenna could function equally well in orbit aboard a satellite.

NCST designed and built the GRAB satellite (shown mounted atop the Transit IIA satellite) and a network of overseas data collection facilities. The launch was approved by President Eisenhower in May 1960, just four days after a CIA U-2 aircraft was lost on a reconnaissance mission over Soviet territory.

The GRAB receivers were used clandestinely to catalogue the waveforms and pulse repetition frequencies of Soviet air defense radars. The data was recorded on magnetic tape and couriered back to the NRL, then evaluated, duplicated, and forwarded to the **National Security Agency** (**NSA**) at **Fort George G. Meade** in Maryland and the **Strategic Air Command** (**SAC**) at **Offutt Air Force Base**, Omaha, Nebraska, for analysis.

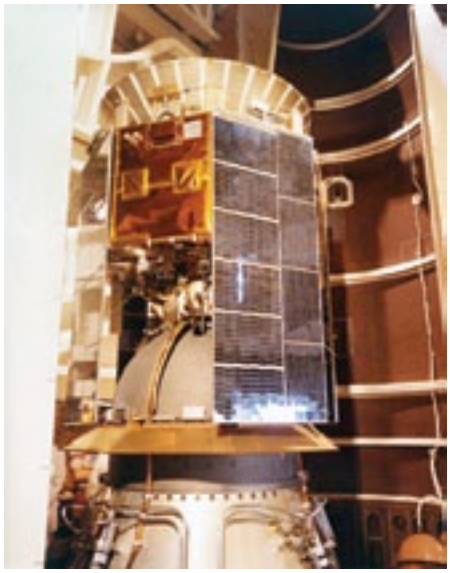
Subsequent SOLRAD satellites collected solar X-ray and ultraviolet data during numerous intervals in the years 1960 to 1973, with instrumentation and quality of data improving in each succeeding spacecraft in the SOLRAD series.

In addition to measuring solar radiation and calibrating satellite tracking systems and a handful of classified deployments, NRL-made satellites have harvested massive amounts of basic data that became crucial for subsequent satellite design and for overall thinking about how the space environment can further the Navy's mission and capabilities, states *Ivan Amato*, author, "Pushing the Horizon."

One of the more notable of these capabilities comes from the launch of the ***TIMATION*** satellite in 1967. A vision of NRL research physicist, *Roger Easton*, TIMATION, short for time-navigation, proved that a system using a passive ranging technique, combined with highly accurate [atomic] clocks, could provide the basis for a new and revolutionary navigation system with three-dimensional coverage (longitude, latitude, and altitude) around the globe.

Through the development and launch of three additional experimental satellites: ***TIMATION II*** in 1969; ***Navigation Technology Satellite*** (**NTS-I**) in 1974; and the first satellite to fly a cesium atomic frequency standard in a 12-hour GPS orbit, ***NTS-2***, in1977, *Easton* had proved the practicality and unprecedented accuracy of satellite-based atomic clocks and laid the foundation for modern day global positioning systems.

By the mid-1980s, NRL had been involved in the launch of nearly 80 satellites. In recognition of this sustained record of excellence, the U.S. Navy in 1986 formalized the Laboratory's status as its lead laboratory in space technology by officially inaugurating the **Naval Center for Space Technology** (**NCST**) at NRL.



NRL'S TIMATION III satellite was redesignated the Navigation Technology Satellite-I (NTS-1) and was launched in the summer of 1974 in connection with the NAVSTAR effort. NTS-1 had two rubidium-vapor frequency standards clocks, while the earlier TIMATION satellites had carried selected high-performance crystal oscillator clocks.

Leading the space program at NRL since 1964, and encompassing more than five decades of experience in the development, deployment and operation of satellites critical to the nation's defense and intelligence gathering capabilities, *Peter Wilhelm* was named director of NCST in October 1986.

With the successful launch of several more satellites – the final satellite in the ***Living Plume Shield*** series (**LIPS-III**) in 1987 to test space-based power sources; the ***Low-Power Atmospheric Compensation Experiment*** (**LACE**) in 1990 with a total of 210 sensors capable of characterizing ground-based laser beams with continuous wave or pulsed emission in the visible, ultraviolet, and infrared bands; and the ***Satellite Launch Dispenser Communications System*** (**SLDCOM**) series in the early 1990s to test bent pipe UHF satellite communications — NCST was tasked to turn its attention toward deep-space exploration and NRL's first lunar satellite.

Formally named the ***Deep Space Program Science Experiment***, the project was soon dubbed ***Clementine*** due to its exhaustible mission. Launched on January 25, 1994, Clementine was built to test lightweight miniature sensors and advanced spacecraft. Extensively mapping the moon between February 26 and April 22, Clementine delivered nearly two million digital images of the lunar surface back to the ground network located in Alexandria, Virginia.

When scientists reviewed the data, they made the major scientific discovery of possible ice within some of the moon's craters. This accomplishment was cited by President *Bill Clinton* as one of the major national achievements in space. This discovery was later confirmed by the **NASA** ***Lunar Reconnaissance Orbiter*** (**LRO**) in 2009.

In the late 1990s and early into the following decade, the NCST hosted ***Project Starshine*** (*Student Tracked Atmospheric Research* satellites), a mentoring program that provided students with insight and understanding into the satellite development process, orbital dynamics and scientific methods. Over the course of the program, three small, optically reflective spherical "STARSHINE" student satellites were launched and tracked by the students who were able to collect data on the density of the Earth's atmosphere. The data, shared via the Internet, was also used by NRL scientists to measure the effects of solar extreme ultraviolet radiation on satellite orbital decay.

In 2003, under the sponsorship of the ***National Polar-orbiting Operational Environmental Satellite System*** (**NPOESS**) ***Integrated Program Office*** (**IPO**), the NRL-developed ***WindSat*** satellite was launched on January 6th to provide important meteorological information on ocean surface wind speed and direction delivering, for the first time, real-time, tactical information to Naval surface units. WindSat's continued measurements over the ocean are also used operationally as input to numerical weather prediction models of the **U.S. Navy**, **National Oceanic and Atmospheric Administration** (**NOAA**) and the **United Kingdom Met Office**.

Embarking on new, cost-effective, compact, quick-launch space-based platforms, two NCST designed and built experimental nano-satellites, NRL's 98th and 99th orbiting spacecraft, were launched in December of 2010 and successfully contacted on their first orbit. Known as the ***CubeSat Experiment*** (**QbX**), satellites ***QbX1*** and ***QbX2*** were deployed to evaluate nano-satellites as a platform for experimentation and technology development. The QbX vehicles, positioned in a low-Earth-orbit and controlled using a novel "Space Dart" mode, remained in orbit for only 30 days before succumbing to the effects of atmospheric drag.

TacSat-4 is readied for encapsulation into the nose fairing (background) of an Orbital Sciences Minotaur-IV+ launch vehicle. The satellite launched from Alaska Aerospace Corporation's Kodiak Launch Complex, Kodiak Alaska, Sept. 27, 2011.

Today, the NCST continues to play an important role in space. With the launch of the 100th man-made satellite to Earth orbit, September 2011, ***TacSat-4*** will help define future options for launching one or more, smaller, *highly elliptical orbit* (**HEO**) satellites and test advances in several technologies and satellite communication (SATCOM) techniques. In addition to demonstrating the potential benefits of a future, combined HEO and geosynchronous orbit constellation, TacSat-4's primary objective is to allow forward deployed troops to communicate "on the move" from obscured regions using existing hand-held radios and without the need to stop and point an antenna towards the satellite.

The NCST is also developing technology, known as *electro dynamic tethers*, that seek to solve the increasingly urgent issue of orbital space debris, a mission vital to the protection of current space-based assets and future satellite placement.

The *Naval Center for Space Technology Directorate* (**Code 8000**) remains the U.S. Navy's lead laboratory in space technology research and applications. Dedicated to preserving and enhancing a strong space technology base and providing expert assistance in the development and acquisition of space systems for naval missions, the activities of NCST extend from basic and applied research through advanced development in all areas of interest to the Navy space program.

Operating under the NCST Directorate is the *Space Systems Development Department* (**Code 8100**), responsible for space and ground support systems research and development, and the *Spacecraft Engineering Department* (**Code 8200**), functioning as the program manager for Navy space programs, providing systems engineering and technical direction and in-house satellite development. ❖

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Jeffrey Chu, Chairman + CEO, Glowlink Communications

Jeffrey C. Chu is the co-founderof this Los Altos, California, based company. He is an expert in satellite monitoring and interference mitigation technology, having co-invented and managed the first generation of such systems for the United States government. Mr. Chu received his Bachelor degree in Science from Harvey Mudd College, and his Master Degree in Electrical Engineering and Computer Science from the University of California, Berkeley.

MilsatMagazine (MSM)
You have built Glowlink through vigorous adherence to a high quality of production standards and complemented by the selection of a solid team of in-house professionals — would you please tell our readers of your Company's history and how you came to found the Company?

Jeffrey Chu
Back in 2000, a few of us had the vision of bringing to the commercial market something called DSP, which is a digital technology mostly used, until then, in high-end, sophisticated communications applications, into the commercial market. In particular, we wanted to exploit this technology to tackle a serious problem that is rampant when dealing with wireless communications over satellites — their notorious susceptibility of being vulnerable to interference problems — this was the motivator for Glowlink's birth.

Interestingly, Glowlink was founded in January of 2000. As many readers may recall, the dot.com disintegration occurred in March of that year, taking a lot of companies down in its wake. The telecommunications sector was especially hard hit. How that affected Glowlink then, and how we managed to make it through this troubling time remains interesting, but is probably a topic of discussion for another time.

MSM
With your advanced degree from the University of California at Berkeley, you must be as concerned as many in the industry regarding the lack of trained specialists within the pool of potential employees — how critical is the lack of engineering talent? Does Glowlink have any mentor programs themselves, or via other initiatives, to assist with STEM training of today's students, whether in middle or high school and at the college level? How can our industry better promote such training?

Jeffrey Chu
I believe the lack of trained specialists is a severe problem, and not just for a company such as Glowlink, but for practically all U.S. companies within the high-tech arena. I remember back in 2006, the CEO of one of the largest investment banking companies in the country remarked that he wished he would never need the services of engineers and doctors, because as the best and the brightest all seemed to flock to Wall Street. Yes, I think we have a HUGE gap in this country because indigent talents tend to shy away from the hard sciences. This is unfortunate, as science and technology are each the singular strength that differentiates our country, vis-à-vis other countries around the world.

If we don't fix this problem, as a nation we will have, and are starting to experience today, a real problem competing in a globalized world where other countries are graduating more engineers and scientists in one month than we do in an entire year! Glowlink is trying to do what it can to help alleviate this

Interference Interaction

situation, but we are somewhat limited by our size and the need to focus on what we do as an innovation-driven company.

However, I can share with you this: My own son is now a senior in electrical engineering and computer science at the University of California at Berkeley. In his spare time, which is a rare commodity in his major, he mentors disadvantaged kids, teaching them math and science. And this is from a guy who, back in high school, had the lofty flake of an idea to wonder around Wall Street with a cup of coffee in his hand, a Wall Street Journal under his arm, producing nothing tangible save for making big bucks creating paper wealth and engineering unrealistic dreams! Thankfully, my son is now working very hard in a tough program. He is not making big bucks. I am very proud of him, and also glad for our country. I think if we all contribute in our own, individual way, we will strengthen our country. Isn't that what America is all about: Sowing our own individual best, and being responsible for our own actions?

MSM
What market segments does Glowlink address and focus upon? Are you involved in both domestic and overseas work?

Jeffrey Chu
We target government and commercial markets. We focus primarily on solving the interference problems in wireless communications, from how to prevent them from occurring, to resolving such "challenges" when they do occur. Glowlink is lucky in that from almost day one, we have been involved in the domestic and international markets. That has given us a front-row seat whereby we are able to watch and analyze global business development trends. Today, our equipment can be found throughout the world. Such an accomplishment is pretty unique for a small, technology-centric company such as Glowlink.

MSM
If instituted correctly, MILSATCOM saves lives and produces successful missions — can you offer us some examples of how your technology has removed some of the interference concerns that have plagued communications capabilities?

Jeffrey Chu
Glowlink equipment has been used in monitoring mission-critical communications on DSCS and WGS satellites on a worldwide basis. In addition, our equipment is used to detect and pinpoint interference problems on commercial satellites that carry important government and military communications traffic. Obviously, the ability to stand as a competent sentry on these types of communications, and to provide actionable information, is the key in maintaining the integrity of the traffic and the users served.

MSM
As we now know, Glowlink focuses on the mitigation of satellite interference problems. Organizations such as sIRG are informing and educating others as to this critical SATCOM "challenge." How serious is the interference problem as of this interview? Do you feel the industry has improved its understanding of the steps that must be taken to protect crucial satellite services?

