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Satellite Communications for net-centric warfare
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COMMUNICATIONS IN HOSTILE ENVIRONMENTS

Plus Priority Briefing:
Colonel David C. Uhrich

Vice Commander, Military Satellite Communications Systems Wing

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EDITOR'S LETTER

I hope you have already availed youselves of the gigantic, info-packed December 2007 issue of *SatMagazine*, our **YEAR IN REVIEW** issue. That particular issue offered satcom and ancillary business expertise from those who know best—the companies who successfully maintained and sustained throughout 2007. In addition, those fine folk also offering a look into this New Year, this 2008, and offered their prognostications for a most interesting read! The power of the experts is yours to read, digest and use in your daily work at the SatMagazine website.

However, there's even more company news that should be especially of value to our readers! Our publishing company's creative director, Simon, has designed and created a complete magazine-on-a-website... no longer will you have to download a ".pdf" file to read *MilsatMagazine* or *SatMagazine*. Simon has created the code enabling our thousands of readers to approach and enjoy our publications ONLINE in magazine format. Incorporated into this online mix are easy to use navigation buttons that'll have you cruising through feature articles, columns, news and more, quickly and easily. In fact, reading *MilsatMagazine* and *SatMagazine* is now similar to the way in which you've been reading our daily and weekly news at our news website.

We hope you enjoy the new online format and find the content stimulating, usable and pertinent to your work. Yes, you may continue to download the ".pdf"—we believe you will find the new online format extremely easy to use, but it is always nice to have a choice—you can also print and/or email each article directly from the webpage, or forward the ".pdf" to associates. Your comments are always welcome.

Additionally, I wish to again offer my "open door" policy... if you wish to write a feature article, an op-ed piece, a spotlight, suggest an interview, send news or company event information, please do so! Simply send an email to me so I may review your proposal and reply to you as soon as is possible. I would also be pleased to forward to any requestors our editorial calendar for 2008 as well as our author's guidelines... and they are just that, guidelines. I look forward to hearing from you regarding that.

This issue offers a superb lineup of articles with a focus on the military side of satcom. Leading the article parade are our three **PRIORITY BRIEFINGS WITH...** features. An interview with Colonel *David Uhrich*, Vice Commander, **Military Satellite Communications System Wing** of the **Space and Missile Center** at Los Angeles Air Force Base, leads the way. *Robert Canty*, the Director of DoD Systems, of Space Systems, **Raytheon**, is our second interview and he reviews his company's contract for the nexgen Global Positioning System Control Segment and other issues. Our third PRIORITY BRIEFINGS WITH offers a follow-up interview with *Marc Le Gare*, the CEO of **Proactive Communications Inc.**, and a veteran in every sense of the word within the satcom industry.

Other superb content offerings include

- Dr. *Axel Jahn*, the Managing Director of **TriaGnoSys** writes concerning *Satellite Communications For Hostile Environments*
- *Satellite Network Acceleration* by *Nick Yurin*, the Director of Sales and Marketing for **Global Protocols, Inc**.
- **iDirect**'s *Karl Fuchs*, the company's Director of Federal Systems Engineering, discusses *Comms On The Move*
- Dr. *Len Losik*, the founder of **Failure Analysis**, reveals the whys-wherefores-and how-comes of failure prediction technology for military satellites and rockets
- A chilly case study involving a kayaking team from the **Royal Navy** in the Antarctic
- A military satellite focus on **AEHF**
- In addition, of course, some news you can use.

Thanks for joining us, once again, and don't forget to write... let us know your thoughts regarding our content, let me know if you wish to contribute, but most of all, **my best wishes to each and every one of you for a prosperous and happy NEW YEAR!**

MILSATMAGAZINE

Production Team

EDITORIAL

Silvano Payne
Publisher

Hartley Lesser
Editorial Director
hartley@satnews.com

P.J. Waldt
Editor

Chris Forrester
Editor, Europe

Michael Fleck
Editor, Asia & Enterprise Markets

Martin Jarrold
Marketing Intelligence

CONTRIBUTING AUTHORS

Axel Jahn
Nick Yurin
Karl Fuchs
Len Losik
Robert Canty
Marc Le Gare

SALES

Jill Durfee
Advertising Director
jill@satnews.com

PRODUCTION

Simon Payne
Creative Manager

Published quarterly by
Satnews Publishers
800 Siesta Way,
Sonoma, CA 95476 USA
Phone (707) 939-9306
Fax (707) 939-9235
E-mail: design@satnews.com
Website: www.milsatmagazine.com

MILSATMAGAZINE PRIORITY BRIEFING WITH...

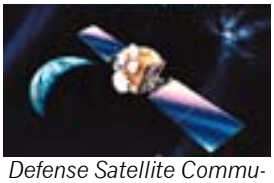
COLONEL *DAVID C. UHRICH*

Vice Commander, Military Satellite Communications Systems Wing, Space and Missile Systems Center, Los Angeles Air Force Base, El Segundo, California

by Hartley Lesser, Editorial Director, SatNews Publishers

Hartley
Good day, Colonel Uhrich. We are delighted you are able to take the time to help us understand the role of your command and the major military satellites systems the MILSATCOM Systems Wing (MCSW) develops, acquires and sustains. Can you tell us a little about the Wing?

Colonel Uhrich
At the macro level, the Wing is responsible for wideband and protected **MILSATCOM** satellites, command and control systems, ground systems and terminals. These systems operate in the Super High Frequency and Extremely High Frequency bands of the electromagnetic spectrum. The U. S. Navy has similar responsibilities for narrowband or Ultra High Frequency communications satellites and systems.



Defense Satellite Communications System (DSCS) Artist rendition provided by MCSW, SMC

The first and oldest of our constellations is the *Defense Satellite Communications System* (**DSCS**). DSCS is a legacy satellite system and has been the backbone of the U.S. military's global satellite communications capabilities since the 1980s. Since the first launch of the first **DSCS III** satellite, this system has been providing anti-jam, high data rate, long-haul communications to deployed and in-garrison users worldwide.

DSCS supports the defense communications system, the Army's ground mobile forces, the Air Force's X-band, airborne terminals, Navy ships at sea, the White House Communications Agency, the State Department, and other special users. There are currently 9 DSCS satellites providing global coverage from their locations in geosynchronous orbit.

Wideband Global System (WGS) Satellite SV-1 Launch October 2007 Photo credit: Ben Cooper, Spaceflightnow.com

The process of augmenting and eventually replacing the DSCS satellites began with the successful October 2007 launch of our first *Wideband Global SATCOM* (**WGS**) satellite. WGS will provide flexible, high-capacity communications for the Nation's warfighters through operations of WGS and the associated control systems. WGS will also provide a quantum leap in communications bandwidth for marines, soldiers, sailors and airmen. In fact, the first WGS satellite will provide more throughput than the entire DSCS constellation combined. In addition, WGS will not only support X-band communications, but will also have 10 Ka antennas to support a wider variety of military communications requirements. WGS' digital channelizer will allow on-orbit cross banding between X and Ka-band users.

Both DSCS and WGS are wideband satellite communications systems.

Hartley
What does the inclusion of the Ka antennas mean to the warfighter?

Colonel Uhrich
First, our Global Broadcast Service, which I'm sure we'll talk about later, will us WGS' Ka capability to service to increase it's coverage area, which means more troops out in the field will have access to GBS. Second, Ka frequencies support high data rates to smaller dish antennas. This means our mobile forces will be lighter, yet more connected. This provision means the warfighter, out in the field, will have greater flexibility, more throughput, and will be one step closer to a true, net centric environment.

Hartley
The WGS will be the nexgen system—what about plans for legacy system support?

Colonel Uhrich
Our second, major, legacy system is the **Milstar** satellite communications system. Milstar was designed to provide secure, jam-resistant communications as well as secure strategic communications throughout the entire spectrum of conflict, including a nuclear event.

Milstar is the *Department of Defense*'s (**DoD**) most robust and reliable SATCOM system. Milstar was also designed to perform all communications processing and network routing onboard. This eliminates the need for vulnerable, land-based relay stations, which reduces the chances and the opportunities to intercept communications on the ground.

Milstar Satellite Artist rendition by MCSW, SMC

The Milstar systems include 5 satellites in geosynchronous orbit providing global coverage for tactical, mobile and fixed terminals, a

command and control system, as well a payload management and control segment. The *Advanced Extremely High Frequency* (**AEHF**) system will be the follow-on to the Milstar system, and will augment and improve the capabilities of Milstar. Like WGS, a single AEHF will have more capacity than the entire Milstar constellation.

Hartley
When will AEHF launch?

Colonel Uhrich
The first AEHF satellite is set to launch in November 2008. AEHF will provide connectivity across the spectrum of mission areas, including land, air and naval warfare, special operations, strategic nuclear operations, strategic defense, theater missile defense, and space operations and intelligence. As with Milstar, AEHF will provide global, secure, protected, and jam-resistant communications for high-priority military ground, sea and air assets.

Advanced Extremely High Frequency (EHF) Satellite
Artist rendition picture provided by MCSW, SMC

Advanced EHF will allow the **National Security Council** and **Unified Combatant Commanders** to control their tactical and strategic forces at all levels of conflict through general nuclear war and supports the attainment of information superiority. Interestingly, the physics of the EHF wavelength make the satellite well suited for strategic communications in a nuclear stressed environment. Plus, the tight beam is a favorite of our tactical and special ops units as it enhances their need for low probability of detection and low probability of interception. Both Milstar and AEHF are considered protected satellite communications systems.

MILSATMAGAZINE PRIORITY BRIEFING WITH...

Hartley
Could you discuss the new TSAT program? Won't that system, one day, be the replacement for the aforementioned AEHF system?

Colonel Uhrich
The *Transformational Satellite Communications System* (**TSAT**) is one of our newest programs. TSAT will augment and eventually replace the AEHF satellite communications system and will pro-

vide unprecedented satellite communications with Internet-like capability to extend the *DoD Global Information Grid* (**GIG**) to deployed users worldwide as well as deliver an order of magnitude increase in capacity over AEHF.

TSAT will be our first family of satellites to perform on-board/on-orbit routing of data using *Internet Protocol* (**IP**), initially IP version 6 in the case of TSAT. This on-board routing, performed by the **Next Generation Processor Router**, will allow huge increases in satellite efficiency because static connections will no longer have to be established and maintained, whether they are being actively used or not. Like Milstar and AEHF, TSAT will provide worldwide, secure, survivable satellite communications to U.S. strategic and tactical forces during all levels of conflict, in the EHF band.

Unlike Milstar and AEHF, which have Radio Frequency crosslinks to connect the satellites in a ring, TSAT will have laser communications crosslinks. These crosslinks will be capable of moving 40 gigabytes per second when we complete fielding of the 5-satellite (plus an on-orbit spare) constellation. In addition, TSAT will have large antennas to support our tactical force's need for protected communication-on-the-move, with small diameter vehicle-mounted antennas.

The space segment will also include laser communications and Ka-band RF for air and space intelligence, surveillance, and reconnaissance (ISR) users. As TSAT will be IPv6 and have an on-board router, mission planning and execution will be an order of magnitude more dynamic—and flexible—than it is today. To address this new capability, the program includes a payload and network management segment called **TMOS**—the *TSAT Mission Operations System*. Of note, TSAT will not have common user wideband communications capability, so it is not a follow on to WGS.

The Transformational Satellite Communications System Mission Operations System will provide network management for the TSAT system, providing network-centric interoperability between TSAT and the Department of Defense's Global Information Grid

Hartley
What other important programs find the Military Satellite Communications Systems Wing, Space and Missile Systems Center responsible for implementing?

Colonel Uhrich
The Wing is responsible for a number of other important programs. They include:

The GLOBAL BROADCAST SERVICE (GBS)
GBS operates as a one-way, wideband transmission service capable of supporting timely delivery of information products for mission support and theater information transfer. Through 2 **Satellite Broadcast Manager** facilities, GBS pulls or is pushed data, video (cable news, predator feeds, etc), intelligence products, etc. from a variety of unclassified and classified sources, servers and networks. The GBS operators bring all this content together and build 3 unique broadcasts, tailored for specific information requirements of various Areas of Responsibility, for transmission from 3 different uplink facilities.

The uplinked data is broadcast to fielded receive suites, in much the same manner as satellite television is sent from an uplink facility to a satellite which, in turn, broadcasts the signal to all those dishes you see installed on houses. By broadcasting information, we are able to free up considerable "reachback" communications bandwidth. If GBS can broadcast an intel product to hundreds of users at once, it overcomes the need for each of these users to individually go back to the source, ask for the product and have it sent multiple times to multiple users.

COMMAND AND CONTROL SYSTEM CONSOLIDATED (CCS-C)
CCS-C provides state-of-the-art satellite command and control systems for our Nation's military communications satellites. CCS-C replaces a main-framed-based legacy satellite command and control system with a PC-based system. The legacy command and control system displayed screens and screens of data containing information about the satellite; it's location, temperatures, fuel, orientation, available electricity, and so on. The operator was required to sift all this data into knowledge and understanding about the state of health of the satellite. CCS-C has a highly evolved operator interface that simplifies training, operations, and anomaly resolution. It also improves operator efficiency, accuracy and effectiveness. The new screens don't necessarily show the raw data to operator, but reveal what the data means in terms of gauges, dials, and colors. 50th SW operators "fly" the satellite bus for DSCS, WGS, Milstar and eventually AEHF satellites using CCS-C.

As mentioned earlier, MCSW has responsibility develop, acquire and operationally deploy and sustain MILSATCOM terminals. These terminals can be fixed, mobile or integrated into a weapons system, such as the B-2, B-52, RC-135s and others. The first set of our terminals is the *Family of Advanced Beyond-Line-of-Sight Terminals* (**FAB-T**). The philosophy behind this program is to bring many stove-piped terminal programs under the umbrella of a "family" of terminals. The program aims to establish a common software communications architecture and other commonalities

between the various terminals. This reduces developmental costs, increases standardization, establishes common interfaces between terminals and the satellite, while still allowing each platform or user to establish their own form, fit and function requirements.

Increment 1 of this terminal program includes the *Advanced Wideband Terminal* (**AWT**) and *Command Post Terminal*. AWT variants add Advanced EHF capabilities to a number of our aircraft, some of which I mentioned previously. The command post terminal variants upgrade ground and airborne Milstar Command Post Terminals for use with AEHF satellites. FAB-T will support future upgrades to allow interoperability with Transformational Communications Architecture requirements.

The second set of our terminals is the *Ground Multi-band Terminal* (**GMT**). With GMT, Air Force tactical units will be able to connect to wideband satellites operating in military X and Ka-band and civilian C, Ku, and X-band frequencies.

The final set of our terminals is the *High Data Rate-Radio Frequency Ground Terminal* (**HDR-RF Ground**). HDR-RF ground terminals will deliver an evolutionary upgrade to the GMT by providing the ISR community with High Bandwidth, High Throughput (HBHT) SATCOM capability.

Ground-Multi Band Terminals (GMT) Photo provided by MILSATCOM Systems Wind (MCSW), Space & Missile Center (SMC)

IPS/EPS

Hartley
How do, or will, these systems support the warfighter?

Colonel Uhrich
I'm glad you asked about supporting the warfighter. For SMC and certainly the MILSATCOM Systems Wing, this is the *real* measure of our merit—what space-enabled capabilities are we putting into the hands of the warfighter? It's *not* about getting "stuff". It's *not* about spending a billion dollars to put 10,000 pounds of complex hardware and software in orbit 22,300 miles away. It's *not* about the thrill of launching a satellite you've worked tirelessly on for the last 5 years to design and produce.

It's about understanding the operational requirement for warfighters, completing the detailed developmental, systems engineering and design work so you know you can actually build it, then producing a satellite that will be highly reliable and available. It's about synchronizing that effort with similar work that's being done on the command and control system, terminals and mission planning segment. This means that at the end of the day, you've fielded a capability. You've put a capability, or more likely, an integrated collection of capabilities, into the hands of our warfighters.

If we've done our job, the space-enabled capabilities we provide will greatly increase the odds America's sons and daughters will accomplish the mission and come home safely—the space-enabled space capabilities we provide also increases the odds the bad guys, have many, many *very* bad days.

DSCS Milstar and GBS are providing capability to warfighters right now, 24 hours a day, 7 days a week, 365 days a year, 360 degrees, around the globe.

Hartley
Milstar has a broader role to play?

Colonel Uhrich
Milstar is supporting strategic EHF terminals in command posts throughout the **DoD**, in the Pentagon's **National Military Command Center**, on **U.S Navy** ships and submarines and across our **ICBM** missile fields. In addition, you'll find deployable Milstar terminals with our special forces. Milstar was on the Gulf Coast after Hurricane Katrina with the **4th Infantry Division**, the **1st Cavalry Division**, the **4th Marine Division**, the **USS Harry Truman** and the **USS Iwo Jima**, all deployed to the region to assist with recovery operations. Also, during the noncombatant evacuation operations of Lebanon during July 2006, the **USS Gonzalez** and the **USS Barry**, both destroyers performing escort missions of transports, used Milstar to coordinate the safe relocation of nearly 800 Americans to nearby Cyprus.

Milstar is the communications system of choice for the warfighters' highest priority communications. As mentioned earlier, EHF is considered protected comms. What makes protected communications "protected" is that the system is jam resistant, survivable and scintillation resistant (nuclear resistant). The high gain antennas and narrow beams of both Milstar and AEHF provide an additional type of protection known as low probability of intercept/low probability of detection—very useful for certain missions.

Hartley
Does DSCS have a different mission?

Colonel Uhrich
Yes, DSCS has a different mission and consequently supports a different set of operational requirements. You find DSCS terminals and satellites setting being used for high data rate connections between tactical, forward-based headquarters and their rear or in-garrison headquarters. You see DSCS in use at Teleports locations where DSCS circuits are connected to the terrestrial portion of the Global Information Grid. You'll find DSCS being used by warfighters at Al Udeid AB in Qatar. This fixed, secure communications hub provided critical reach back for forward deployed forces at the outset of Operations ENDURING and IRAQI FREEDOM. This vital DSCS terminal and connectivity

directly supported build-ups for successful fall and winter campaigns and currently supports all CAOC operations in both areas of responsibilities, and is still used today.

GBS is a workhorse. GBS provides worldwide, high capacity, one-way transmission (video, imagery, geospatial intelligence products and other information requiring large amounts of bandwidth) in support of our nation's joint forces and command centers; whether in garrison, transit, or deployed to global combat zones. For CENTCOM alone, GBS currently transmits about 1.9 terabytes on daily basis.

GBS has over 500 Receive Suites fielded to Army, Air Force, Navy, Marines, and other government agencies. Receive Suites are located in virtually every COCOMs AOR and, as one example, aided joint warfighters during **Operations IRAQI & ENDURING FREEDOM** by providing the **Combined Air Operations Center** near-real-time video and imagery feeds for urgent combat operations.

Special Forces customers were especially pleased GBS was able to receive detailed *Unmanned Aerial Vehicle* (**UAV**) video, data and imagery broadcasts that directly aided in capture of senior Al-Qaida operatives. As an example, it takes about 7 seconds for a UAV streaming video to move from the UAV, back to CONUS via SATCOM, then to a Satellite Broadcast Manager facility, built into a broadcast, uplinked to the broadcast satellite and sent down to any number of receive suites—7 seconds and anyone who needs the information can see exactly what that UAV saw, no mater where they are located on the globe. GBS is a force multiplier, a force enhancer and a force enabler. GBS clearly improves situational awareness and flexibility in support of joint operations. GBS also helps get key information to lower echelons, since all they need is a 2 transit-case Receive Suite—they don't need the bulkier SATCOM transmitter, nor due they tie-up addition scarce bandwidth.