Jeffrey Chu
Satellite interference has always been a problem and the very reason why we founded Glowlink 12 years ago. I don't believe the interference problem has become any worse, or better, for that matter. I just think interference awareness has been increased, and not because users don't know about it, but because interference can no longer be ignored. Even an ostrich has to come up for air once in a while, right? That said, I don't think the industry has improved its understanding of the steps that must be taken to protect crucial satellite services. There are a lot of bright lights and an increasing crescendo of "concerns" surrounding the interference problem, but I think the approach has been largely amateurish and symbolic, with little insight or substance. I am glad that at least the problem is public and can no longer be denied.

MSM
How does Glowlink manage to "be heard" by those within the government and military acquisition command chains, especially when competing with larger companies?

Jeffrey Chu
Mostly via word of mouth and through media channels such as SatMagazine and others to reach our intended audience. Importantly, our valued government customers are sometimes the best marketing resources. We found this approach to be quite effective for us. We don't have the deep pockets or size of our much larger competitors who are able to deploy massive amounts of marketing resources and people. So, we don't try to match them. In fact, Glowlink has no marketing or sales staff whatsoever. That has worked to our favor in a couple of aspects. One, it lowers the overall cost of doing business as we can pass along the saving from zeroing out marketing directly to our customers. Second, when a customer calls, they talk to the real people who can understand their problems and know how best to solve them. Sometimes, when we do not have the solution for their problem, we refer them to other reputable vendors. I know our customers appreciate end respect us for doing the right thing.

MSM
Does your Company weave its technologies into SATCOM products offered by other commercial firms?

Jeffrey Chu
Not at this point in time, but we expect to start doing that in the near future.

MSM
Would you please explain how geolocation techniques are melded with monitoring to inform users of satellite interference?

Jeffrey Chu
When we first looked at the geolocation application, which is basically a way to find out where an interference is originating, we realized the key to this determination is a superb signal processing platform. The underlying orbital mechanics and mathematics, formidable as they may be, are not terribly complicated. It so happens that our carrier monitoring system has a fantastic signal processing platform because we had designed the technology in that way when the company was formed. We basically took that platform, added the math, and, voila, a great geolocation product — the Glowlink Model 8000, was born.

It turns out this melding of the two applications has two other tremendous benefits: One, it allows monitoring and geolocation to be performed quickly and seamlessly, a factor that is key in detecting and geolocating fast moving type of interferences that are here one moment and gone the next; the other major benefit is the compactness and portability of single-chassis construction that enables the unit to be easily transported and setup. A user can simply move the chassis to a satellite ground station and set it up quickly to continuously monitor the satellite of interest. When an interference surfaces, the Model 8000 can detect it, ID it, and proceed to geolocate it. — it truly is as simple as that.

MSM
A growth area for your Company seems to be that of VSAT transmit antenna commissioning — please explain how this technology supports your product offerings.

Model 8000 Interference Detection and Geolocation System in a single chassis

Jeffrey Chu
The VSAT product, we call it VXCS, can be used to quickly and efficiently establish a VSAT network, using patented technology already deployed and proven in other Glowlink products. By quickly and accurately setting up VSAT terminals, VXCS can significantly reduce the risk of inadvertently generating interferences, which supports the main theme of our entire product offerings: The prevention and resolution of interferences.

MSM
In what other complimentary areas of the satellite communications industry is Glowlink involved?

Jeffrey Chu
Glowlink interference technology has helped to fundamentally improve the quality and integrity of satellite communications traffic. Going forward, we will likely bring to the market technologies that prevent interferences as well as proactively raise the bar on improving the efficiency of the communication itself, such as more bits per hertz of bandwidth used.

MSM
Looking back over the past decade, what projects bring a smile to your face and a true sense of satisfaction?

Jeffrey Chu
When I graduated from Berkeley, I joined a startup company in the Silicon Valley and helped developed the first generation of automatic satellite monitoring system for the U.S. Government. On the strength and success of that product, the company went public and I did well, financially speaking. However, the real satisfaction is this: That system went out to monitor the defense satellite communications system (DSCS) for the next 25 years. When Glowlink was formed and contracted to produce the replacement, we delivered, on time, the Model 1000 product. And almost to the day, 25 years later, we were able to move the original system to the Model 1000, which the government is now using to monitoring the Wideband Global Satellite (WGS) constellation. This brings a true sense of satisfaction to all of us who worked on the project. I think I feel particularly fortunate to be involved in such a personal way in both of these projects, spread over 25 years.

MSM
Over the next year or two, how do you see the battle against interference being waged? What do you believe we can expect as far as new technologies in the SATCOM and MILSATCOM arenas?

Jeffrey Chu
The problem of interference will always exist, no matter what is done. The key is adaptability. Approaches such as carrier ID, the satellite common database, while worthwhile, are not enough. Trying to solve the problem via any policy or forced adoption would be ineffective and could backfire. Technology is key.

In terms of new technologies, I do see the additional melding of digital and analog technologies, where product will become even smaller and simultaneously more powerful. Technologies will continue to emerge that will solve the bandwidth limitation problem without power limitation problems. Satellites will continue to play an indispensable role, in civilian and military applications, with increasing demand for pristine and wide bandwidth.

MSM
Where will Glowlink be in the next year, and what new products that can be discussed will become evident from your Company?

Jeffrey Chu
We expect to announce products and technologies to support the evolution toward cleaner and broader satellite bandwidths. You will also see us start to deploy these products and technologies in areas outside of the satellite environs and move more into the mainstream, mass communications market. We are keeping our head in innovation and our fingers on the market pulse to make certain we hit the market when the market is ready. Not before. Not after. ❖

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Preventing Climate Data Gaposis With NPP

Ball Aerospace & Technologies & Jennifer LaPan, NASA Langley Research Center

The *NPP* mission is the bridge between the nation's Earth Observing System (EOS) satellites and the next generation *Joint Polar Satellite System* (JPSS). NPP will help scientists understand, monitor and predict long-term climate behavior and also provide vital near-term weather data to meteorologists. The mission hosts a suite of advanced-technology remote sensing instruments that will provide critical data for the nation.

Importance Of Climate + Weather Data

Polar-orbit satellites contribute vital information for national forecasts, severe weather warnings, search and rescue operations, military contingency planning and climate monitoring. The nation's ability to understand its climate and weather is central to our economic competiveness and the safety and security of its citizens. NPP will help **NASA** continue its long record of climate monitoring established by EOS. This data record provides critical information about clouds, oceans, vegetation, ice and the atmosphere.

The Role Of NPP

NPP has a unique role in that it will monitor the health of the Earth from space. This will be the first satellite to acquire a wide range of land, ocean and atmospheric measurements while also preparing to address the nation's requirement for operational weather forecasting.

Ball Aerospace is responsible for designing and building NPP satellite bus, the *Ozone Mapping and Profiler Suite* (**OMPS**) instrument, integrating all instruments, and performing satellite-level testing and launch support.

NPP has a projected lifespan of five years and will attain a sun-synchronous orbit, with 16 orbits per day at an altitude of 512 miles (824km), producing coverage of nearly the entire Earth. The spacecraft bus is the ***Ball Configurable Platform*** (**BCP 2000**) and NPP's dimensions are 4.028m x 2.610m x 2.206m with a weight of 4,600 pounds (2,100 kilograms).

The NPP spacecraft is a member of the BCP family of spacecraft designed for cost-effective, remote sensing applications. The NPP spacecraft bus is the eighth spacecraft built by Ball Aerospace on the same BCP core architecture. In all, this architecture has more than 50 years of successful on-orbit operations.

Additionally, the NPP spacecraft incorporates both **MIL-STD-1553** and **IEEE 1394** (FireWire) data networks to support the payload suite. The NPP spacecraft is a fixed-price contract with NASA's **Goddard Space Flight Center**.

The Launch

NPP is scheduled to launch in October 25, 2011 from **Vandenberg Air Force Base** in California via a **United Launch Alliance** ***Delta II*** launch vehiclee.

The satellite will carry five instruments, all of which can trace thei r heritage to instruments on NASA's ***Terra***, ***Aqua*** and ***Aura*** missions, on **NOAA**'s ***Polar Operational Environmental Satellite*** spacecraft, and on the **DoD**'s ***Defense Meteorological Satellite Program***.

- **The Visible/Infrared Imager Radiometer Suite (VIIRS)**
- **The Cross-track Infrared Sounder (CrIS)**
- **The Advanced Technology Microwave Sounder (ATMS)**
- **The Ozone Mapping and Profiler Suite (OMPS)**
- **The Clouds and the Earth Radiant Energy System (CERES)**

As presented at ***NASA's NPP Missions*** *infosite, Jennifer LaPan of NASA's* ***Langley Research Center*** *offered the following excerpted information regarding the purpose of the NPP satellite, as well as an interview of Norman Loeb, the* ***CERES*** *instrument's principal investigator.*

CERES is an acronym for ***Clouds and Earth's Radiant Energy System.*** Measuring climate is not as easy as popping a thermometer into Earth's mouth every day. The crux of climate change is energy. In 1984, NASA began measuring and keeping a record of changes in Earth's energy with a satellite instrument known as ***ERBE*** (*Earth Radiation Budget Experiment*) and then its successor, CERES (Clouds and Earth's Radiant Energy System).

Five satellites and 27 years later, not a single year has passed without a record of Earth's energy budget. This year, the climate-monitoring torch is being passed to the ***NPOESS Preparatory Project*** (**NPP**), a satellite carrying the fifth edition of CERES.

Norman Loeb, a climate scientist at NASA's Langley Research Center and the principal investigator for CERES, offers some insight into what he and other scientists have been able to discern from our current record of Earth's climate — and why a long-term, continuous record is so important.

Jennifer LaPan
Why are we measuring energy on Earth? What does that have to do with the Earth getting warmer?

Norman Loeb
Just like you have a budget at home that you must balance with income coming in and expenses going out, the climate has a very similar process. Sunlight is the incoming resource (or energy), and the outgoing energy back to space is from reflected sunlight and emitted thermal radiation. The balance of incoming and outgoing energy is commonly referred to as the Earth's energy budget. A balanced energy budget keeps Earth's temperature at a consistent level. However, we currently have less energy leaving

Ball Aerospace Begins Integration of VIIRS for NPOESS Preparatory Satellite

the Earth than is necessary to keep a steady temperature. Most of the extra, trapped energy is stored in the ocean, contributing to sea-level rise, and the remainder melts snow and ice over land and warms the atmosphere.

Jennifer LaPan
Can you point to the cause of this trapped energy?

Norman Loeb
We feel confident that one reason for the change in Earth's energy budget is due to greenhouse gases. Greenhouse gases, like water vapor and carbon dioxide (CO_2), block energy from radiating back out to space. Just as if you were to put another blanket on your bed at night, a layer of greenhouse gases makes the Earth warmer by not allowing heat to fully escape. The more CO_2 we put in the atmosphere, the thicker the blanket we have, and the warmer the Earth gets.

A second key component of climate change is the role of clouds. The CERES team combines measurements made by other instruments on the same spacecraft as the CERES instrument to observe changes in cloud properties in conjunction with changes in Earth's energy budget. The influence of clouds on the energy budget is complex because clouds both reflect sunlight back to space and block energy from radiating to space. Which of these two dominates depends upon the properties of clouds, such as their amount, thickness and height. As the Earth undergoes changes in its climate, cloud properties may change in ways that may amplify or offset climate change. Understanding the influence of clouds on the energy budget is therefore a critical climate problem.

Jennifer LaPan
Based on all of the ERBE and CERES energy data that has been collected, how much, exactly, has the energy budget changed in the last few decades?

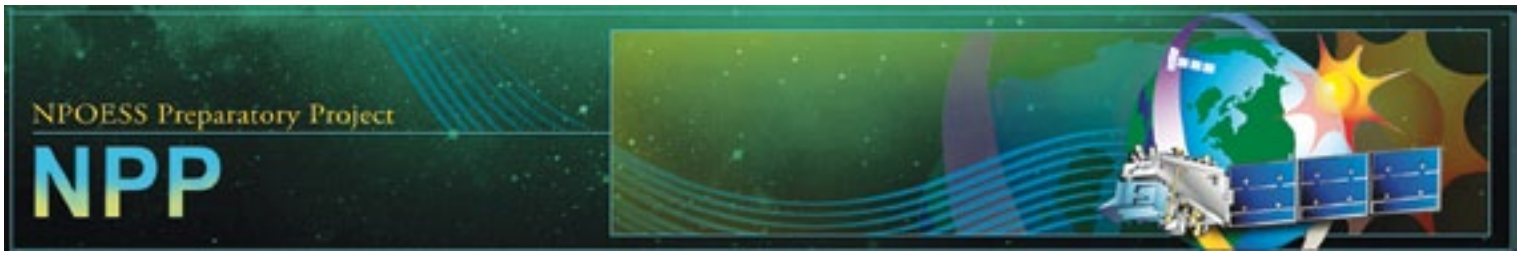
Norman Loeb
We measure the energy coming into earth in watts per square meter. Averaged over the entire planet, the sun gives us about 340 watts per meter (about the energy radiated from six incandescent light bulbs) yearly. The Earth returns an equal amount of energy back to space, keeping the temperature constant. However, because greenhouse gases are preventing some energy from leaving, there appears to be a little over 0.8 watts per square meter that aren't leaving. This trapping process doesn't change the atmospheric temperature immediately, because most of this excess energy is absorbed and stored in the ocean. However, over the past century the global temperature has risen 1.44 degrees Fahrenheit (0.8 degrees Celsius).