Hartley
Could you tell us some more about WGS, AEHF and TSAT?

Colonel Uhrich
With the launch of WGS in October 07, we are well on our way to completing system check out and the ops testing of this first-of-family wideband satellite. WGS is currently slated to support the **PACOM AOR** starting in the spring of '08. WGS will provide an increase in bandwidth, improve the coverage and flexibility of GBS broadcasts as well as providing a new capability to support Ka-band communications.

WGS' unique digital channelizer not only supports on-orbit cross-banding between X band and Ka, but also adds the efficiency of a one-to-many, or many-to-one, fan out capability, reducing the number of point-to-point circuits. Future launches of WGS are scheduled for July and November 2008.

Advanced Extremely High Frequency (EHF) Core Module
Photo credit: Lockheed Martin

With the launch of the first of 3 AEHFs starting in November '08, we will provide significantly more coverage opportunities with the addition of electronically steerable beams. In addition, AEHF can accommodate many more simultaneous users than Milstar is currently able to accommodate. Finally, AEHF mission planning will be much more flexible, allowing users in the field to borrow/trade versus going back to a headquarters for a re-apportionment approval and retasking.

With TSAT, everything changes. While WGS and AEHF are evolutionary gains in capability and capacity, *TSAT is truly transformation*. Certainly, TSAT is more of the same in some respects; TSAT will offer a tenfold increase in capacity over AEHF. However, when you consider IP routing in space, the incredible gains as the result of laser communications, the efficiency delivered through dynamic bandwidth allocation (you get the bandwidth you need, when you need it) and T1 (1.544 Mbs) date rates for protected comm-on-the-move users with small diameter antennas, TSAT will change the way we fight, coordinate, collaborate, maneuver—I could go on and on. TSAT will move more data, more protected data, to more users, while on the move. TSAT will be the space segment of the GIG and not merely connect two terrestrial segments.

Hartley
How are, or, how will, these systems become interoperable with other satellite systems? The investment in legacy systems is enormous and they, obviously, continue to play an extremely critical role...

Colonel Uhrich
Forward and backward compatibly is a key requirement and challenge as we develop and design the MILSATCOM enterprise. WGS needs to be backward compatible with DSCS in order that fielded legacy terminals are able to operate with WGS.

Likewise, AEHF needs to be backward compatible with legacy Milstar terminals. In addition, AEHF needs to be able to crosslink into the legacy Milstar constellation.

AEHF also needs to be forward compatible with TSAT. Our Joint Terminal Engineering Office works with all the services so they understand the interfaces and build terminals to interoperate with the new satellites we're fielding, as well as continue to work with the legacy satellite systems. The MILSATCOM Systems Wing establishes the protocols, interfaces and standards to guide the development of each Service's terminals.

For interoperability between satellite systems and within the greater Defense Global Information Grid, DISA established ground stations called Teleports located at various worldwide locations, for Service-provided ground terminals to access MILSATCOM satellites and to provide gateway capability between them. For example, a Marine in the battle zone with a UHF radio can send his message to request a Navy air strike through a UHF satellite to a Teleport that re-transmits it to a Naval carrier strike group over Wideband SATCOM. Newer MILSATCOM systems, such as TSAT, will be IP-based and will interoperate with the global network grid directly.

Another interoperability goal and challenge involves TMOS. TMOS will perform payload and network management of the TSAT constellation. However, we're designing TSAT to also pick up those responsibilities for AEHF—when we start to operate TSAT, we'll have one payload and network management system for all of our protected communications

We've established processes, such as the MILSATCOM Change Board (MCB), where any change to a system is vetted with representatives from all our programs to understand and analyze any interoperability implications. For instance, if Milstar requires a software upgrade, that change is brought before the board to understand how the change impacts the interoperability requirements of AEHF and consequently, TSAT, as well as the terminal segment. Certainly a complicated process, but one we diligently work to ensure all of our systems work together to support the warfighters' communications requirements.

Hartley
Please explain what systems are currently on orbit, which ones are in development, and the progression of augmenting and/or replacing satellites in the current constellation/s?

Colonel Uhrich
I think I've addressed most of this earlier, but here are a few additional thoughts...

The DSCS satellite constellation is currently on orbit providing DoD wideband communications. The process of augmenting and replacing the DSCS satellite system began with the October 2007 launch of our first *Wideband Global SATCOM* (**WGS**) satellite. The first WGS will be ready for on-orbit operations in about April 2008. The second and third are scheduled to launch next year. The fourth, fifth, and sixth will follow within the next six years.

The five MILSTAR satellites were launched between 1994 and 2003. The first three AEHF satellites will be launched between

The U.S. Air Force's first Wideband Global Satellite Communications (WGS) spacecraft was encapsulated Sept. 24 at Cape Canaverals Air Force Station, Florida

November 2008 and April 2010. AEHF and Milstar will operate as a single, combined system. After the third AEHF launch, there will be eight satellites providing protected, survivable, worldwide communications. As the Milstar satellites reach end of life, we will have TSAT ready to augment and eventually replace the AEHF fleet. TSAT, currently in the **Risk Reduction and System Definition** phase, is the next generation protected communication system.

Hartley
Security and redundancy are also big issue elements for any launch or on-orbit system. How secure are these systems? What form of backup is available should any of these systems be compromised or fail?

Colonel Uhrich
MILSATCOM protected systems (Milstar, AEHF and TSAT) provide protection against enemy efforts to disrupt, intercept or exploit messages moving over their networks—without impeding the ability of legitimate users to get the information they need in a timely fashion. The anti-jam characteristics of the transmissions to and from terminals, software and hardware, are so powerful they can withstand almost any level of interference. Plus, the location of the satellites in geosynchronous orbit will place them far beyond the reach of most anti-satellite weapons. Each of the MILSATCOM systems is engineered for robustness and has redundancy designed in—any one component or element failure will not result in a loss of service to the end user.

Wideband Global System (WGS) Satellite Photo credit: Boeing

WGS is based on **Boeing** commercial-market satellites. That said, WGS added significant security mechanisms and has recently received its information assurance certification. Each satellite and ground element has internal redundancy. This allows the system to continue to provide communications after a discrete failure. If a satellite were to be taken offline, for any reason, we'd have to evaluate the rest of the constellation to see if we can close the gap through repositioning of available satellites or possibly augment military SATCOM with commercial SATCOM capability.

Hartley
Colonel, your work at **SMC** deals with all of the MILSATCOM environments. Would you be kind enough to give us a look at your background, how long you've been in the military, and how you became involved in these projects?

Colonel Uhrich
I've been in the Air Force since November 1985, a little more than 22 years. By background and training, I'm a Communications and Information Officer. I've spent my career in the communications career field in the Pentagon, tactical communications with the **3d Combat Communications Group**, fixed communications as the Commander of the **100th Communications Squadron**, RAF Mildenhall, England, a member of the **Air Combat Command** communications staff, a 3 year tour on the **Joint Staff J6 staff** and finally got my first taste of space as the Commander of the **50th Network Operations Group** at Schriever AFB, Colorado, in 2004. In this job, I had responsibility for operations and maintenance of the global **Air Force Satellite Control Network**, as well as base communications for the Schriever AFB.

Following that assignment, I came out to the *Space and Missile Systems Center* (**SMC**), Los Angeles AFB, California. This job was a good fit, but a stretch job for me. While at Schriever, the only Air Force base to fly and operate MILSATCOM satellites, I gained a different perspective of MILSATCOM. Throughout my career, I was a user of MILSATCOM. I've spent 6 months in Honduras, deployed to Saudi Arabia in the early 90's, and led communications units supporting air ops in numerous exercises.

At Schriever, I gained insight into the operation and employment side of MILSATCOM satellites and systems, and how MILSATCOM, integrated with other space-enabled warfighting capabilities, provide a huge asymmetric advantage to our fielded forces. While I don't have a space acquisition background, nor a career of experience in space operations, I'm able to bring into play the

user perspective, the operational perspective to the acquisition side of the house.

Lt. General *Hamel*, the Commander of the *Space and Missile Systems Center* (**SMC**) took a chance by bringing someone to Los Angeles without the "typical" experience and background found in most other system wing leaders. It's been a tremendously rewarding and challenging experience and one I am most thankful to have. This is exciting, rewarding and meaningful work. It's easy to get up each morning and make my way to work knowing the things we're doing here, across the Center, will make a difference on the battlefield, each and every day, for our warfighters around the globe fighting and winning our nations wars.

Hartley
Colonel, What do you see as the most important issues that need to be addressed for the MILSATCOM environment in 2008?

Colonel Uhrich
Operationalizing WGS will be a significant milestone for MILSATCOM in 2008. The Air Force is introducing the next generation MILSATCOM capability to our users, worldwide. WGS was launched on October 10, 2007 and, once initialized, will provide more wideband communications capacity than the entire legacy constellation. WGS incorporates an additional on-orbit Global Broadcast Service node. This first military Ka payload will dramatically increase the military's ability to disseminate ISR and help get critical intelligence information into the hands of analysts and military decision makers across the global.

Advanced Extremely High Frequency (EHF) U Frame
Photo credit: Lockheed Martin

A second important issue will be the successful launch of our first AEHF. We're on a path to complete development, test, and launch of the first Advanced EHF satellite in November 2008. Once initialized, this (first of three) satellite will dramatically increase the capacity and leverage of survivable protected global communications. It will represent an important first step toward replacing the aging Milstar fleet and provides additional capability for the country's most vital communication links (Presidential comms, NMCC, nuclear C2, etc). In addition, AEHF will increase the user base of such comm links, providing increased availability of protected communications to tactical users (military customers in theater).

Third, we will continue technology risk reduction activities on TSAT in order to optimally prepare the government and industry team to begin preliminary design on the program's satellite (space) segment. Getting the TSAT space segment on contract and moving forward to the design and build phase is a key issue for us in 2008.

Forth, we must continue to expand and mature our partnerships with allied nations. This will ensure future coalition operations will have compatible equipment and communications systems to enhance synergy in our joint operations. Recently, the U.S. signed an agreement with Australia. The Australians will purchase a 6th WGS and join the U.S. as a partner in sustaining and using this new capability.

We will continue to grow our relationships with **Canada**, the **United Kingdom**, and **The Netherlands** in developing AEHF. Finally, we hope to continue actively working with the above nations and other allied countries to expand our partnerships in future MILSATCOM endeavors.

Also of importance in the MILSATCOM arena is working through the DoD's normal requirements and budgeting processes to ensure that our strategy for employing future MILSATCOM systems (space and ground) remains synchronized with the expanding needs of our user community. As you can imagine, each of the Services MILSATCOM terminal offices have their own budgetary and schedule pressures. Keeping those specific terminal programs in sync with the space segment, so that capability is put on orbit in sync with terminal fielding, remains a focus area and a continuous challenge.

Hartley
Two areas that are not quite as intriguing or exciting as the project itself include milestone determination and project budgeting for each element. How do you manage this critical exercise, especially when private companies may be involved in component delivery, and oversight committees are constantly looking over your shoulder?

Colonel Uhrich
You're right, budgeting, contractor management and oversight and telling our story to the Air Force, OSD and lawmakers is challenging. However, acquisition processes are relatively mature, understood and for the most part, put into place for good reasons. We're spending billions of taxpayer dollars each year on MILSATCOM, so it's really not surprising there is close oversight. In addition, when you look at the history of space acquisition, we have not always lived up to our end of the deal.

The heart of the challenge and the key to success is understanding, at the most fundamental level, what cost and schedule resources are needed to meet warfighter requirements. To improve our track record in this area, we've reexamined the way in which we go about the business of space acquisition. We're more integrated with our contractors so we can identify cost, schedule and performance problems early, while there's adequate time to recover. We've redoubled our efforts to conduct rigorous systems engineering early in the process so we've got an executable program and a system we can build and deliver on time and cost. We've adopted a block approach so the first couple satellites have a basic capability that we can build upon as we gain experience with new technologies and capabilities. Similar to laying down a few bunts to get some runners on base instead of trying to hit a home run the first time you step up to the plate when facing a new pitcher.

Advanced Extremely High Frequency (EHF) SV2
Photo credit: Northrop Grumman Company

The second thing we've done is to fine-tune our oversight processes. These include more frequent and detailed management reviews at the program, Wing and Program Executive Officer (PEO) level. Likewise, DoD has increased their scrutiny and oversight of our activities. If we're doing the job correctly, we're happy to operate in a transparent fashion and tell our story to everyone who has a stake in our success.

On the budget side, our system acquisition plans and costs are not developed in a vacuum. MCSW works closely with the **GAO**, **PA&E** and the *OSD Cost Analysis Improvement Group* (**CAIG**) to rigorously develop consistent assumptions, apply lessons learned, and use appropriate estimating techniques for schedule and cost to formulated program plans. The CAIG also develops a *Program Independent Cost Estimate* (**ICE**) for each milestone decision. As per *National Security Space 03-01* policy, the top-level policy governing space systems acquisition, these cost and schedule plans are reviewed for sufficiency by an *Independent Program Assessment* (**IPA**) team that reports to the *Milestone Decision Authority* (MDA) before each program milestone decision point.

Hartley
Colonel Uhrich, it's been a pleasure talking with you regarding your work with MCSW. We wish you and those who protect our freedoms through satellite technologies much continued success and thank you and your staff members for all of your sacrifices.

Colonel **David C. Uhrich** is the Vice Commander, **Military Satellite Communications Systems Wing**, **Space and Missile Systems Center**, Los Angeles Air Force Base, California, and has served in that capacity since September of 2006. He directs acquisition planning, programming, budgeting and operational support for a $46-billion portfolio for military satellite communications systems including the Milstar constellation, the Defense Satellite Communications System, the Wideband Global Satellites Program, the Advanced Extremely High Frequency Program, the Transformational Satellite Communications System Program, the Global Broadcast System Program, the Command and Control System-Consolidated Program, associated Air Force communication terminals and mission control systems.

Colonel Uhrich received his commission as a Distinguished Military Graduate from Auburn University's Air Force Reserve Officer Training Corps program in 1985. His career highlights include squadron command, operations group command, a variety of tactical and fixed communications positions, the Air Combat Command staff and the Joint Staff.

MAJOR AWARDS AND DECORATIONS
Legion of Merit
Defense Meritorious Service Medal
Meritorious Service Medal with three oak leaf clusters
Joint Service Achievement Medal with two oak leaf clusters
Combat Readiness Medal
National Defense Service Medal with one device
Southwest Asia Service Medal with one device
Global War on Terrorism Service Medal
Humanitarian Service Medal
Air and Space Campaign Medal
Kuwait Liberation Medal

MILSATCOM SYSTEMS WING

by Hartley Lesser, Editorial Director, SatNews Publishers

Your executive team has just informed you of your department's mission...

... acquire and develop military space systems. These systems include GPS, military satellite communications, defense meteorological satellites, space launch and range systems, satellite control network, space based infrared systems, intercontinental ballistic missile systems and space situational awareness capabilities ...

After you pick yourself up from the floor, remove the paper bag from enveloping your nose and mouth to steady your breathing, and as you slow your heart rate down, you quickly sit down before you fall over once again...

"Don't worry," you're told. "You'll have more than US$60 billion in contracts to work on with an annual operating budget of US$10 billion and, heck, you're going to be able to direct more than 6,800 employees!"

A tall order? You think?

How about one massive effort? It certainly is, and one that ensures the safety of your country, your warfighters, and your allies. This is the mission of the Space and Missile Systems Center... nothing less. One element... just one element within this organization is the U.S. Air Force's Military Satellite Communications Systems Wing, otherwise known as MCSW. To have National Objectives as your goal, where the order is to sustain space-enabled, global communications capabilities requires a force of approximately 162 military, 88 civilians, 340 Federally Funded Research Corporation contractors, and 132 Systems Engineering Technical Assistance contractors, is Herculean, and MCSW is definitely able to handle the challenge.

MCSW was established in August of 2006 and is located at the Los Angeles Air Force Base (LA AFB) in El Segundo, California. They also have an operations located in Alexandria, Virginia and Colorado Springs, Colorado. All terminal programs are executed by the Electronic Systems Center at Hanscom AFB , Massachu-

FOCUS ON

setts and the Space Logistics Group in Colorado Springs, Colorado maintains the MILSATCOM terminals.

Within MCSW, there are five Groups, and one squadron and four Wing staff agencies. At MCSW, these folks deliver three primary Satellite Communications (SATCOM) product lines. These include the Protected Communications Group, the Wideband Communication Group and the Transformational Satellite Communications System (TSAT).

PROTECTED COMMUNICATIONS GROUP

AEHF sateliite

The Protected Communications Group provides the Department of Defense (DoD) global, secure, protected, jam-resistant communications for high priority military ground, sea and air assets as well as operations and sustainment support to on-orbit Milstar constellation. They develop and acquire the AEHF (Advanced Extremely High Frequency) and EPS (Enhanced Polar System) programs and users can communicate critical information, without fear of jamming or adverse weather affecting their "discussions".

Budgets? Well, we're looking at US$6.7B to execute the AEHF program and US$1.2B to execute the EPS program. Mix in the equipment and/or terminals required for the DoD protected communication systems in the currently operational Milstar Command Post Terminal (CPT) and the US$3.2B to execute the Family of Advanced Beyond-Line-of-Sight terminals (FAB-T) development programs.

Think it's easy to simply determine the correct course of action for a single element within the Protected Communications Group? Think again... take terminals, for example. Terminals come in various forms—but, which one to use, which one to replace, which one to update is no quick decision. Fortunately, AEHF can talk to MILSTAR via crosslinks and communicate with legacy MILSTAR terminals. The AEHF ground system commands both constellations, meaning users can leverage the AEHF spacecraft's new waveforms and the legacy waveforms of the Milstar program.

Milstar satellite

Milstar is a family of satellites providing low data rate (LDR) capabilities, originally intended as a strategic system. Milstar Block 1 ensured secure voice comm, Block 2 found warfighters able to send large data files via satellite for the first time. And the need to send more data, even more quickly and securely, is the reason for AEHF satellites. Milstar has proven its efficacy time and time again.

WIDEBAND COMMUNICATION GROUP

One of their most recent successes was the launch of the first Wideband Global SATCOM (WGS) satellite into space. This occurred last October 10th aboard a United Launch Alliance Atlas V booster and the satellite is one of many that will eventually replace the Defense Satellite Communications System (DSCS), the SATCOM backbone for the last 20 years or so. This group is responsible for providing worldwide, high-volume, voice and data comms to warfighters. The Group works with a US$1.9B budget for the WGS system.

WGS Launch

TRANSFORMATIONAL SATELLITE COMMUNICATIONS SYSTEMS

TSAT is the DoD's future MILSATCOM system. Designed to provide new services and support new mission areas, TSAT is an evolution of the protected and wideband Military Satellite Communications (MILSATCOM) Systems. It will provide a significant increase in protected communications over current systems, i.e., AEHF and Milstar, and will allow services to transition off commercial and other systems, which are vulnerable to jamming or interception. TSAT will support Air and Space Intelligence, Surveillance and Reconnaissance (AISR / SISR) assets; serving as a relay and providing increased situational awareness and targeting information to the warfighter. It will provide a "comm-on-the-move" capability to small mobile terminals—such as HUMVEEs operating in Iraq—with small antennas about the size of satellite TV dish. New technologies such as advanced laser communications, RF waveforms and Internet-like packet switching, as well as its greatly expanded capability and connectivity are what make this system transformational. TSAT's use of this technology and Internet Protocols will allow the warfighter to use bandwidth on a dynamic, as-needed basis.