Jennifer LaPan
There are still CERES instruments actively taking measurements of Earth's energy budget from space. Why do we need another CERES instrument on NPP?

Norman Loeb
The CERES instruments on the Aqua and Terra satellites are indeed continuing to take measurements, however, both of these instruments have exceeded their expected lifetime. While we are happy they have continued to provide data, they could stop working at any time.

The easiest way to see significant changes in Earth's climate is to know what the Norman pattern of incoming and outgoing energy looks like and to keep a continuous record. We've been tracking those patterns with CERES, but if we were to lose an instrument before another was launched, we would lose the ability to intercalibrate the newer instrument with the older one, and would also lose time interval of data. It would be exceedingly difficult, if not impossible, to accurately tie the two records together, and it would be impossible to accurately determine what happened to the energy budget during the measurement gap. We can't just guess the missing measurements and pencil them in, nor can we correct for any calibration differences between the two instruments without having overlap; we essentially have to reset the climate record to zero and the separate pieces of the record are forced to stand on their own.

A long data record also helps us sort out uncertainties that we still have with climate change. One of the biggest mysteries in predicting climate change is the impact of clouds on the energy flow through the Earth, and having CERES on NPP will allow us to continue to study this relationship. ❖



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Early U.S. Recon Satellites

by Jos Heyman FBIS, CEO, Tiros Space Information

The belief is that the engineers and scientists of Nazi Germany were the first to consider the possibility of placing a (piloted) satellite in orbit for military reconnaissance purposes.

In 1946, the **Rand Project** report, which had studied the feasibility of satellites for the **United States Army**, suggested that satellites could be used effectively as observation platforms and several studies resulted from this report under a variety of guises.

These days, both the United States and the Union of Socialist Soviet Republics make extensive use of satellite based surveillance systems which provide an around the clock "look" at each other's territory. Such surveillance is tolerated by both superpowers, if not willingly, by the fact that there is relatively little that can be done about it.

Obviously, details on the spacecraft used and the instrumentation on board of those spacecraft are quite scarce and patchy.

Identification Or Reconnaissance Satellites

Initially, the United States did identify its military satellites by name. However, starting in early 1962, the U.S. military authorities ceased to assign names to military satellites as a general practice. While it is relatively easy to identify a number of programs, in particular the communications, meteorological and navigational satellite programs, military photo reconnaissance satellites have proven difficult to accurately identify.

Although the satellites continued to be identified by an '**Ops**' number, it was clearly evident these number were either associated with an unknown identifier, perhaps a construction number, or they were used in purely random order. Other identification means have been Code numbers, assigned in random order, and code names.

Over time it has been possible to identify a number of programs through the disclosure of the launch vehicle as well as other information that became available through the literature. Also, some details of the earliest programs, such as ***Corona***, have been unclassified recently.

Nevertheless, the classified nature of military surveillance satellites, and the occassionally conflicting information in the literature, makes the accurate compilation of tables of launch dates of each series difficult. The tables presented in this article may, therefore, differ from tables published elsewhere.

Introduction

The development of a strategic satellite system for the United States began in early 1955 when the Air Force issued the specifications for Weapons System 117L which called for a rocket upper stage which was to be used as a 'bus' for a number of applications packages.

The stage was to be carried into orbit on either a ***Thor*** or an ***Atlas*** missile and three roles were envisaged:

- **Development of recovery techniques**
- **An operational early warning system**
- **An operational reconnaissance satellite system**

In October of 1956, the ***WS-117L*** contract was awarded to **Lockheed** and gave birth to the ***Agena*** upper stage as the basis for the satellite systems. The Agena stage had a diameter of 1.52m and a length of 5.94m and was fitted with a ***Bell Hustler*** rocket motor. It had an in-orbit mass of 700kg and carried the payload in a conical forward section which included a 135kg re-entry capsule with a diameter of 84cm and a length of 68cm.

Once in orbit, the Agena stage would turn around and face backwards from the line of flight so that the re-entry capsule would be aligned for release and atmospheric re-entry.

The obvious choice for instrumentation was a television system, but in those days the resolution achieved by a television system was considered too poor. **Kodak**, **Philco** and the **CBS Laboratories** developed a film scanning technique as an alternative. With this technique, a photographic plate was exposed, developed on board, and scanned by an electronic instrument. The subsequent radio signal was transmitted to Earth. In addition, the film return option also considered which would provide a higher resolution image. The latter option required a reentry capsule.

The intention was to develop two separate families of reconnaissance satellites. One family was to fly in high altitude orbits for 'area survey', viewing large areas of the Earth's surface, while another family was to fly in lower orbits to concentrate on 'close look' reconnaissance, selectingspecific objects for detailed investigation.

Early experiments with 'area survey' equipment were conducted but proved to be unsatisfactory due to the low resolution offered by imaging equipment. Not until the development of new and advanced equipment could effective area survey be introduced from the ***KH 9*** series onwards.

Corona Series

The Corona program involved a range of different camera systems. The **KH 1** and **KH 2** cameras were developed by the **Fairchild Camera and Instrument Corp**. While the **KH 3**, **KH 4**, **KH 4A** and **4B** cameras were developed by the **Itek Corp**. Of these, the **KH 4A** and **KH 4B** systems were essentially two KH

4 cameras stacked on top of one another.

The KH 1 camera had a resolution of 11.7m. This was improved to 7.3 on the KH 2, 3.5m on the KH 3, and 2.9m on the KH 4 cameras. The KH 4A and 4B cameras permitted the stereo images with a resolution of respectively 2.6m and 1.1m, respectively.

Although '***Keyhole***' is often cited as the meaning of the acronym KH, it is suspected that the meaning of this military designation is different. (This suspicion is supported by the use by the U.S. Air Force of the letter **K** to designate aircraft cameras (such as **KA-59** for a 1965 camera designed for medium altitude reconnaissance missions). The meaning of the letter **H** may be found in the apparent designations RH and VH and the associated designations VS and VU. The latter two are for non-satellite detection systems for surface and sub-surface nuclear explosions. Since the letters **S** and **U** have been used in other designation system to indicate surface and sub-surface, H may mean satellite borne.)

The first 38 satellites in the Corona program were identified as ***Discoverer***. Subsequent satellites did not receive a name but have been referred to, as is common practice, by their KH system number followed by a serial number.

The satellites in the Corona series were launched by a Thor Agena launch vehicle and were placed in a polar orbit which allowed the recovery of the re-entry capsule over the Pacific Ocean (east of Hawaii) on the 17th or 18th orbit, after one day, or on the 32nd or 33rd orbit, on the second day, and so on. After ejection from the satellite, a small retro-rocket motor reduced the speed of the re-entry capsule to about 1400km/h. At an altitude of about 15km, the heatshield was jettisoned and the parachute deployed. The parachute and capsule were then captured mid-air by a trapeze-shaped device attached to, initially a **Fairchild Packet** aircraft and, later on, a **Lockheed Hercules** aircraft. Once winched inside the aircraft, the capsule was flown to the **Hickam Air Force Base** in Hawaii, with a different aircraft then flying the film to Washington where it was developed and interpreted.

The execution of the program proved to be far from easy. After an initial launch failure, the U.S. Air Force succeeded in placing ***Discoverer-1*** in orbit. This satellite did not contain a re-entry capsule and was intended to test the tracking and acquisition facilities required in the recovery process. Unfortunately, tumbling of the spacecraft prevented accurate tracking.

Discoverer-2 did contain a re-entry capsule which was, however, ejected too early in the flight to be effectively recovered. Instead of coming down over the Pacific Ocean near Hawaii, the capsule fell in the arctic regions of Norway and, although observed coming down, was never located.

Discoverer-3 and ***-4*** were launch failures and did not achieve orbit. Discoverer-4 was fitted with a KH 1 camera system and was also known as mission **9001**. The objective was to test the capsule recovery technique but insufficient second stage velocity prevented the satellite from reaching orbit.

Discoverer-5, on the other hand, did attain orbit, but was aligned in such a manner that the re-entry capsule was fired into the opposite direction and was lost.

The capsule of ***Discoverer-6*** did eject but could not be tracked due to a failed radio beacon. This capsule eventually fell into the sea.

Discoverer-7 could not be stabilized in orbit and the capsule was not separated. Due to a malfunction of the Thor launch vehicle, ***Discoverer-8*** was placed in an incorrect orbit and the capsule overshot the recovery area.

Discoverer-9 and ***-10*** failed to orbit, the latter being destroyed on the launch pad by the range safety officer.

Discoverer-11, after having been successfully placed in the correct orbit, did eject the capsule and was lost when it fell into the ocean.

Some measure of success was finally achieved with ***Discoverer-13***. Because of all the previous failures, this satellite had been fitted with special instruments to monitor the performance of the satellite and to obtain data that would be useful in future flights. The satellite also carried **SCOTOP**, an instrument to determine if the satellite was being tracked by the USSR. The capsule was ejected on the 17th orbit and came down successfully, 500km north west of Honolulu, although the recovery aircraft failed to pick it up. Instead it drifted in the ocean for three hours before it was recovered by a helicopter which was on stand-by.

It has been suggested that ***Discoverer-14*** was the first operational reconnaissance satellite which carried a modified version of the **HYAC** camera system, previously used in the **WS416L** balloon reconnaissance program. The target of the satellite was the Plesetsk cosmodrome, the existence of which had not been confirmed at that time.

On the 17th orbit on August 19, 1960, the capsule was successfully recovered by an aircraft during parachute descent.

On the ***Discoverer-15*** flight, the capsule ejected successfully but could not be recovered.

The flight of ***Discoverer-16*** saw the introduction of the ***Agena B*** upper stage, which had an improved performance, as well as the **KH 2** camera system. While this flight failed to orbit, subsequent flights met with some success. The re-entry capsule was successfully recovered on the ***Discoverer-17*** and ***-18.*** While ***Discoverer-19*** did not carry a re-entry capsule, it did test infrared equipment for the ***Midas*** program.

Discoverer-20 was the first to carry the **KH 5** camera system. The KH 5 camera system was used in the ***Argon*** program and was a geodetic mapping camera with a resolution of 134.7m used by the U.S. Army to obtain data for pin pointing strategic targets. In addition to the normal payload, the satellite carried samples of silicon test material to determine the effect of space radiation on solar cells, external flashing lights for optical tracking as well as a precision tracking beacon experiment for further evaluation of the *Transit Doppler* shift navigation system. Due to a system malfunction the capsule was not released.

Discoverer-21 did not carry a camera system and capsule for recovery as the primary objective was to test changing the satellite's orbit by restarting the Agena engine. This was successfully achieved. In addition the satellite carried infrared imaging sensors for the Midas program as well as other reconnaissance equipment.

Discoverer-22 and ***-24*** failed to orbit — the re-entry capsule ejected by ***Discoverer-23*** was not recovered.

In addition to being fitted with a KH 2 camera system, ***Discoverer-25*** also carried:

- **Three GeigerMueller tubes to monitor cosmic rays**
- **Ion density gauges**
- **Micrometeorite density gauges**
- **Instruments to count and measure micrometeorite impact**
- **Samples of gold, bismuth, iron, titanium, cadmium, magnesium, nickel and yttrium**

After the 33rd orbit, on June 18, 1961, the capsule was successfully recovered.

Discoverer-26, another satellite fitted with a KH 2 camera system, also carried instruments to measure the density and effects of ions and micrometeorites and included an impact detector and a tuned piezoelectric crystal erosion gauge.

The capsule, which was recovered on July 7, 1961 after 32 orbits, contained samples of silicon, iron, bismuth, yttrium, magnesium, nickel, lead and uranium which were studied for the impact of space radiation on these materials. It also contained infrared sensors and photographic equipment for use on board of future ***Midas*** and ***Samos*** type spacecraft.

The ***Discoverer-27*** and ***-28*** flights failed to orbit.

The ***KH 3*** camera system was first used on ***Discoverer-29***. The satellite also tested an electron spectrometer, a galactic RF detector and an Xray counter for the **Vela Hotel** program. In addition, emulsions, biological samples (including two types

of viruses and embryonic chicken hearts) were carried in the capsule, which was recovered after 33 orbits. The re-entry capsule was successfully recovered on the ***Discoverer-30***, while ***Discoverer-31*** carried a re-entry capsule which was not ejected.

Discoverer-32 carried, in addition to the KH 3 camera system samples of yttrium, gold, iron, magnesium, titanium and nickel to test their shielding properties; an electron and ion density gauge; a NoraAlloe beacon transmitter; a Secor experiment; an erosion gauge; and seed corn to evaluate the genetic effects of radiation. The capsule was recovered after 18 orbits on October 14, 1961.