TSAT satellite

Another benefit of TSAT can best be defined using this illustration... a simple photo using today's Milstar takes about two minutes for the transfer... the same operation using an AEHF satellite would take about 23 seconds...the same operation using a TSAT satellite would require less than one second! Furthermore, this would be done without fear of jamming by enemy forces. TSAT will be a constellation of five satellites with a worldwide capacity of 36.0 Gbps for ground, air and space users and is estimated to cost US$24.0B.

MILSATCOM C2 SQUADRON

This squadron manages the Command and Control System-Consolidated (CCS-C), the versatile ground system responsible for operating all MILSATCOM satellites. Already supporting the on-orbit Milstar, DSCS, and WGS constellations, CCS-C will ultimately be in charge of more than 26 military communications satellites across five families: DSCS, Milstar, WGS, AEHF, and TSAT. Though it is the smallest acquisition unit within the Wing, the squadron's responsibilities literally stretch across every other

program in MCSW. Based largely on commercial-off-the-shelf hardware and software, CCS-C delivers maximum bang for the buck and has become known as "the backbone of MILSATCOM."

MILSATCOM TERMINALS & GLOBAL BROADCAST SERVICES

The Ground Multi-band Terminal (GMT), the High Data Rate—Radio Frequency (HDR-RF) ground terminal (an upgrade to the GMT), and the FAB-T Increment 2 terminals all support the WGS satellites and its wideband capabilities. The GMT is a tactical SATCOM ground terminal supporting X, C, Ku and military Ka-band ops. These terminals use the DSCS, WGS and other, commercial comsats. They provide a dual hub capability and can handle increasing bandwidth needs for deployed U.S. Air Force units. GMTs are compatible with tactical satellite communications (SATCOM) terminals and can withstand repeated tactical deployments throughout the world.

The HDR-RF is an upgrade to the GMT and provides a high data rate SATCOM that's needed to support the Intelligence, Surveillance, and Reconnaissance (ISR) community with High Bandwidth High Throughput (HBHT) capabilities. These terminals are interoperable with FAB-T Inc 2 and support a full array of operations, from disaster relief to full scale theater war.

FAB-T is an acquisition program that provides Beyond-Line-Of-Sight (BLOS) SATCOM terminals possessing open architecture. They are able to deliver multi-mission capable, ground-based and aircraft qualified SATCOM terminals.

The Global Broadcast Service (GBS) is another program under MCSW. Operating with a budget of US$600M, GBS operates as a one-way, wideband transmission service capable of supporting timely delivery of classified and unclassified data and information products for mission support and theater information transfer.

Los Angeles Air Force Base is where MCSW is headquartered, the only active duty base in the Los Angeles area. This is also the home of the **61st Air Base Wing** and **SMC**, of which MCSW is part. SMC is a subordinate unit of the **Air Force Space Command**, located at **Peterson Air Force Base** in Colorado. We should all appreciate the freedoms we enjoy, in part due to the thoroughness, hard work and technologies brought to bear upon the world stage by MCSW and by SMC.

COVER STORY

SATELLITE COMMUNICATIONS FOR HOSTILE ENVIRONMENTS

by Dr. Axel Jahn, Managing Director, TriaGnoSys

Communication is central to managing situations in any hostile environment, be such in the military sphere, in response to an emergency, or when dealing with a major disaster. Must-haves for communication solutions in hostile environments are reliability, robustness, security, portability and ease of operation.

Communications for these situations have been based on radio, satellite, and civilian infrastructures where they exist. New satellite communications technology, particularly picocell backhauling, provides exciting new opportunities that either augment or replace traditional solutions.

Improvements in the backhauling of picocells mean that GSM and UMTS (2G and 3G) networks can now be established literally anywhere, and the hardware allows for the fast and efficient establishment of ad hoc sophisticated telecommunications infrastructures. These networks operate in exactly the same way as a standard mobile phone network, with the crucial difference that they are not dependent on any wired connections: the picocell, which acts as the mobile phone mast, communicates with the network operator via satellite.

TECHNOLOGY INNOVATION

Satellite communication in itself is not new or particularly innovative and has been expensive when compared to terrestrial wireless, radio or fixed-line technologies. As a result, satellite-based usage has been, by and large, limited to critical communications in remote, inaccessible areas. Frequently, this has been as a result of a disaster or when secure transmission is a high priority. Until now, it certainly has not been seen as a mainstream contender for network access.

It has been possible for some time to establish a GSM network using satellite technology, but it has been relatively crude and the disadvantages have been significant. They have also been expensive to buy and operate, as well as being quite bulky. The solutions avail-

able are not suitable for military, or emergency and disaster response uses – they have been used more for static applications, such as providing GSM access in remote ski resorts.

But the future for satellite-based network provision is about to change – all thanks to the picocell. Picocells have traditionally been used to extend coverage to indoor areas where physical restrictions mean poor signal reception, or to add network capacity in areas with very dense phone usage, such as train stations. However, they can now be backhauled via satellite to provide coverage anywhere. The network has a radius if 700 metres and anyone within that area using a GSM or UMTS compatible electronic device can use it in exactly the same way as if they were in the middle of a city.

System eefficiency is the key enabler to the technology behind the new GSM, GPRS, EDGE and UMTS networks based on satellite transport. Much of the pioneering development work that has gone into enabling picocell backhauling has been based around optimisation, including compression of payload, IP Header and signalling.

The reason why compression of headers is so important is because they add a total overhead of 40 Bytes to each voice packet, regardless of the size of the packet. This means that a voice packet of 12 Bytes, used by GSM and UMTS picocells, is increased by more than four times by the headers.

Robust Header Compression is used in combination with the technique of bundling several voice packets into a single IP datagram. This means that very significant compression can be achieved, with overheads being reduced to only 5 Bytes.

The real benefit is when the optimisation technology is combined with miniaturisation of the hardware, to the extent that it can be carried by one person. It requires a power source, which can either be a battery pack or a generator – the equipment only needs a 100W power supply, so a small petrol generator is all that is needed.

Finally, a GSM or UMTS network established using a backhauled satellite can be managed by a virtual operator anywhere in the world, meaning that there is no need for a communications expert on the ground. The network is not bound to any local operator, so it not subject to any locally imposed restrictions, and it can use any satellite system.

The advances in technology have meant that the establishment of GSM/UMTS networks in hostile environments is now a cost-effective reality.

COVER STORY

APPLICATIONS

The focus here is on the use of picocell backhauling to provide GSM and UMTS networks in hostile environments.

Military

The use of a backhauled picocell technology is never going to replace standard radio technology for military use. Radio meets the essential requirements of military communications and does so securely, reliably and cost-effectively. However, the ability to establish ad hoc 2 or 3G networks using satellite backhauling technology anywhere at any time supplements the options currently available.

The three main functions of military communications are:

1. Providing secure and reliable communications

2. Signals intelligence: intercepting and monitoring enemy communications such as mobile phone calls, satellite phone calls and radio transmissions

3. Electronic intelligence: analysing and tracking the location of communications signals

The fact that a communications network can be set up anywhere at any time is a clear benefit of using a backhauled picocell. In particular, the 700m radius of the network makes the use of a picocell suitable for remote headquarters. In-built NATO-approved encryption can be used to ensure privacy and security in all voice and data communications, which extends to guaranteeing privacy over the satellite link. In addition, the picocell can be set to accept connections only from registered devices, therefore rejecting connections from unknown ones. A further advantage is the point-to-point calls within the network, which are not routed via the satellite, are free, making on-site communications simple.

The portability of the equipment also makes it ideal for signals intelligence. It can be used to jam transmissions, as well as monitor GSM and GPRS content as well as to redirect calls and emails. Therefore, it has significant potential for intelligence gathering and the disruption of any enemies' communications.

Finally, a network based on a single picocell can handle up to 14 simultaneous calls. This means it can be used for both operational and personal communications. While personal communications are good for morale purposes, operational communications must have priority. To that end, the network can be set up to ensure the most important communications always have priority for the use of the network. In addition, the technology is scalable: further picocells can be added, thereby increasing the number of simultaneous calls by 14 for each picocell added.

Figure 1: Backhauled picocell in military use

Emergency response

As is true with military operations, effective and efficient communications are essential when dealing with large-scale emergencies. These emergencies may be man-made or natural, such as terrorist activity, flooding or widespread fires.

Emergency services use dedicated emergency networks where they exist. However, they often rely on public land-based and mobile networks for communications. All terrestrial networks are subject to failure should power supplies malfunction. If that happens, either at headquarters or a forward operating base, communications can be lost. While contingency planning will cover this scenario, a back-up communications system that is totally independent from any other communications source and that can be established quickly ensures communications need never be lost.

Backhauled picocell networks offer two unique benefits as a back-up solution. The first is the equipment required is simple to hold in readiness at any headquarters; it is also sufficiently small enough to be included in the back-up equipment of a forward unit, such as a fire appliance or indeed a reconnaissance or supply aircraft.

The second strength is that it operates independently of the terrestrial networks—a small generator can supply power. That means that communications will always be available, even if all other networks are not working.

Figure 2: The control center

Disaster Recovery

When disaster strikes, co-ordinating a response is often hampered by a lack of information and the inability to communicate to emergency services, government and aid organizations. For example, when in 2005 an earthquake hit Kashmir, the international community responded very quickly. However, much of the effort was misdirected, as there was little information about what was needed, or where it was needed. It was also difficult to communicate what little information was available to the relevant people. That meant some villages were visited by emergency services several times a day, while others received no help at all.

Natural disasters frequently occur in areas that have little or no existing communications infrastructures. Where those infrastructures do exist, there is a strong possibility they will have been knocked-out by the disaster. The ability to set-up and operate a GSM or UMTS network can have a huge impact on the efficacy of the response, both in the first hours of the disaster, and also as the scale of the response grows.

The fact that the relevant equipment can be carried to the right place by one person means that the use of a backhauled picocell network is the ideal solution in the early stages of a disaster, both to report on the situation and to co-ordinate the initial response. In the first few hours of a disaster response, the opportunity to set up a robust communications network is critical to direct aid to the most badly effected areas and thereby save more lives. The network can also play a significant role in the later stages, for example, in a field hospital or a charity's headquarters.

Hostile environments require a communications technology that is wholly reliable, portable and independent from any other form of communications. Picocell backhauling technology is unique in being able to offer a complete solution.

Dr. Axel Jahn is Managing Director of TriaGnoSys, a leading provider of mobility satellite communications solutions for remote mobile air, sea and land communications from anywhere to anywhere via satellite. Before founding TriaGnoSys, Axel worked at DLR, the German Space Agency. He has been at the forefront of the development of picocell-based satellite backhauling. TriaGnoSys solutions are used for a range of commercial applications, including the provision of GSM/GPRS services on commercial aircraft, cruise ships, container tracking and for military and emergency use.

TRIAGNOSYS

TriaGnoSys is also involved in a wide range of research projects, focusing on a broad range of mobile satellite communication areas in conjunction with leading academic, government and industry researchers to advance the state of the art in such areas as mobile end-to-end solutions, next generation satcom and aircom, and combined navigation/communications applications and technologies.

FEATURES

SATELLITE NETWORK ACCELERATION

Not An Option—Essential!

by Nick Yurin

Acceleration and WAN Optimization; A Forecast for 2008

Once viewed as an ad hoc addition to the occasional Department of Defense (DoD) satellite network, acceleration technologies are no longer considered optional. They are an essential component in modern military satellite architecture. Today's satellite programs RFPs specify acceleration in absolute terms, with interoperability and standards compliance at the forefront of program requirements. Trends in the DoD acceleration industry have made these technologies more sophisticated and much more pervasive in military satellite networking. In 2008, expect many of these trends to continue unchanged, while other trends will take the technologies in this market in an entirely new direction.

The Space Communication Protocol Standards (SCPS)

Leading the way among acceleration technologies in 2007 were the Space Communication Protocol Standards (SCPS), an open-source acceleration technology, which in 2007, became an official mandate in the DoD IT Standards Registry. Adhering to the mandate, the DISA Standardized Tactical Entry Point (STEP) program upgraded their entire acceleration suite to high-powered SCPS platforms at the end of FY 2007. This compelled the thousands of military consumers of STEP bandwidth to likewise use SCPS for their acceleration. These two events as well as the wide scale adoption of SCPS by several key military programs and numerous hardware vendors accounts for the pervasiveness of this standard and its continued use in FY 2008 and beyond.

Accompanying SCPS in the military satellite acceleration market are the feature sets generally termed *WAN optimization* technologies. Although they are currently represented by no official DoD standards, WAN optimization features are attracting a great deal of attention among DoD satellite network architects. They are finding their way into an increasing number of military programs.

Where SCPS once served as the singular acceleration technology in the DoD network, expect to see more networks deployed with technologies such as data caching, compression and application-specific acceleration running alongside SCPS. Web caching, in particular, has shown great promise in bandwidth optimization, especially in networks where web-based applications comprise a large portion of the remote-side network traffic. Unlike some other WAN optimization technologies, web caching is localized and typically not dependent on a peer, and, as such, poses little threat to cross-program interoperability.

Other popular WAN optimization technologies, including compression and some application acceleration features, are often proprietary and require a peer with identical capabilities on the opposite end of the connection in order to optimize the data flow—if they are able to establish the connection at all. This lack of cross-vendor interoperability will limit these types of deployments in the near term and will be discouraged by many elements of DoD. Nonetheless, these technologies provide far too many performance benefits to be neglected completely.

Expect to see network architects cautiously continue to deploy proprietary WAN optimization technologies in their tactical networks. There will be increasing scrutiny from DoD standards bodies and configuration control authorities. Particular attention will be paid to those technologies that jeopardize interconnectivity between programs and lock program managers into single-vendor solutions for their WAN optimization requirements.

The impact DoD oversight will have on the WAN optimization vendor community remains to be seen. However, expect to see a degree of push from within DoD for greater interoperability among the vendors' various proprietary technologies. Despite the natural unwillingness among competitors in this market to cooperate technologically, there are advocates within DoD who would like to see a greater degree of interoperability. They are advocating it in areas such as compression and error-recovery. Although unlikely

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to occur on a broad scale soon, DoD consumers will continue to ask for greater cross-vendor interoperability. They may even look toward establishing military standards that will compel interoperability on the vendor community.

Size, Weight and Power

As tactical satellite programs continue to migrate away from the traditional transit case solutions toward the lighter and more mobile comms package, so, too, are networking hardware vendors reducing the size, weight, and power consumption (SWaP) of their products. In recent years, it was not unusual to see SCPS and other acceleration technologies deployed in a 1u, rackmounted chassis, conveyed in a tactical transit case. But this form factor, along with its weight, power requirements and thermal signature, is not well suited for the contemporary mobile comms environment.

PEP-on-Stick ™ by Global Protocols illustrates the trend toward lightweight, low-power accelerators

As SCPS can be deployed as a software-only solution, program managers are looking to reduce the size of the tactical performance enhancing proxy (PEP) as well as attempting to imbed SCPS software at points in the network that would render a standalone PEP unnecessary. Programs with a mobile or man-packed element, such as Warfighter Information Network-Tactical (Win-T) and Common Army/Marine Command and Control (CAMC2), are particularly sensitive to the need to reduce SWaP. They are architecting acceleration solutions that focus on form factor reduction or software-only deployments of both SCPS and accompanying WAN technologies. As more comms-on-the-move programs come online in DoD, the trend away from the big box solution toward the more lightweight, mobile and software-only solutions will continue. In 2008, expect to see more imbedded solutions in products such as modems and routers, and less standalone acceleration platforms.

Trends in acceleration are influenced greatly by trends in modem technologies, performance requirements, and network architectures. Military trends in bandwidth-on-demand systems and highly mobile terminals are directing the PEP vendor market toward lighter weight platforms and more sophisticated implementations of their technologies. Primarily used with VSAT systems in the past, as more Inmarsat BGAN systems are deployed in military networks, and as more DVB-RCS-based programs come online in DoD, SCPS and other acceleration methods will be paired with these newer technologies in increasingly complex and creative ways.

Acceleration has been firmly established as a standard component of the military satcom architecture. As DoD customers become savvier with their acceleration solution options, expect them to generate requirements that substantially change the face of today's acceleration technologies. 2008 will likely see a new breed of DoD acceleration technologies in form factors that were previously unavailable, with feature sets that reflect the changing needs of the military satcom user.

The SCPS Reference Implementation (RI) was the original blueprint code for what is today the SCPS standard. The RI is maintained and distributed by the Mitre Corporation through funding provided by NASA/JPL. Anyone seeking to build their own SCPS implementation, integrate SCPS onto a network hardware platform, or simply evaluate the protocols, is encouraged to first review this open-source distribution. This is provided as C source code and is intended to be compiled on a FreeBSD platform. You must build your own binaries for the gateway code. Less than 1MB in size, the RI can usually be sent to a requester as an email attachment and the file contains the readme files to assist in the build and configuration settings. Global Protocols does not directly support this code. However, the Global Protocols' staff is very familiar with the code and its performance. The company offers consulting services to clients seeking support and consulting while working with SCPS-RI.

To obtain a copy of the SCPS-RI, M visit this link: http://www.openchannelsoftware.com/projects/SCPS.

Global Protocols™
Protocol Solutions for Extreme Networking™

Nick Yuran is the Director of Sales and Marketing for Global Protocols, Inc. As a founding member of the company, Nick has worked to promote SCPS and other standards through DoD. His focus is on interoperability in tactical systems. Prior to joining Global Protocols, Nick served as a telecommunication analyst for various U.S. intelligence agencies. He possesses a BA in Slavic Languages from the University of Arizona as well as a MS in Telecommunication from George Washington University.

COMMS ON THE MOVE—QUIT STALLING AROUND!

by Karl Fuchs
Director of Federal Systems Engineering
iDirect Government Technologies

Overcoming key technology barriers that halt military Communications on the Move (COTM)

Military personnel cannot afford to lose connectivity at any moment. Whether cruising on the seas, flying through the air or traveling across the battlefield, high speed, reliable, always-on connectivity is imperative to their success. Increasingly, the military is turning to satellite communications for these critical needs.

Providing this high level of service poses some key technical challenges to satellite providers.

- Technology must work effectively over ultra-small antennas that can be mounted on mobile vehicles of all sizes
- The units must belong to a global satellite network, allowing vehicles to automatically connect from anywhere and enabling network operators to easily track assets.
- Satellite network platforms *must* meet the military's stringent security needs

New developments in satellite technology address these challenges. On the ground, advances in spread spectrum technology have enabled efficient transmission through very small antennas. At the same time, enhanced global network management systems allow mobile units to seamlessly connect from anywhere using a dedicated IP address. Advances in security have enabled the cloaking of individual communications and network activity of mobile units.

Improving connectivity transmitted through small antennas

Providing heightened connectivity through small mobile antennas is a challenge. One of the fundamental characteristics of an antenna is its ability to focus a beam to reach the satellite. Generally, larger antennas produce tighter beams that can focus on the satellite more directly. Conversely, sub-one meter antennas—

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iDirect recently outfitted a Ford Excursion to demo improved COTM capabilities. The truck's passengers have access to broadband connectivity while traveling at high speeds.

such as those needed for COTM—often spread radio frequency energy over a wide area. In addition, small antennas have low gain characteristics. As a result, higher power is required to ensure the receiving terminal hears the remote over the background noise created when the satellite boosts the signal. Furthermore, as satellite spectrum is limited, the high rate signals coming from small antennas often cause interference with adjacent satellites that may be using the same frequency and polarization.