Discoverer-33 was another failure, followed by ***Discoverer-34***, which carried a re-entry capsule which was not ejected, and ***Discoverer-35*** and ***-36***, for which the re-entry capsules were successfully recovered. The Discoverer-36 launch also carried the **Oscar-1** amateur radio satellite as a secondary payload. A few other launches in the series also carried secondary payloads, usually referred to as 'Hitchhikers'. ***Discoverer-37*** was a launch failure.

Samos Series

The early ***Satellite and Missile Observation System*** (**Samos**) satellites may be a considered as an experimental series of military reconnaissance satellites equipped with a CBS/Kodak imaging system. Using the Agena satellite bus and upper stage, the satellites were intended for area survey reconnaissance. Also known as ***Sentry***, the satellites were initially placed in relatively high orbits of 250 to 700km, but it was soon found the area survey approach did not provide satisfactory results. The program was terminated during 1962. The satellites had a mass of about 1860kg.

KH 4 Series

The first **KH 4** camera system was carried on ***Discoverer-38***. The capsule was recovered after 65 orbits. The satellite also carried samples of silicon, iron, bismuth, gold, magnesium, nickel and titanium which were exposed to radiation, as well as magnetometers, two total energy detectors and a radio scintillator. Following the flight of Discoverer-38, further U.S. military flights were classified and were no longer named.

KH 6 Series

The **KH 6 Lanyard** camera system had a resolution of 60cm and was specifically developed for the surveillance of suspected missile sites near Leningrad, in the USSR. Five satellites were built but only three were orbited and only one was successful.

KH 6-2 carried also instrumentation for the detection of auroral electrons.

KH 7 Series

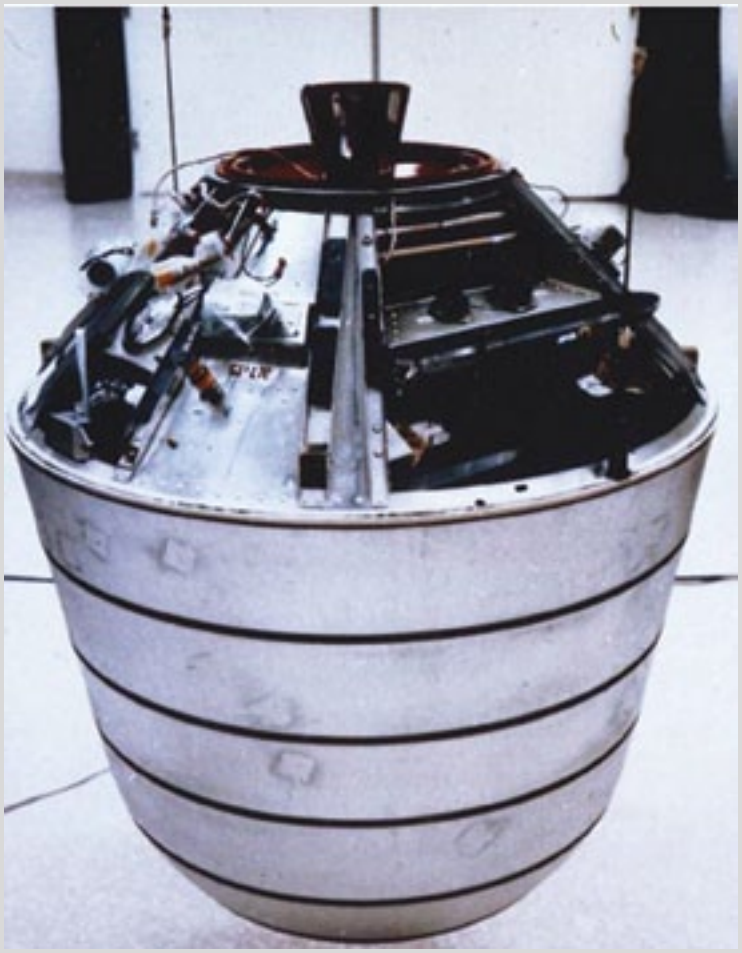
The **KH 7** military reconnaissance satellites were based on the Discoverer series of satellites and carried the KH 7 camera system. Also known as ***Gambit***, this system had a resolution of 45cm. Several of the satellites in this series, which were launched by the ***Atlas Agena D***, ejected capsules or Hitchhiker secondary satellites.

KH 4A Series

The **KH 4A** series of satellites carried the KH 4A close look camera system which had a resolution of 2.5m. The systems was essentially two KH 4 cameras stacked on top of one another. Launched by a ***Thor Agena B***, several of the satellites also carried emulsion and dosimetry film and other auxiliary experiments.

KH 8 Series

The **KH 8** series was the third generation of close look military reconnaissance satellites. They were based on the Agena upper stage and had a mass of about 3000kg. The KH 8 multispectral camera was developed by **Itek Corp**.



A satellite recovery vehicle (SRV) that carried KH-7 and KH-8 exposed film. Photo courtesy of NRO.

KH 4B Series

The next series carried the **KH 4B** camera system was based on the KH 4A system and had a resolution of 1.10m. These satellites were launched by a ***Thor Agena D*** launch vehicle.

KH 9 Series

The **KH 9,** or ***Low Altitude Surveillance Platform*** (**LASP**), more commonly known as ***Big Bird***, was originally developed as a back-up to the cancelled ***Manned Orbiting Laboratory*** (**MOL**) project (also referred to as **KH 10**). The KH 9, which has also been referred to as **Code 612**, **Code 467** or **Hexagon**, was built by **Lockheed**. The satellites had a length of 15m and a diameter of 3m with an estimated mass of 13000kg. They were placed in a sun-synchronous orbit with an altitude from 160 to 260km.

The **KH 9** satellites combined the close look and area survey requirements in a single spacecraft. For the close-look function, the satellites carried a **Perkin Elmer** camera with a resolution of 30cm, sufficient to distinguish between civilian and military personnel. The film with the images was processed on board and was returned to the surface in a return film capsule, which was recovered over the Pacific Ocean. As many as six such capsule were carried. To perform area surveys, KH 9 carried an **Eastman Kodak** camera system with a film scanner, data of which was sent back to the ground station by means of radio. Other instrumentation that was included, not necessarily on all flights, were a multi-spectral scanning system and side looking radar.

The KH 9 series also carried one or more Hitchhiker sub-satellites which served a number of purposes, including electronic

data gathering and miscellaneous scientific and technology objectives. These sub-satellites, sometimes referred to as P11 were octagonal in shape with a diameter of about 90 cm. It is believed the KH 9 satellites had limited maneuvering capability through the propulsion systems of the Agena upper stage. At the end of the mission, the satellites were de-orbited.

Beyond KH 9

The designation **KH 10** was assigned to an operational development of the U.S. Manned Orbiting Laboratory (MOL). MOL was cancelled in June 1969, along the KH 10. Subsequently, **KH 11** and **KH 12** reconnaissance satellites were placed in orbit, as well as reconnaissance satellites operating with other names. Some of these may still be operational today. ❖

Series	First launch	Last launch	Orbited	Failed
Re-entry tests	21-Jan-1959	18-Feb-1961	5	3
KH-1	25-Jun-1959	13-Sep-1960	7	3
Samos	11-Oct-1960	11-Nov-1962	8	3
KH-2	26-Oct-1960	23-Oct-1961	6	4
KH-5	17-Feb-1961	21-Aug-1964	10	1
KH-3	30-Aug-1961	13-Jan-1962	5	1
KH-4	27-Feb-1962	21-Dec-1963	24	2
KH-6	18-Mar-1963	30-Jul-1963	2	1
KH-7	12-Jul-1963	4-Jun-1967	36	2
KH-4A	25-Aug-1963	22-Sep-1969	50	2
KH-8	29-Jul-1966	17-Apr-1984	50	4
KH-4B	15-Sep-1967	25-May-1972	16	1
KH-9	15-Jun-1971	18-Apr-1986	20	1

Reconnaissance satellite series (abstracted from Heyman, J., *World Spacecraft Digest* 2010)

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 and is also a regular contributor to the British Interplanetary Society's Spaceflight journal.

A U.S.A.F. H-21 helicopter, Pacfic Ocean, on a Samos satellite recovery operation.

Richard M. Lober, V.P. + G.M., DISD, Hughes Network Systems

Rick Lober joined Hughes in late 2008 as Vice President and General Manager of the Defense and Intelligence Systems Division (DISD). He has over 25 years experience with both COTS-based and full MIL communications and intelligence systems starting as a design engineer and progressing to a P&L executive. He has previously worked at Cubic Communications, Inc. and Watkins-Johnson Company. Mr. Lober received his BS and MSEE degrees from the University of Illinois, Urbana.

MilsatMagazine (MSM)
Mr. Lober, would you please tell us about your experience in this industry and how you came to select Hughes Defense and Intelligence Systems to further your career?

Rick Lober
I joined Hughes as the Vice President and General Manager of the Defense and Intelligence Systems Division in late 2008. Over the past three years, I've had the opportunity to see the Division grow and expand significantly. Prior to joining Hughes, I worked in communications and intelligence engineering and leadership roles in both military and commercial markets at companies such as Cubic Communications, Inc. and the Watkins-Johnson Company. The emphasis in both companies was C4ISR products and telecommunications technologies.

I joined the Hughes team because I am passionate about developing technologies that allow our warfighters to have increased capabilities to meet their mission needs at an affordable cost. Hughes is able to take commercial-off-the-shelf (COTS) technologies and apply them to the unique needs of our soldiers, and SATCOM is a technology that crosses over between commercial and military markets. I also enjoy start-up opportunities, and while our former Hughes parent had been strong in defense for decades, Hughes Network Systems had only recently entered this market. It was an opportunity to grow a new Division with the backing of the world's largest VSAT operator and SATCOM technology provider. The entrepreneurial spirit at Hughes has allowed me the room to grow and bring some of my DoD experience to our business with the goal of once again making Hughes a household name in defense communications.

MSM
In today's austere budget environment, how can the military and intelligence agencies best utilize the expertise and commercially-proven equipment of the private sector?

Rick Lober
Our country is in a budget crisis, and it is important to utilize the best practices of commercial SATCOM providers to help increase capabilities while decreasing costs. Bandwidth efficient technologies and advanced network management techniques are inherent to commercially oriented companies like Hughes and can provide significant savings in the SATCOM area for our military, both in reducing hardware and operational costs. Additionally, to be sustainable in the field, warfighters need smaller antennas, lightening their load and allowing for more ubiquitous deployment of communications-on-the-move (COTM) equipment. We are continually assessing ways to reduce weight and cost, while increasing communications capabilities in a bandwidth constrained environment. We feel we can bring significant advantages to existing networks, in particular in the growing area of airborne ISR, by delivering technologies that are generations ahead of what the military is currently using at a fraction of the equipment and operational cost.

MSM
What's the next big trend in satellite communications-on-the-move? In tactical and transformational systems?

Rick Lober
Given the saturation of current Ku- networks, I think we will see a move to Ka- and X-bands as COTM antenna technology as this area matures, and as Ka- networks such as Jupiter™ that's being developed by Hughes are built out. Hybrid terminals that use Ku-, Ka- or X-band coupled with an L-band back-up (which tends to be a bit more ubiquitous in terms of coverage and ease of set-up but much more expensive to operate) should also find a place in the DoD. Continued advances in modulation and coding in SATCOM modems will continue to help push antenna size down while preserving bandwidth. This should allow COTM to take off in a big way versus its current limited usage. Finally,

the employment of modern network management techniques in shared networks should allow the DoD to maximize on its utilization of limited bandwidth.

MSM
As UAVs and airborne ISR become ever more prevalent, how does the military best use a commercial global network?

Rick Lober
The first step would be to replace the dated modem technology currently in use in most airborne networks. Modems that utilize modulation and error correction codes are generations ahead of what is in use in most military operations today, and are available in an open standard and widely used commercially. Second, would be the use of an optimized, managed network that could be shared among assets – including those on the ground. Today, the DoD is buying large segments of bandwidth and dedicating it to these airborne assets – clearly the need and priority is there – but with a move to more modern modem technology and shared network management, bandwidth utilization by many of these systems could be cut back drastically with equivalent or better performance than that being achieved today. Hughes is currently operating an airborne network over large parts of the world for commercial applications and has won initial programs for the US government airborne applications. Working with our partners, we expect to complete a comprehensive global network very soon.

MSM
Hughes was awarded a Ka-band study contract with the U.S. Air Force earlier this year. How is the study progressing, and what impact will the study have on the commercial SATCOM market?

Rick Lober
The study has been very successful thus far; USAF recently awarded us an extension to the original work. Early in the study, we focused on COTM and how changes in various SATCOM architectures would affect military needs and outcomes. At this stage we are focusing on the complete system – space segment, ground segment and terminal segment, along with approaches to commercially oriented acquisition. Hughes uses a systems level approach in our commercial network developments to make trades among segments. Given our results, applying the same approaches to the military will create savings for the military in terms of cost and schedule, should a new COMSATCOM initiative be put in place. Our expertise in high throughput, Ka spot beam systems such as Hughes Jupiter has also garnered much interest. We are not wed to a particular architecture – just identifying and implementing the one that best meets the needs of the DoD.