The challenge for network engineers then becomes to provide broadband connectivity to moving platforms without causing, or being impacted by, adjacent satellite interference. This problem is solved only by spread spectrum technology.

Spread spectrum is a feature hosted on the satellite router that diffuses powerful, high rate signals by "spreading out" the transmissions in such a manner as to minimize the interference to adjacent satellites, but does not limit connectivity to the desired satellite. This feature allows the satellite engineer to overcome virtually any adjacent satellite interference.

Building on this technology, iDirect has developed Direct Sequence Spread Spectrum over TDMA. In Direct Sequence Spread Spectrum, a pseudo noise code is injected into the data stream at a given "chip" rate. The resultant data stream is modulated at a lower spectral density. Using TDMA ensures only one remote in the network ever transmits at a time.

With only one remote transmitting at a time, the total spread factor for a given network can be much lower than is found in CDMA based spread spectrum systems. This innovation enables military organizations to spread signals at a much lower rate than CDMA or CRMA solutions. It also provides more efficient use of ultra small antennas on aircraft, maritime and land-based vehicles.

Equipped with these technologies, mobile units are now being provided with always-on, broadband connectivity of up to T-1 (1.544 megabytes), capable of transmitting videoconferencing to vehicles traveling at high speeds.

Creating seamless global networks

Enabled by spread spectrum technology, COTM is changing the way the military approaches the design and management of mobile networks. In general, IP networks have been designed with the understanding that routers, switches and other core network devices will remain at a fixed location—even if host devices are allowed to enter and leave the network. All of those assumptions change with COTM.

The use of COTM by aircraft and marine vessels, as well as with the increased global mobility of ground units, has resulted in IP routers being transported around the globe and across multiple satellite footprints. This new mobility challenges military network management systems to support global satellite networks in which COTM remotes can be tracked and supported from anywhere in the world.

New satellite networks are being designed from a system-wide perspective. These networks are capable of managing an array of issues. Most importantly, they allow remotes to retain their IP addresses, and such allows network operators to track and manage vehicles across the world. These networks also permit mobile units to automatically reconfigure with different satellite beams across different satellite footprints.

As you can well imagine, switching beams automatically requires sophisticated technology. The remote must be able to determine when, and to which beam, to switch. The new signal must then

automatically integrate with the COTM antenna to minimize any loss of connectivity. To determine the appropriate point at which to switch beams, global networks must use precise maps on the position of satellites as well as GPS information gathered from the remote itself. When these remotes switch beams, the system automatically accounts for different QoS profiles as well as for changing data rates.

With the new global satellite networks, military personnel conducting training with a vehicle at Fort Hood, Texas, can load that vehicle onto a ship or aircraft, travel to the Middle East—automatically switching from one satellite beam to another at the correct moment—and hit the ground with the same IP address and the ability to log into the servers at Fort Hood as if they were actually on the ground in Texas.

COTM and network security

As networks become more dynamic and mobile, they are increasingly vulnerable to intrusion from foreign remotes. With military personnel using COTM to relay critical information behind enemy lines, the need for stringent security is obvious. Standards such as FIPS 140-2 encryption and X.509 digital certificates protect inbound and outbound transmissions and ensure that adversaries cannot acquire illicit connections to secure networks.

Going beyond these standards, iDirect Technologies has developed Transmission Security (TRANSEC) for TDMA-based COTM systems. TRANSEC features the ability to give the appearance that the network is in full use at all times. This cloaks communications by prohibiting the enemy from tracking bursts in activity.

COTM pulls ahead

The need for communications on the move in the military is as old as warfare itself. Ancient armies used flags to communicate across the battlefield. During World War II, commanders shouted orders over bulky, hand held walkie-talkies.

Today, COTM is redefining communication on the battlefield. Commanders are able to make decisions using data from multiple locations, such as spy satellites and unmanned vehicles beyond the line of sight. Troops are employing COTM capabilities in conjunction with Wi-Fi or WiMAX, creating mini mobile wireless networks serving allied vehicles within a 500 yard radius.

These and other advances are indications that COTM has become an integral part of military operations, extending net-centric warfare into its final frontier: the battlefield.

Karl Fuchs is the Director of Federal Systems Engineering for iDirect Government Technologies. He can be reached at kfuchs@idirect.net.

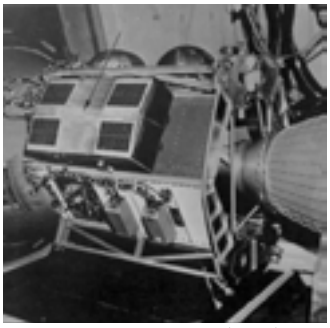
FEATURES

MILITARY SATELLITES AND ROCKETS—NO MORE FAILURES!

by Dr. Len Losik, President, Failure Analysis

Science fiction may now have become science fact. A new technology for halting launch vehicle failures and on-orbit satellite failures is available. Prognostic is a term used when describing proactive diagnostics or failure prediction technology for satellites and launch vehicles. Dr. Len Losik, as the Global Positioning System (GPS) Telemetry, Tracking, and Control (TT&C) subsystem engineer, developed this technology between 1978 and 1984 to ensure the project received full funding from the Department of Defense (DoD).

Should've Learned From The Past



Naval Reasearch Lab (NRL) scientists recognized the TIMATION concept could accelerate and simplify the positioning process and make it more accurate. TTIMATION was launched May 31, 1967 on a Thor-Ageria vehicle into a 500 nautical mile polar orbit.

In 1974, the U.S. Air Force contracted with Rockwell International (now Boeing) to design and build the first 12 Global Positioning Satellites (GPS) called Block I. There were already two other satellite-based navigation systems in service at the time used by the Navy, TIMATION and TRANSIT, packed with the finest available voltage-controlled oscillators (VCXO) available for on board timing. GPS was designed to exceed existing satellite based navigation system performance as well as to meet the navigation needs of all the military branches. The Air Force was motivated to obtain full DoD funding for GPS.

The GPS satellites use atomic clocks for timing generators. The generators stabilize a 10.23 VCXO; from which the L-band navigation downlinks are derived to the accuracy necessary to out

perform existing satellite based navigation systems. In 1974, atomic clocks had never been flown in space and were the least reliable component of the GPS satellite payload. All the necessary modifications for formerly ground-only based clocks to operate in space had not been completely defined.

NIST F-1 is an atomic cesium fountain clock and is so accurate it could run for nearly 20 milllion years without gaining or losing a single second. The clock is called a fountain clock because it measures the light emitted by super-cooled cesium atoms as they fall through a microwave cavity.

Existing atomic clocks excited either rubidium or cesium atoms, which emit RF energies at specific frequencies and at specific rates that are so dependable, our second of time is defined by it. Rubidium and cesium atomic clocks have opposite performance behavior and the air Force had not yet decided which to use on a permanent basis. A cesium atomic clock uses as a reference the exact frequency of the microwave emitted energy emitted by atoms of cesium in resonance, in particular its isotope of atomic weight 133. The integral of frequency is time, so this frequency, 9,192,631,770 hertz, was defined as 1 second and provides our fundamental unit of time.

In 1978, the GPS engineering team, on contract to the U.S. Air Force, were asked to both to define the on orbit support requirements as well as to predict the operational stability of each satellite atomic clock. This would enable critical, system wide testing, which could be planned during times when the atomic clocks were the most stable. In this way, the GPS system performance could be best determined when each satellite's atomic clock was performing at its best, thereby increasing the likelihood of exceeding the existing satellite based navigation systems performance.

Having access to the GPS Kalman filter performance, which illustrated each satellite's on board clock behavior from the GPS Master Upload Station located at Vandenberg Air Force Station, the GPS engineering team was able to predict atomic clock failures using telemetry prognostics. Kalman filtering is a mathematical process for predicting future behavior from past behavior by incorporating real-time updates.

As we were building, launching and operating GPS satellites in space, the engineering team had available all of the information necessary to engage in telemetry prognostics. Prognostics should have been developed after the development of the strip chart recorder in 1958, when it became possible to easily display and analyze large quantities of analog telemetry.

However, no one asked the builders of America's aircraft, missiles and rockets at that time to, in fact, do so. For almost 50 years, the U.S. military has been buying, launching and operating satellites in space in support of our nation's security. During that time period, the process for designing, testing, launching and operating satellites has changed very little. Although many new tools and materials are used, the procedure for such activity has remained unchanged.

Flight equipment diagnostics used to recognize satellite and launch vehicle equipment operating conditions during factory test and use were developed in the 1950's for reducing the amount of faulty equipment launched into space. Equipment diagnostics include such things as

- Hardware and software debugging
- Piece part failure analysis
- Circuit analysis
- Generation and recording of equipment test data
- Post event analysis of test data.

Equipment diagnostics were used during rocket motor testing in the 1940's and 1950's. Rocket motors in development were instrumented with expensive and complex data generation systems for measuring voltages, currents, pressures, temperature, accelerations and force. Huge amounts of test data were recorded and analyzed after the rocket motor ignition to determine if the motor was functioning properly. At first, data was logged by hand by huge groups of people hired to write down the information as it was being created.

Francis L. Moseley conceived the idea of an x-y recorder using standard-size graph paper after the drudgery of writing down columns of data, plotting graphs and drawing smooth curves. In 1951, he marketed the first 2-axis strip chart recorder, which he built in his garage. This device allowed the recording and simultaneous display of test data on long sheets of paper and was a great boon to the flight test and rocket engineers. Data was collected in real-time, processed and analyzed after each test.

Francis L. Moseley 1908-1984

Most of today's military rockets began life as highly unreliable intercontinental ballistic missiles (ICBM's). In a hurry to field ICBM's after Russia's Joseph Stalin built the world's first ICBM with a nuclear bomb payload in 1953, the U.S. played catch-up. Eventually, the Russian military missile program beat the U.S. into space with the successful back-to-back launch of 2 Sputnik satellites.