MSM
You addressed the Satellite Industry Association's (SIA) Army Commercial SATCOM Users' Workshop in August on situational awareness. What's your take on interoperability of communications equipment for coalitions?

Rick Lober
As I noted in the workshop, it really depends on the level of interoperability required. Given two HUMMVs in the middle of the desert with no other form of connectivity, you better be interoperable at the physical layer – i.e., a truly open standard – or be using the same radio family. For Coalition operations where there are ties at the command post level, interoperability at higher layers will likely suffice (Ethernet connections). Then there is the issue of multi-level security (encryption) across Coalition partners which may be more of a policy issue than a technical problem. However, from an acquisition and cost reduction point of view, open standards encourage competition and can create significant cost savings for the military. I have witnessed large cost reductions in an ISR datalink with standards such as Common Data Link (CDL). Everything that Hughes has recently developed, and is developing, is based on open standards. Our Hughes HX System not only meets FIPS information assurance (IA) standards and is being Wideband Global SATCOM (WGS) certified, but has gone through European Telecommunication Standards Institute (ETSI), Telecommunications Industry Association (TIA), and the Institute of Electrical and Electronics Engineers (IEEE) standards processes to be truly open.

MSM
As the U.S. begins to pare down troops in Afghanistan, do you think satellite communications will play an even larger role in remaining ISR missions?

Rick Lober
Yes, I do. Satellite ISR technologies not only ensure our deployed troops have the best information possible, but also allow us to help keep our borders and homeland safe. In conjunction with other intelligence gathering, satellite-based ISR has been crucial in identifying and ultimately eradicating key targets. While defense budgets will be cut in the future, C4ISR is expected to stay well funded and SATCOM is a key element for over the horizon communications among these assets.

MSM
Can you share some tactical networking best practices you've learned from Hughes' implementations?

Rick Lober
Our DoD Systems team, led by Senior Director Dan Losada, has worked with many US tactical forces. Some best practices from our implementations follow:

- **Use embedded FIPS 140-2 encryption on the satellite network instead of external devices, via a Network Management System. This saves bandwidth and limits complexity in the network by reducing encryption overhead.**
- **Use enterprise quality Network Management Systems that allow operation over multiple satellites and over multiple enclaves to allow centralized control of all network assets. This provides a true net-centric SATCOM solution.**
- **Use advanced dynamic routing technologies such as BGP and RIPv2 over satellite links to improve reliability and minimize use of inefficient tunneling solutions.**

Hughes HX280 Mesh/Star Broadband Router

- **Use adaptive coding and modulation technologies to adapt network links to environmental conditions or heterogeneous terminal sizes.**
- **Provide simple to use edge-user devices that require very little user intervention. Any complexity in the system should be at the network gateway locations where subject matter experts can be located. This requires using remote management technologies, such as those found in the COTS world.**

MSM
What areas do you see the Defense and Intelligence Systems Division (DISD) focused on in 2012?

Rick Lober
In DISD, we often focus on the more difficult problems facing our military and intelligence customers. Airborne ISR looks to be a strong growth area for us because we have already developed expertise running a large airborne network for some of our commercial customers. Our work on classified programs is growing quickly and I expect that to continue. In the DoD area, we are focusing on projects that result in improved bandwidth efficiency through advanced waveforms and coding along with modern network management techniques, Hughes' strengths given the commercial nature of our primary business. We are applying these techniques to airborne and ground-based COTM systems. We also continue to promote open standards – even as we move to our next generation Ka systems, which will yield even higher throughputs. We feel that many of these COTS technologies can be applied to evolving US programs of record in the ISR area. We are also seeing some of our international Coalition and NATO partners truly understand the value in our open standards approach to VSAT networks. As Hughes not only designs SATCOM equipment, but also operates SATCOM networks, we can provide guidance and solutions to solve some of the more difficult challenges for the military and intelligence communities.

MSM
What recent advances has Hughes made in its solutions for military/intelligence customers?

Rick Lober
Our HX 280 high-performance satellite router was recently validated as Federal Information Processing Standard (FIPS) 140-2, Level 2 certified. Additionally, our HX System for land mobile, maritime, and airborne COTM is undergoing Wideband Global SATCOM (WGS) certification by the U.S. Strategic Command (USSTRATCOM) SATCOM Systems Expert (SSE). We also continue to apply our knowledge of airborne SATCOM to the military market and are investigating new waveforms and coding technologies that will address some of the tougher problems out there including protected SATCOM, use of smaller COTM antennas, and SATCOM operation on rotary wing aircraft. We have CRADAs in place with three DoD Research and Development commands to help advance modern SATCOM methodologies.

MSM
Of all of the projects for which you have been responsible, which one or two truly bring a smile of satisfaction to your face?

Rick Lober
I can't get into some of them, but anything we have the opportunity to do that helps keep our country more secure has always been very satisfying. With regard to our DoD efforts, we are winning our first airborne ISR programs and it is exciting to see how much a COTS-based approach can save the DoD in both equipment and operational costs – in particular in an environment that is both budget and bandwidth constrained.

MSM
Given that the pool of professional candidates for companies within the SATCOM industry is dwindling, how can firms assist in STEM education endeavors so we don't fall further behind other nations in the application of knowledge for crucial projects?

Rick Lober
As federal, state, and local governments continue to face a budget crisis, educational programs continue to be on the chopping block. It is important for companies and individuals to support educational endeavors, especially in science, technology, engineering, and mathematics (STEM). STEM education is so important to nurturing the next generation of innovators in the SATCOM industry. In addition to financial support, it is important for current engineers, scientists, and innovators to make time to speak to students, to share their passion for their industries and help mentor these future leaders

MSM
Is Hughes involved in any STEM support programs? If so, would you tell us about them?

Rick Lober
Hughes is deeply committed to supporting STEM education. We sponsor the FIRST Robotics competitions in the greater DC-region each year. ❖

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Survivable, Protected Communications

by David Rhodes, Defense & Space Division, EMS Technologies

The U.S. Air Force's *Advanced Extremely High Frequency* (AEHF) system is the nation's next-generation military strategic and tactical relay system, which will deliver survivable, protected communications to U.S. forces and selected allies worldwide. When fully operational, the system will consist of four cross-linked satellites, a ground mission control center and user terminals. The AEHF system provides joint, interoperable, assured connectivity for warfighters in operations in all levels of conflict – a capability not available through other planned military communication networks. The satellite serves as a smart switchboard to establish, maintain, reconfigure and disassemble required communications circuits as directed by the users. The terminals will provide encrypted voice, data, teletype, or facsimile communications." One key to the success of this communications satellite is the ability to provide reliable, high speed, secure, anti-jamming, survivable tactical communications capability. The AEHF beam-forming network (BFN) is at the heart of one of these on-board systems.

EMS Technologies, Defense & Space division, now a part of Honeywell, recently announced the award to build the AEHF BFN, nicknamed "nuller", for the fourth AEHF satellite, under contract to Northrop Grumman. The satellite is under contract to Lockheed Martin, the AEHF prime contractor and overall space system manager. Northrop Grumman builds and integrates the AEHF payload that consists of processors, antennas, radio frequency subsystems and crosslinks. The first satellite is on orbit, launched 14 Oct 2010, and is due to come online in the fall of 2011.

The ***AEHF*** satellites build on the capabilities of the ***Milstar*** satellites, and are interoperable with those communication systems, providing ten times the data throughput of the Milstar satellites. AEHF provides the Milstar **LDR** (*low data rate*) and **MDR** (*medium data rate*) waveforms as well as the new AEHF **XDR** (*extreme data rate*) waveforms. "AEHF protections included anti-jam capabilities, *Low Probability of Detection* (**LPD**), a *Low Probability of Intercept* (**LPI**), and advanced encryption systems. In addition, the waveforms use frequency hopping to communicate over narrow bands that constantly move within the total bandwidth of the system.

The equipment is nuclear hardened to provide survivable protected communications systems that do not degrade in either tactical or strategic environments. These communications systems service the warfighter on land, sea, and air.

The AEHF BFN is a **Q-band** (**EHF**) uplink satellite RF receive network that is a part of the *High Resolution Coverage Antenna* system, providing two spot beams per satellite. The antenna normally receives signals from its entire field of view, but the BFN provides the capability to produce nulls, or areas where no signal is received, within its field of view. In operation, the AEHF BFN acts to null out jammers from the field of view,

The AEHF satellite, image courtesy of Northtrop Grumman

thus its nickname, the "***nuller***". This is accomplished through multiple RF receive ports that overlap in the field of view and combine to provide the RF data stream. Each of the ports can be observed for the presence of a jamming signal. If jamming is present, a null can be formed to block that region of the field of view.

This nulling acts on RF microwaves like a sun visor acts to shield the eyes from the sun. Imagine that you are shielding your eye from the sun by holding a ping-pong ball at arm's length so as to block the sun from your vision. Now imagine that the position and size of the ping-pong ball is automatically controlled so that it stays between your eye and the sun providing continuous blockage. The remainder of your field of view is not obscured allowing you to see everywhere except directly into the sun. This is analogous to the operation of the BFN in the presence of a jammer. An undesirable signal such as an enemy emitter can be blocked (nulled) so as to provide clear communication everywhere in the field of view except directly from the emitter.

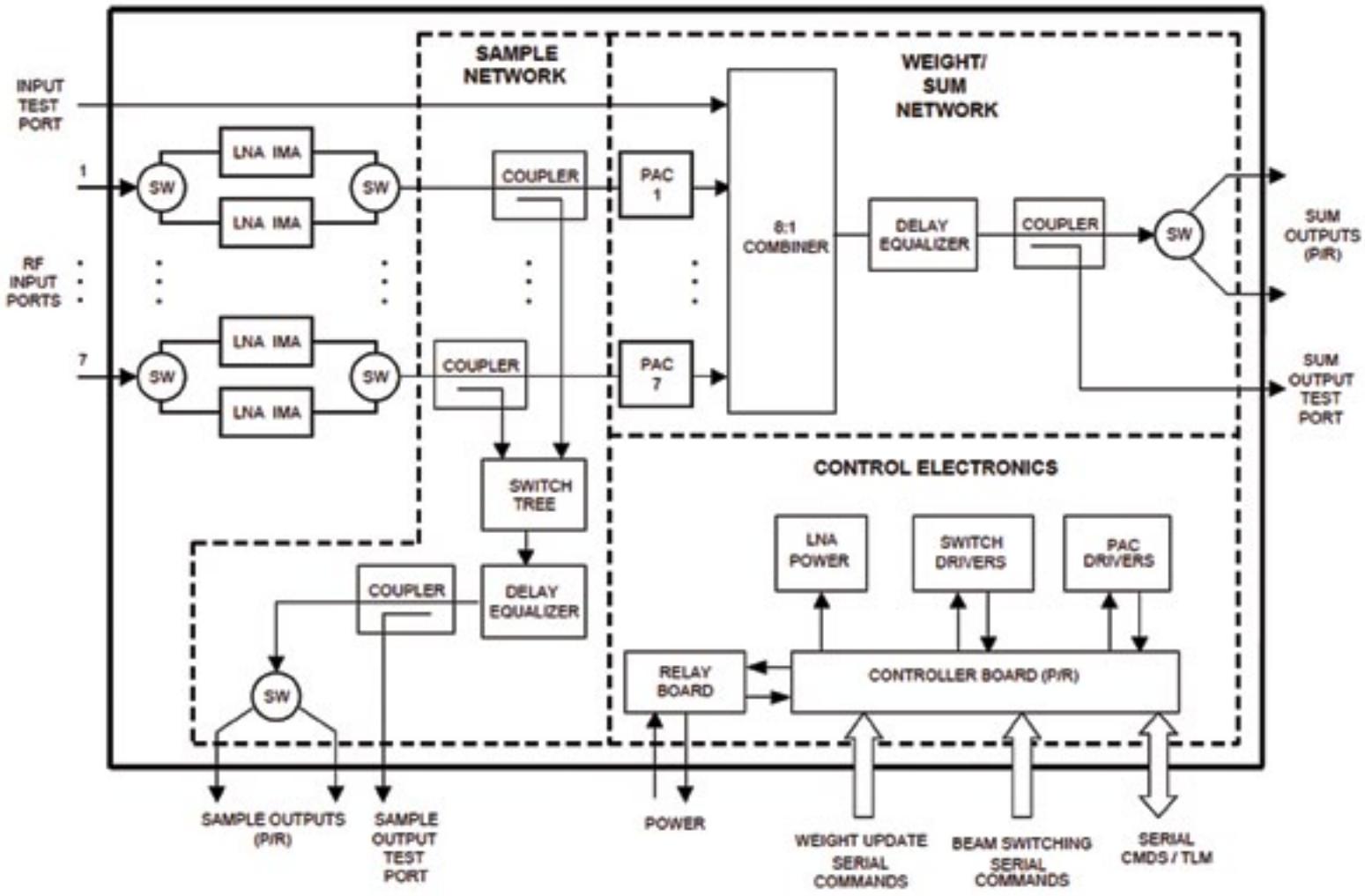
The nulling is accomplished by independently controlling the amplitude and phase of each of the overlapping RF ports. Samples of the RF signal are made at each of the multiple ports and these data are used to adjust the phase and amplitude of the multiple of the multiple channels to result in a rapidly converging excitation that minimizes the effects of a jammer and allows users to access the satellite. The size and shape of these nulls can be controlled real-time to compensate for various types of emitters.

The resultant signals from all ports are then combined to provide the RF data stream for further processing, demodulation and decoding. The system provides assured communications against both hostile interferers and friendly interfering sources.

The AEHF BFN is based on **EMS Technologies**' design heritage that was initiated on the Milstar constellation where a similar BFN was developed and delivered in the mid 1990's. The microwave section of the BFN is a waveguide system that consists of *low-noise amplifiers* (**LNA**'s), phase-amplitude controllers, RF switches, and power combiners. EMS's precision ferrite phase shifters and switches are used to implement the RF control elements. The use of ferrite allows for low-loss RF processing of the signals to be performed, providing broadband beam forming control of the incoming signals.

All of these elements are combined into a network that is controlled by electronics taking commands as inputs and translating to the particular desired configuration that is synchronized with the frequency hopping of the signal waveforms. The BFN employs redundancy to implement a highly reliable system.

EMS/Honeywell continues to develop the technology to provide systems that address the warfighter's dependence on secure satellite-based communications. In addition, as hosted payloads augment the military's telecommunications requirements, EMS's advancements in the military use of beam forming



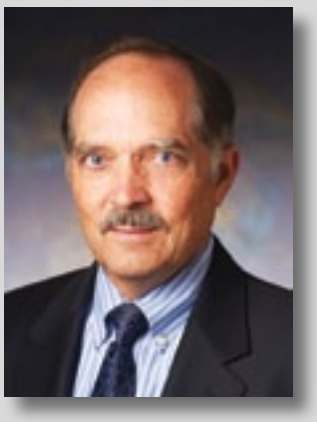
Q-Band Beam Forming Network Functional Schematic

network capabilities are being adapted for commercial communication and direct broadcast satellite applications.

The commercial BFN offers similar capabilities as the AEHF application, but without the sophisticated waveforms, enabling safeguards against jamming and unauthorized access. With the military leasing a large percentage of the worldwide SATCOM capacity, continuous and secure communications is imperative. In the highly competitive communications industry, commercial entities that cannot protect their communications link face the possibility of customers moving to other satellite providers or terrestrial applications. ❖

EMS Receive Beam Forming Networks Military and Commercial Space Qualified Rx BFNs

About the Author



David Rhodes, a principal engineer within the Defense & Space Division of EMS Technologies, now a part of Honeywell, has worked over the past 20 years on Milstar satellite programs as well as AEHF satellite programs. Rhodes has designed electronics for microwave hardware for both satellite and terrestrial based systems. He also designed wireless computer equipment at LXE, a division of EMS Technologies, prior to joining the Defense and Space Division. After serving in the U.S. Navy, Rhodes began his electronics career at Bell Laboratories where he designed terminal equipment.

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Giles Peeters, Director, Track24 Defence SCC

Giles Peeters spent 19 years working as a communications specialist for the United Kingdom Ministry of Defence, before moving to the private sector to consult for organisations such as NATO, on Blue Force Tracking (BFT) requirements. Now Defence Sector Director at Track24 Defence, Peeters is the driving force behind the launch of the company's new, commercial-off-the-shelf (COTS) Blue Force Tracking solution, Situational Command & Control (SCC).

MilsatMagazine (MSM)
As the Defence Sector Director for Track24, would you enlighten our readers as to your duties with the Company?

Giles Peeters
My main responsibility is running the defence group within Track24; this covers a wide range of duties from business strategy and development and overseeing sales and marketing, to technology innovation and development.

MSM
Having spent nearly 20 years with the U.K.'s Ministry of Defence (MoD), what projects did you undertake there that prepared you for your move into the commercial MILSATCOM world? Would the same apply to your experience while working with NATO when you were with EMS Technologies?

Giles Peeters
While I can't talk about specific projects, my initial post at GCHQ was where I first came into contact with commercial high-tech solutions for the intelligence community. Up until then, like most personnel, my only experience of military comms had been 'combat network radios'; however, working at GCHQ exposed me to the wonderful technology that was available commercially and which, more importantly, actually worked where and when we needed it.

As the *Commercial Satellite Service Delivery Officer* with the *Satellite Integrated Project Team* (**IPT**) at DCSA Corsham, I was the 'go-to' man for anyone with a satellite communications requirement MoD-wide. We were effectively the MoD's procurement agency for commercial satellite service delivery; military personnel would come to me with requirements and I would approach commercial providers to fill that capability gap. That was where I started to develop a more in-depth understanding of what commercial technology could do – particularly through my responsibility for the satellite contracts between Inmarsat and the Navy.

My final three years as the joint communications subject matter expert, at *Joint Helicopter Command* (**JHC**) included communications and command and control responsibility for all U.K. MOD helicopters entering Afghan and Iraqi airspace – an operation that required the use of the first home-grown ***Blue Force Tracking*** (**BFT**) equipment engaged by the British military.

My experience with NATO involved project managing the integration of a Blue Force Tracking system into the international peacekeeper's communications system.

MSM
How do you see MILSATCOM evolving over the next year or two in efforts to support warfighters? What major goals in this area would you like to see accomplished?

Giles Peeters
There has been a major comms. change in the operations of recent years – the environments in which troops are engaging with the enemy are a challenge for radio and GPRS – *beyond line-of-sight* (**BLOS**) communication is still a critical capability gap. Troops are being deployed more quickly and at shorter notice than ever before, and joint operations are becoming more common (such as Libya), meaning that system interoperability must be a key aim for satellite communications.

MSM
Please explain Blue Force Tracking and how such is so crucial to front-line missions.

Giles Peeters
Even on the battlefields of old it was necessary for commanders to have a good overview of deployed military assets. In modern warfare it's even more important as the conflict is no longer taking place in line-of-sight, but hundreds of miles from forward operating bases. A commander cannot effectively engage the enemy unless they have a complete understanding of the force available to them; BFT offers that *Common Operating Picture* (**COP**), and metrics on everything from available ammunition

Blue Force Air Situational Command & Control (ASCC) platform

to the local environment. Exciting developments in commercial systems and machine-to-machine communications mean we're now seeing integrated red force contact and telemetry from deployed machines. We're watching battle management evolve from simple BFT to integrated situational command and control.

MSM
How does Track24 involve themselves in Blue Force Tracking projects/products and other areas of military defence?

Giles Peeters
There are organisations already in Afghanistan using something similar to BFT – these guys on the ground are using old technology, and are starting to realise that there are other capabilities available at a fraction of the price. We're currently in talks with many security companies active in that region, and are offering tactical solutions to the U.S. military. Existing users of BFT with expensive systems are starting to look at alternatives, and military organisations are reassessing their existing capability and realising there are lower cost alternatives – this is where Track24 Defence comes in.

MSM
Track24 describes themselves as being involved in the Security Tracking and Risk Management Sector (STRMS) — what areas of defense does this sector cover, and how does your Company project their offerings against competitive products?

Giles Peeters
With the STRMS side of the business, the technology is similar but the customer is different – instead of military and defence sector organisations looking for command and control, the customer might be a high-level CEO travelling to high-risk countries or ensuring civilian safety whilst involved in re-construction efforts.

Track24 has seen the market change over the years and has adopted a more technical approach to service provision, allowing it to offer customised solutions to companies and military organisations. We're involved in strategic product development with manufacturers to ensure exclusivity in core markets; that means that the product and service offered by Track24 is of the highest quality and fit for purpose in often-demanding environments.

MSM
Was the transition from the military to the commercial world challenging for you?

Giles Peeters
Many military personnel struggle to integrate into the civilian, commercial world, but I didn't really find it a challenge – mostly because I already had experience of dealing with private satellite companies. The commercial sector has changed drastically from when I was with the military; since the recession, companies are struggling, so everyone is working extremely hard and being more flexible in their business transactions.

Concurrently, the forces have also changed – if you compared the military I joined to the one I left, you would not recognise the two. Whereas the majority of personnel had no understanding of the commercial world (with the army's own communications systems, they believed there was no need), the constant developments overseas and the austere environments in which troops are fighting, means that they are being forced to find solutions from within the commercial sector. The two worlds are not so different and this is proven by the U.S. military; 80 percent of their combat ready-satellite capability is from the commercial sector.

MSM
How do you think your military command experience has prepared you to work with military organizations now that you are with Track24? Do you find the process to be more difficult on the "other side of the fence?"

Giles Peeters
When I go into military organisations, I see a lot of them at the same stage I was several years ago, when I started to look at new technologies – my experience allows me to pass on the lessons I have learned – both the successes and the mistakes. They are trying to solve a problem, and I have experience of problem-solving at the highest levels on the front line, in Afghanistan and Iraq. I was in the right place at the right time to learn about commercial satcom technology, and will always be able to help people. In South America, for example, we're seeing organisations just starting to think about how could BFT could benefit them, what it could give them and how they'd integrate it – our experience and military background means we're well respected and perfectly placed to help them make those decisions.

I tell everyone the same thing: The key consideration is the concept of operations. It's not necessarily about the technology itself, it's about how you implement it and get it to work with everything else. For example, how do you enable an Apache helicopter to communicate with a Chinook when they are using different systems? My military command experience can guide them in the right direction.

MSM
Having worked with the MoD and NATO, did you find yourself working with the militaries and government agencies from other countries as well? Do you find such helpful today as you engage in more and more global activities?

Giles Peeters
Rarely. My work has mostly been with U.K. personnel, and some from the U.S. My consulting work with NATO involved some interaction with other organisations at a very high level, and in my last role at my previous company, I worked on projects with organisations in Romania and Poland.

MSM
What do you see as the most dire communication and security needs for today's warfighters? Will these needs be addressed soon, or are they merely "wish lists" for the future that may never see the light of day?

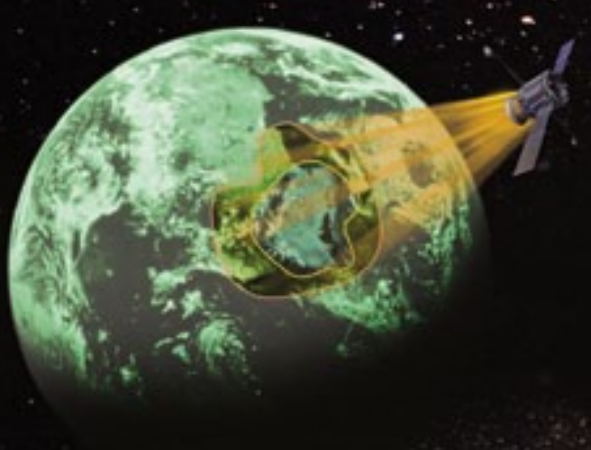
Giles Peeters
The biggest security need at the moment is a communication path/bearer that works beyond line-of-sight, offers the right data capacity and is secure. We believe that the Track24 offering comes closest out of anything on the market to fulfilling this need, at a fraction of the cost of other systems.

MSM
How important was it for the Company to open a new office in North America? What are your lead goals for this office, and for your own success?

Giles Peeters
It has been crucial. There is a considerable technology divide between North America and the rest of the world, in terms of brand recognition. There are massive European companies in our sector that few people have heard of in America, and vice-versa. I've seen companies try to break into North America without having an office there, and it never works; you can't sell to the U.S. from Europe. It works the other way, as well, as there are several big American BFT companies doing very well with the U.S. military who can't sell anywhere in Europe.

Our Canadian office allows us to exploit our business and military connections on the continent (we could not sell to the U.S. military without a North American office) as well as giving us an additional conduit to bring our technology to the rest of the world, alongside our U.K. and Dubai offices. It also allows us to offer 24/7 support to our customers across three time zones: GST, GMT and EST. ❖

Blue Force Air Situational Command & Control (ASCC) platform



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— A Discussion —
The Fight Against Maritime Piracy: SATCOM's Role

with Wouter DeKnopper, director of European, Middle East + African Markets, Iridium Communications

MilsatMagazine (MSM)
First, Mr. DeKnopper, tell us about your background and your role at Iridium.

Wouter DeKnopper
I began my career with **SAIT Communications** and have been working in the satellite industry for almost 15 years. Currently, I am based in Belgium and am responsible for bringing new **Iridium** products and services to European, Middle Eastern and African markets.

MSM
How serious is the problem of piracy? Can you give us some facts and figures?

Wouter DeKnopper
The great majority of pirate attacks are taking place off the **Horn of Africa**, with highly organized pirate gangs working out of Somalia, a country without a functioning government. To be sure, there are also other "hot spots" of pirate activity, including the coasts of **Nigeria**, **Indonesia** and **Malaysia**, but we are primarily focused on the **Indian Ocean** and **Gulf of Aden**. This is one of the most heavily travelled shipping lanes in the world, since all ships using the Suez Canal must pass through these waters. The pirate gangs attack the unarmed merchant ships and hold the vessels, their cargos and their crew for ransom. The figures are staggering.

According to the **International Maritime Bureau**'s (**IMB**) *Piracy Reporting Centre*, during 2011 pirates attacked 335 ships and successfully seized 35 of them. As of this writing, Somali pirates are holding 20 ships and around 400 hostages. Although the number of attacks reported is at an all-time high, the piracy success rate has dropped considerably thanks to improved preparedness of ships and disruption of *Pirate Action Groups* (**PAG**). There have been reports of multi-million dollar ransom payments to recover the ships and crew. The waiting time while ship owners and insurance companies negotiate with the captors is growing longer, and the level of violence against hostages has escalated.

The pirate attacks started out several years ago as an unorganized bunch of unemployed fishermen looking for easy money by attacking other vessels. It is now controlled by highly organized and sophisticated criminal cartels in Somalia, who are generating millions of dollars in untaxed profits.

MSM
What's being done to protect merchant ships and their crews?

Wouter DeKnopper
There are a number of international naval forces operating anti-piracy patrols in the danger zone, but the area of operations and the number of merchant ship targets are too large for the naval forces to prevent pirate attacks. To give you an idea, pirate infested waters off the Somalia Coast extend to an area of more than 2.5 million square nautical miles. It may take hours for the military forces to reach the ship, and by then the pirates have seized the vessel and are using the hostages as human shields. The IMO has published *Best Management Practices*, providing guidelines for ship operators to avoid attacks and actions to take once the ship is boarded by pirates. One of the key components in the ship's anti-piracy plan is communications.

MSM
Can you give us some specific examples of the role played by satellite communications?

Wouter DeKnopper
One of the IMO recommended practices is to establish a "**citadel**" – a hardened safe room below decks away from outside bulkheads and windows, where the crew can take refuge if the pirates seize control of the ship. The idea is that the crew can disable the ship's propulsion and navigation systems, then barricade themselves into the citadel where they can wait safely for rescue by naval forces. The citadel needs to be sufficiently hardened so that pirates cannot break in. There also needs to be a reliable, secure, stand-alone communication system installed in the citadel, connected to a concealed antenna above decks with internal cabling, so the crew can communicate with the naval forces coming to their rescue.

In April, **NATO** published updated advice for communication systems used in ship citadels. The NATO guidelines call for the citadel to be equipped with a self-contained, independent, two-way external communications system, specifically recommending a satellite voice/e-mail solution. The communication system should have a power supply for a minimum of three days, based on a continuous open line.

Iridium is the preferred communication medium for this purpose, due to its global reach and reliable real-time telephony and low-latency *short-burst data* (**SBD**) for GPS tracking. In addition, the small, lightweight Iridium antenna units lend themselves to concealment. Several Iridium service partners offer Iridium-based citadel communication packages that meet the IMO Best Management Practices and NATO advisory.

The Best Management Practices recommend that the ship's master check in with the **U.K. Maritime Trade Operations** (**UKMTO**) center in Dubai, which provides liaison between naval forces and commercial shipping vessels. Seafarers transiting piracy prone waters are advised to maintain regular reports to the UKMTO, while transiting the danger areas. **Iridium has established a policy of providing calls from ship terminals to the UKMTO number free of charge to encourage frequent reports and better lines of communication.**

MSM
Are there other ways satellite communications are involved in combating maritime piracy?

Wouter DeKnopper
Under the ***Safety of Life at Sea*** (**SOLAS**) ***Treaty***, all ships over 500 gross tons are required to be fitted with a *Ship Security Alert System* (**SSAS**) since 2004. The SSAS is a satellite data terminal that includes a hidden, emergency button which initiates a covert satellite alert transmission to designated authorities in the event of a pirate attack. Using the Iridium two-way, low-latency SBD transmission path ensures that SSAS messages cannot be detected by other vessels nearby or pirates on deck.

The SOLAS treaty also requires a *Long Range Identification and Tracking* (**LRIT**) system to be installed on all ships over 300 gross tons. The LRIT system transmits ship ID and position coordinates to the LRIT data center designated by each flag state. Using the global coverage of Iridium SBD service, position data can be transmitted at regular intervals from anywhere across the globe, providing another tool for tracking the locations, movements and status of ships on the high seas.

Lastly, we also see a growing number of ships taking security and safety teams onboard when transiting through the maritime danger zones. These deterrent forces often make use of independent, lightweight portable, mobile satellite communication devices such as Iridium. ❖

Thomas M. Pirrone, V.P., SSC Universal Space Network

Thomas M. Pirrone is the Vice President of Customer Development for SSC Universal Space Network (USN) and North America's chief customer service officer. He joined USN in 1997, which was acquired by Swedish Space Corporation (SSC) in 2009 and today serves as a vital partner in the Company's global satellite ground station network. During this time, Mr. Pirrone led marketing, business development and customer service programs that helped USN achieve a leadership position in the commercial and civil space markets. Prior to joining USN, he served for eight years as general manager of GDP Space Systems, a ground station products manufacturer serving NASA, the commercial space industry and the Department of Defense (DoD). Other career highlights include engineering, sales and management positions with Aydin Corporation (now L-3 Communications), where he played a critical role in the design and implementation of satellite ground station equipment for NASA and the DoD.

MilsatMagazine (MSM)
What are your responsibilities and what previous duties and work experience prepared you for these challenges?

Thomas Pirrone
The entire SSC organization is rooted in the customer interface with regard to operations and engineering. My job is to ensure we develop business well, provide exceptional products and services and continue to grow and thrive as an organization. I have spent my entire career in engineering, sales and management roles with aerospace companies. I have a strong pulse on the industry and where it is headed. This knowledge allows me to uniquely understand our customers' needs and develop solutions to meet those demands.

MSM
How challenging is your work with government agencies and how do you prepare and overcome such regimented acquisition processes?

Thomas Pirrone
SSC is a very disciplined company and we know how to navigate the regimented acquisition process. But, this process is not our biggest hurdle. Sometimes our primary competitor is the very government agency we are trying to support. They are

The USN Dongara Australia Ground Station

committed to the use of commercial services and weaning themselves off of expensive and declining infrastructure. However, they find it difficult to let go for reasons ranging from political to fear of losing control to loss of career advancement opportunities for government employees. Despite these difficulties, SSC is committed to growing our government agency clients by continually demonstrating how our solutions meet their mission-critical needs while saving substantial sums of money. We're going to have to keep the pressure on ourselves to deliver exceptional service while reminding the government customer that buying services may be more advantageous than acquiring a stove-piped solution. We believe this paradigm shift will result in a win-win for everyone.

MSM
What product lines do you represent? How important are those product lines to warfighters and why are they so crucial to their mission success?

Thomas Pirrone
USN represents the entire suite of SSC products and services, which are designed to help people make better use of space. Our three biggest services include PrioraNet, the largest commercial network for ground station services in the world, Nanospace, which produces *Micro Electro Mechanical Systems* (**MEMS**)-based products for space application, and **ECAPS**, which focuses on green propulsion-based products for space application.

Our products and services help the DoD save money, while enhancing operations for warfighters. Normally troops would have to wait 90 minutes for a satellite orbit to occur in order to retrieve data. With our worldwide satellite management system that uses mid-latitude locations, we can reduce this time to 15 to 30 minutes, allowing data to be more readily available to commanders in directing troop movements and enhancing ground communications.

MSM
Please delve deeper into PrioraNet and the benefits associated with this system.

Thomas Pirrone
PrioraNet was built with the vision that the customer's data is the most important part of a satellite mission. With contact from any orbit, PrioraNet offers unparalleled high-latitude coverage and equatorial stations in strategic locations, assuring greater than 99 percent reliable global comprehensive satellite access. It's responsive and secure. Furthermore, with today's environment of reduced budgets, it is an extremely cost-effective alternative to the high life-cycle costs associated with ground station ownership. Infrastructure and maintenance costs are shared between multiple customers.

MSM
What does SSC bring to the table, as far as technologies and capabilities?

Thomas Pirrone
It's about expertise and global reach. Through our subsidiaries, we offer satellite management services, sounding rocket and balloon launch services, microgravity experiment equipment, airborne maritime surveillance systems and propulsion systems. We integrate new technologies and talents that result in proven, reliable, responsive and cost-effective solutions for our customers.

We have the ability to make key infrastructure purchases in strategic locations to fulfill our goal of becoming the dominant, worldwide provider of satellite communications services. Furthermore, we are investing heavily in green propulsion, which I believe is going to eventually to become a game-changer at launch ranges.

MSM
Given the history of the Department of Defense as a prime customer for USN, how does the SSC acquisition of USN strengthen the company and enhance its value to the customer?

Thomas Pirrone
SSC has greatly enhanced USN's ability to serve our DoD customers by providing a broader spectrum of global assets that can be applied to a specific U.S. government need. We provide daily support to several on-orbit DoD missions, and recently, we participated in the orbit-raising efforts for two new DoD communications satellites. The merger of our capabilities allows SSC to provide global tracking station assets the DoD can use to augment its in-house capabilities.

MSM
What are your key differentiators when working with DoD markets?

Thomas Pirrone
Protecting their data is key and critical. If you are not paying attention to information assurance (IA), you aren't paying attention. Once that IA piece is satisfied, we save the customer money because costs are shared between multiple owners. But, even more important, we enhance operations because we oversee the largest commercial network for ground station services in the world. As a result, we can reduce the latency of products, radar and imagery, reconnaissance and communications. Warfighters get the information they need much faster. And, in times of war, that can mean life or death.

MSM
How does SSC's ability to share resources and upgrade space operations assets offer customers greater value?

Thomas Pirrone
Two words … cost-effectiveness. Why own, operate and maintain your own resources when they aren't used to capacity? By sharing resources, customers pay a fraction of the cost and gain access to more technology than ever before. I equate it to airplanes. Instead of a company owning an airplane and having to bear the cost and time of maintaining it, they can do the equivalent of buying a ticket on OUR airplane by buying access to our network and only use it when they need the resources. It's just good business sense.

MSM
How can SSC help customers deal with changing infrastructure needs in a dynamic geopolitical environment?

Thomas Pirrone
The answer is simply, "Our customer don't have to." As their partner, we take care of building new infrastructure and maintaining existing ones, based on their needs. We can provide services ranging from hosting to full outsourcing, including ground communication around the globe. The primary challenge with the DoD customer is they are overly "requirements based," sometimes even to a fault. They would be better served if they let go of the design and simply focused on buying capabilities. Additionally, the U.S. might realize quicker returns if sustainment budgets were invested in R&D.

MSM
How can SSC help customers meet new mission requirements to LEO without large infrastructure investments?

Thomas Pirrone
There are more resources available with current infrastructure to better serve LEO, including increased contact with more satellites. However, instruments that fly on LEO satellites tend to generate large volumes of data that need to be downlinked rapidly by high-frequency bands, such as X-and Ka-band in the future. Currently, such high-frequency bands don't exist on current infrastructure, but SSC is making investments to offer this upgrade. In fact, we are already working with the DoD to support its X-band expansion. Another example is the recently mandated *space/ground-link subsystem* **(SGLS)** frequency sell-off. Should the country build and sustain a new offshore tracking station for decades or simply lease that capability?

MSM
How can SSC help reduce O&M costs? What is a tailored utilization model?

Thomas Pirrone
Customers have been used to building infrastructure for peak needs. Instead, SSC offers tailored service provisions or a tailored utilization model. We help customers reduce their infrastructure needs below peak, and then have them tap into us only during peak times. Then, they don't have to carry the additional capacity and reduce their operations costs, while not missing any passes. The result … an infrastructure cost reduction by as much as 65 percent.

MSM
With government agency and military budgets being reduced, how does SSC plan to counter such effects and remain a top provider of product?

Thomas Pirrone
As SSC provides services that reduce the cost of spacecraft operations and communications, this new era of austerity in government agency budgets is actually an opportunity for us. In times of plenty, it is easier for government agencies to prioritize in such a way that cost-savings on operations is not the primary objective. However when everyone is tightening their belts, our ability to effectively reduce space operations and communications services budgets becomes an attractive alternative to institutional infrastructure. Our customers pay for our services as they are used, on a per-pass or per-hour basis, as opposed to maintaining a standing army of people and hundreds of millions of dollars of equipment and systems. By expanding the use of commercial services to supplement in-house capabilities, the DoD could reap similar savings that the world's civil space agencies are currently enjoying. ❖

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CALCULATION

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

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

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

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

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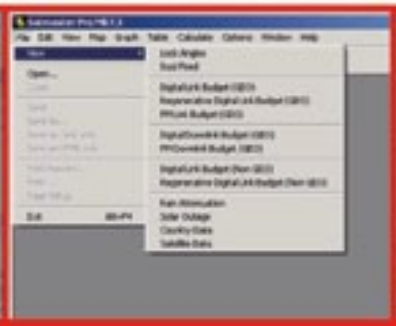

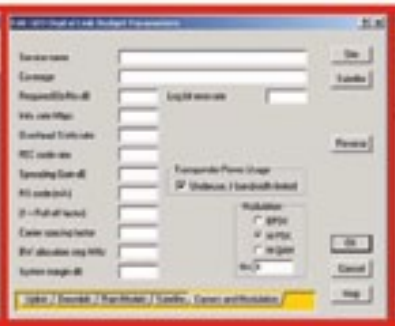

http://www.satnews.com/satfinder

Power To The GPS

The pathfinder spacecraft has been turned on, a major milestone for the GPS III satellite launch in 2014...

The Lockheed Martin team developing the U.S. Air Force's next generation Global Positioning System has turned on initial power to the program's pathfinder spacecraft, known as the GPS III Non Flight Satellite Testbed (GNST). The milestone gives the team high confidence in meeting the scheduled launch of the first GPS III satellite in 2014. The GPS III program is the lowest risk solution to constellation sustainment and the most affordable path to meet the needs of military, commercial and civilian users worldwide. GPS III will improve position, navigation and timing services and provide advanced anti-jam capabilities yielding superior system security, accuracy and reliability.

With a focus on affordability, the GPS III team is first developing the GNST, a full-sized prototype of the GPS III spacecraft used to identify and solve issues prior to the first space vehicle. This approach significantly reduces risk, improves production predictability, increases mission assurance and lowers overall program costs.

The GNST, populated with fully functional non-flight boxes, provides space vehicle design level validation; early verification of ground, support, and test equipment; and early confirmation and rehearsal of transportation operations. "Turning initial power on for the GNST is a major milestone for the GPS III team demonstrating we are well on track to deliver the first satellite for launch in 2014," said Lt. Col. *Don Frew*, the U.S. Air Force's GPS III program manager. "Our joint government and industry team is committed to delivering GPS III on schedule to sustain and modernize the GPS constellation for users worldwide."

The GPS III team has installed power subsystem components, harnesses, and tracking, telemetry and control hardware on the GNST structure to support phased checkout of the integrated design. Flight software versions have also been delivered for all of the spacecraft and payload computer processors. In parallel, GPS III teammate ITT is integrating the GNST Navigation Payload at their facility in Clifton, New Jersey. Successfully powering on the GNST demonstrates initial mechanical integration, validates the GNST's interfaces and leads the way for electrical and integrated hardware-software testing.

The GNST will be shipped to Lockheed Martin's GPS III Processing Facility in Denver late this year to demonstrate Assembly, Integration and Test procedures. It will then be delivered to Cape Canaveral Air Force Station in the summer for 2012 for pathfinding activities at the launch site. ❖

Core Support and BLOS + LOS For DoD

Harris Corporation (NYSE:HRS) has been awarded a 16-month, $9.7 million contract by the U.S. Air Force Space Command's Space and Missile Systems Center to deliver network support services at Los Angeles Air Force Base in California.

Under the contract, Harris will deliver core IT and communications operations and maintenance services including: Network control center support; consolidated video teleconferencing services; consolidated help desk services; and information assurance and support to Missile Defense Agency networks. Harris has extensive expertise managing comparable, essential networks for customers such as the U.S. Air Force's 50th Space Wing, the 505th Command and Control Wing at Hurlburt Field, Florida and Nellis AFB, Nevada, and the 88th Communications Group at Wright Patterson AFB, Ohio. The Harris team includes subcontractors Abacus and ManTech. This contract was awarded under the Network-Centric Solutions (NETCENTS) contract vehicle.

The Company has also received a $16 million order from the U.S. Department of Defense for additional Falcon III® AN/PRC-117G multiband manpack radios systems. The radios will supply DoD forces with networked line-of-sight and beyond-line-of-sight tactical communications.

Harris AN/PRC-117G

The field-proven AN/PRC-117G delivers unprecedented situational awareness to the battlefield through voice, wideband data and mobile ad-hoc networking. It is the first JTRS Software Communications Architecture-certified and NSA Type-1 certified wideband manpack radio system. Software-defined with significantly reduced size, weight and power, the radio supports a growing number of network-enabled missions.

Harris has shipped 15,000 AN/PRC-117G radio systems to the U.S. DoD and allies such as Canada, the United Kingdom, Germany, other NATO nations and Australia. The radio was developed following the JTRS program Enterprise Business Model (EBM). The EBM encourages companies to develop next-generation solutions in tactical communications using their own investment capital to integrate JTRS waveform software. In doing so, the EBM stimulates competition, increases innovation, and reduces costs through software re-use. ❖

Moving On Up...

Northrop Grumman Corporation (NYSE:NOC) announced today that it has appointed retired Army Lieutenant General Kevin T. Campbell, vice president and corporate lead executive

(CLE) for company business in Huntsville, Alabama.

Campbell reports to John R. Landon, vice president of missile technology and space programs. "I am very pleased to welcome Kevin Campbell as our new lead executive in Huntsville," said Landon. "His broad military leadership, especially in the areas of missile defense, space and cyber defense, will serve him well in his new position. We look forward to his contributions to our company and its shareholders, customers and employees."

In his new role, Campbell is Northrop Grumman's senior executive for the Huntsville region, representing all sectors and all business activities. He will maintain direct liaison with the U.S. Missile Defense Agency; U.S. Army Space and Missile Defense Command; U.S. Army

Material Command; U.S. Army Aviation and Missile Command; and NASA's Marshall Space Flight Center. Campbell is the primary company interface with customers and peer industry partners and business leaders in the region. In addition, he represents Northrop Grumman in the Huntsville community and works with other community leaders in support of economic development activities and local community service and philanthropic activities.

Campbell joins Northrop Grumman after retiring from a distinguished 37-year career with the U.S. Army, having most recently served as Commanding General, U.S. Army Space and Missile Defense Command/U.S. Army Forces Strategic Command, Redstone Arsenal, Alabama. Prior to that, he served as Chief of Staff, U.S. Strategic Command, at Offutt Air Force Base, Nebraska, one of numerous joint leadership assignments throughout his career. He has earned a number of U.S. military decorations, including the Defense Superior Service Medal (with Oak Leaf Cluster); the Legion of Merit (with two Oak Leaf Clusters) and the Bronze Star Medal. ❖

A Host Of Duties

The Boeing Company will serve as corporate host for the MILCOM 2011 conference and exposition...

The event occurs from November 7th through the 10th at the Baltimore Convention Center. This will be the conference's 30th year of gathering leaders from the military, industry and academia to promote and discuss all aspects of military communications technologies and services. The conference is co-sponsored by the Armed Forces Communications and Electronics Association (AFCEA) International and the Institute for Electrical and Electronics Engineers (IEEE) Communications Society. The U.S. Army Communications-Electronics Command (CECOM) is the Department of Defense adviser for the conference.

Featured speakers at MILCOM 2011 include: Army Gen. Ann E. Dunwoody, commander of U.S. Army Materiel Command; Air Force Lt. Gen. Michael J. Basla, vice commander of Air Force Space Command; Air Force Lt. Gen. Charles R. Davis, commander of Electronic Systems Center; Army Lt. Gen. Rhett A. Hernandez, commanding general, U.S. Army Cyber Command/2nd Army; Army Lt. Gen. Susan S. Lawrence, Army Chief Information Officer/G-6; Air Force Lt. Gen. Ellen M. Pawlikowski, commander of the Space and Missile Systems Center; and Army Maj. Gen. Randolph P. Strong, commanding general of CECOM Life Cycle Management Command. Industry and government leaders also will share their

perspectives during daily panel presentations. The MILCOM 2011 technical program includes classified and unclassified sessions that will feature both tutorials and technical panels. More than 400 technical paper presentations are scheduled to cover the following topics:

- ◊ *Waveforms and signals processing*
- ◊ *Networking protocols and performance*
- ◊ *Cybersecurity and network operations*
- ◊ *Middleware services and applications*
- ◊ *Communications and network systems*
- ◊ *Department of Defense programs*

This year's program also includes a Small Business Workshop, which offers potential suppliers and partners two days of face-to-face interaction with Boeing and other prime contractors. MILCOM 2011 features a full technology exposition, gathering industry leaders in an interactive exhibit hall. Boeing will feature the capabilities of its Wideband Global SATCOM satellites; Combat Survivor Evader Locator radio; Enhanced Medium Altitude Reconnaissance and Surveillance System (EMARSS); Phased Array Antenna; Phantom Eye unmanned aircraft; Joint Tactical Radio System (JTRS) Enterprise Network Manager; and NarusInsight Solution for Cyber Protection. ❖

Enhanced Intelligence

DigitalGlobe (NYSE: DGI) has been awarded a one-year contract at a funded level of $37.9 million by the U.S. Government via the National Geospatial-Intelligence Agency (NGA) under the NGA's new Enhanced GEOINT Delivery (EGD) program.

The award will enable value-added support to NGA, as DigitalGlobe continues to meet more advanced imagery requirements and provide final product deliverables. This award advances the production capabilities of the company's "Rapid Delivery of Online Geospatial Intelligence" (RDOG),

a capability first pioneered jointly by DigitalGlobe and NGA in 2009, and which NGA has since used to develop imagery and map-based intelligence solutions for U.S. national defense, homeland security and safety of navigation in multiple geographic locations around the world.

EGD expands the EnhancedView contract to meet the government's evolving requirements for ortho-rectified products in large quantities. The new EGD product deliverables will include three elements: a nearly cloud-free wide-area mapping layer; continuous delivery of daily images via the web within 24 hours of collection; and quick-turnaround images of NGA-designated high-priority geographic locations.

Initial production and deliveries under the agreement are expected to ramp beginning in the fourth quarter 2011, with revenue to be recognized in accordance with deliveries. ❖

WWSS Win

TeleCommunication Systems, Inc. (TCS) (NASDAQ: TSYS) has received $16.1 million of new orders from the U.S. Army to continue to provide satellite communications equipment, engineering support, training and maintenance for the U.S. Army.

The orders are initially funded at $5.0 million and will be funded up to a total of $16.1 million if the options are fully exercised through July 2012. The U.S. Army Project Manager for the Warfighter Information Network-Tactical (PM WIN-T) Commercial Satellite Terminal Program (CSTP) is funding these procurements through the Army's $5 billion World-Wide Satellite Systems (WWSS) contract vehicle, which has been extended to July 27, 2012 with all deliveries required to be completed by August 28, 2012.

In addition, TCS has received $3.2 million of additional incremental funding under previously announced orders. This brings the total of WWSS orders for the period August 26-September 30, 2011 to more than $78 million. ❖

Mission Critical Move

Kratos Defense & Security Solutions, Inc. (Nasdaq:KTOS) has garnered sales valued at a total of $1.1 million from four major U.S. Government agencies for NeuralStar®, its flagship network management and situational awareness software product.

The names of the agencies, all of which are aligned with critical defense and intelligence operations, were not disclosed due to customer-related and other sensitivities. NeuralStar monitors, aggregates and integrates mission-critical network availability, cyber security and compliance management data from heterogeneous technologies to create flexible, dynamic dashboards for enhanced management and complete situational awareness. This allows NeuralStar to provide a Common Operational Picture (COP) for all levels of command across large distributed network and field operations, especially those that rely upon a variety of communications, information and security technologies.

For example, two of the agencies purchasing NeuralStar rely heavily upon analog-based satellite communications. NeuralStar uniquely allows them to easily integrate management of these systems into their overall communications command and control picture for a unified 360 degree view.

"All of these agencies function on the frontiers of communications and cyber security operations," said Phil Carrai, President of Kratos Technologies and Training Solutions. "They include some of the world's largest global networks as well as smaller, highly specialized and in-the-field operations. It is gratifying to see this endorsement of the NeuralStar platform as the standard for highly-secure network management and situational awareness." ❖

Demo Success For FAB-T

Boeing has successfully demonstrated high-data-rate transmissions between a Family of Advanced Beyond Line-of-Sight Terminals (FAB-T) system and a test terminal for the Advanced Extremely High Frequency (AEHF) satellite.

This was one in a series of development tests that are demonstrating extended data rate voice, text and data communication with a FAB-T unit. FAB-T will provide the U.S. Air Force and U.S. Navy with protected wideband satellite communications in support of command and control of U.S. nuclear forces. The demonstration, conducted in August at Northrop Grumman Aerospace Systems in Redondo Beach, California, involved a FAB-T unit and an AEHF Universal System Test Terminal (AUST-T) communicating through a ground AEHF payload. Using the latest program hardware, the terminal team successfully conducted extended data rate (XDR) re-key, XDR text communications, and dual FAB-T log-on with the AEHF payload. In separate testing essential to operating the fielded FAB-T system, Boeing also interfaced with the AEHF Satellite Mission Control Subsystem, demonstrating XDR capability with the AEHF ground satellite. The program continues to make measurable progress against its planned baseline. ❖

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