SM-65 Atlas built by Convair Division of General Dynamics

In 1953, the U.S. military developed a list of 100 targets for ICBM engagement. The reliability of the first 2 ICBM's, Atlas and Titan, were so low the military determined they would need at least 4 ICBM's to hit one target with the assumption of only a 70 percent chance of target strike success. Instead of

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Titan missile manufactured by Glenn L. Martin Company

winning a production contract for 100 missiles, each missile contractor won contracts for 400 missiles.

This action led to the acceptance in the aerospace industry that launch failures were not only acceptable, but also quite normal. Contractors such as Martin and Convair benefited greatly by the military's decision for multiple missiles, as any increases in missile reliability meant a reduction in orders.

In the late 1950's, as jet planes flew faster and faster, flight failures meant pilots were being killed during mishaps. Unable to find out why the pilots were crashing, flight test engineers added telemetry instrumentation systems to send engineering data to ground personnel during tests flights. Remote ground stations were added to collect telemetry when the jets were far from the landing strips. Flight test engineers then began adding telemetry instrumentation to missiles at about the same time, as well as with command destruct systems for out of control missiles.

In 1957, stored Titan missiles had been exploding, killing the soldiers stationed in the silos. The Air Force retired the dangerous Titans and replaced them with the less volatile Atlas and others.

In 1960, when the technology was available to predict each missile performance, everyone had already accepted as fact launch failures were to be expected — nothing could be done about the failures. Prognostic technology was, simply, not developed.

In 1961, the U.S. government decided to use the Titan missiles as launch vehicles for military satellites. This was seen as a method to increase access to space as well as reducing the massive financial losses of the original 400 Titan ICBM purchases. NASA refused to use the Titan missiles for its satellites and instead choose the Thor missile, a much smaller, less capable missile.

Many of the same contractors who had designed and built the U.S. jet aircraft also designed and built missiles, rockets and satellites. This meant the same design and test practices used in the aircraft development were used in all space applications.

Using telemetry systems is expensive and complicates vehicle design. Due to its high cost and electrical complications to the vehicle, telemetry has been relegated to simple diagnostic function use only. For decades, telemetry has been used to determine flight equipment status during equip-

FEATURES

ment manufacturing and testing and also for completing customer acceptance testing on satellites and launch vehicles before shipping them to the launch pad.

Prognostics Rule

After the creation of telemetry prognostics in the 1980's, the benefits of prognostics could be realized. Prognostics allows for the identification and repair or replacement of unreliable piece parts and electro-mechanical components at the factory or on the launch pad, all prior to launch. As most of the equipment testing at the factory is designed to identify equipment that has failed, prognostics allows for reduced testing, shortening delivery schedules, and reducing labor hours.

If embraced throughout flight equipment design, manufacturing and test, vehicle design, manufacture and test, launch and on orbit operations, telemetry prognostics will:

- Lower project costs
- Shorten delivery schedules
- Increase equipment reliability
- Extend on orbit equipment usable life
- Decrease the number and severity of on orbit failures

Other telemetry prognostics benefits include:

- During equipment manufacturing as well as during satellite or launch vehicle integration, all piece parts and all equipment that is failing and will fail in the near future can be identified and replaced
- During on orbit satellite operations, infant mortalities can be stopped because all equipment that was to fail soon after launch would have been identified on the ground and repaired or replaced before the launch.
- During on orbit operations, future equipment failures will be identifiable and equipment use can be modified so that such failures do not mitigate payload services.

Dr. Len Losik is President of Failure Analysis and offers telemetry prognostic technology for licensing for use with satellites and launch vehicles. He can be reached at: lenlosik@failureanalysisco.com and www.failureanalysisco.com. Dr. Losik has also written two books on this subject, available from bookstores as well as AMAZON.com. They are entitled, "Predicting Failures & Measuring Remaining Usable Life for Highly Reliable Aerospace Equipment", ISBN 978-0-9741358-4-7 and "An Introduction To Predicting Failures & Measuring Remaining Usable Life for Highly Reliable Aerospace Equipment", ISBN 978-0-9767491-9-6.

MILSATMAGAZINE PRIORITY BRIEFING WITH...

ROBERT N. CANTY

Director of DoD Systems of Space Systems
Raytheon Company
Aurora, Colorado

Late in November of 2007, Raytheon Company was awarded a US$160M, 18-month competitive contract to develop a new system design for the nexgen Global Positioning System Control Segment. The U.S. Air Force Space and Missile Systems Center awarded the contract. The system will include anti-jam capabilities, improved system security, accuracy and reliability and will all be based on a modern, service-oriented architecture to integrate government and industry open system standards.

Mr. Canty took time from his busy schedule to discuss this system award and other recent developments that should be of particular interest to the readers of *MilsatMagazine*. Raytheon's Space Systems business area develops and deploys large-scale data processing systems and networks for space-related markets and customers, with their primary expertise in the area of satellite command and control. The Space Systems Division business encompasses government programs, commercial systems, DoD systems, civil programs and the National Polar-orbiting Operational Environmental Satellite System (NPOESS).

Artist's concept of NPOESS satellite

Hartley
Good day, Mr. Canty, and thank you for imparting to our readers some of this most important information from Raytheon. To start, would you please describe the recent contract that Raytheon's Intelligence and Information Systems (IIS) was downselected to develop for the U.S. Air Force?

Robert
Certainly—Raytheon Company was one of two companies chosen to develop the system design for the **Next Generation Global Positioning System** (GPS) **Control Segment** (OCX) (Contract # FA8807-08-C-0001). **GPS OCX** will provide command, control and mission support for current GPS Block II and all future satellites as well as support for existing and new interfaces. The contract, awarded by the U.S. Air Force Space and Missile Command, is valued at US$160M. Following the conclusion of this 18-month phase, a 15 to 20 year development contract will be awarded to a single contractor.

Hartley
Would you please provide the functions of GPS and the different segments involved?

Robert
In GPS, there are three different segments and a Systems Integrator. The first segment is the control segment or GPS OCX. The control segment, to the first order, is the timekeeper for the system. The control segment receives all of the satellite signals and calculates the satellite ephemeris and clock updates. As necessary, the control segment commands the satellite to update clocks and position knowledge in order to maintain system timing and navigation accuracy. Optimizing the GPS System requires a number of very complex math algorithms.

The second segment is the user equipment. User equipment can be a hand held device for a soldier, a device in guided munitions, or a unit in the cockpit of an aircraft. The user equipment processes the signals from space and triangulates on a minimum of four satellites to determine its location.

The third segment is space. Twenty-four satellites are required for a full constellation. Additional satellites above twenty-four provide further redundancy and system availability. The satellites are, essentially, clocks in the sky. The GPS system sends out the time of day and the location of the satellites.

Hartley
Which of these segments is of most interest to Raytheon?

Robert
The future ground control segment, or GPS OCX, is the focus of Raytheon's Intelligence and Information Systems (IIS). Raytheon's Space and Airborne Systems is currently performing on the Modernized User Equipment (MUE) contract. Raytheon has led close to 100 GPS related programs and has delivered thousands of pieces of user equipment for the DoD, civil, commercial and national markets, ranging in activities from navigation, transportation, surveying and rescue operations. There are three contractors currently performing work on the MUE. Preliminary Congressional Budget language calls for maintaining continued

competition in this segment and accelerating the development of the MUE.

Hartley
What is Raytheon's experience in developing Global Positioning Systems?


Artist's concept of the GAGAN system

Robert
Raytheon brings more than 40 years of high availability precision satellite command and control systems experience to GPS OCX. In addition to deploying 110 unique satellite ground systems, Raytheon has a solid history of successful, time certain delivery with a 98 percent award fee average.

Raytheon is the world leader in designing and building satellite navigation augmentation and service monitoring systems for civil and military aviations applications. Raytheon is engaged with the FAA's **Wide Area Augmentation Systems** (WAAS), Japan's **MTSAT Satellite-based Augmentation System** (MSAS) and India's **GPS Aided GEO Augmented Navigation System** (GAGAN). Raytheon is the only company to deliver a FAA-certified satellite navigation system.

Hartley
Please describe the procurement process – what are the next steps in selection and the duration for which the process will last?

Robert
The contract just awarded is to develop the system design and perform risk reduction tasks for GPS OCX. This phase with two contractors will last for 18 months concluding with a System Design Review and a Proposal Update Request from the Air Force. The Air Force will evaluate the updated proposals and select one contractor to develop the GPS control segment for the next 15-20 years.

Hartley
Why has the government procurement office opted to separate out the ground from the satellite systems instead of contracting them together?

MILSATMAGAZINE PRIORITY BRIEFING WITH...

Robert
The Air Force has separated the control segment from the satellite contract in order to address the challenging military and civil needs across the globe. The Air Force looks at GPS OCX acquisition as a pathfinder for future acquisitions. Establishing each segment as a separate contract allows better contract oversight, a commitment towards strengthening Space and Missile Systems Center's industrial base and facilitates technology infusion into the GPS architecture.

In past acquisitions, if the space segment milestones slipped, so did the control segment milestones. Decoupling space and control segment allows for delivery of enhanced system capabilities much more rapidly. By integrating commercial best practices, enhanced automation and state-of-the-art mission management software hosted on a service-oriented architecture, OCX will provide the revolutionary opportunity to focus not just on flying satellites, but enhance services to operational users.

Therefore, time certain delivery is a critical aspect of the control segment procurement going forward. Being able to not only deliver on time, but to deliver enhanced capabilities much more rapidly, is the key to success. Our unique history of working with all satellite vendors enables our approach to time certain delivery.

Hartley
How will the Next Generation GPS differ from its predecessors?

Robert
The Next Generation GPS will provide improved position, navigation and timing services to the warfighter and civilians by improving accuracy, integrity and resistance to jamming.

A key attribute is improved accuracy of the overall system. The control segment is the key component to satisfying this need. More data points from the satellites, better predictive algorithms and more frequent clock and ephemeris updates ensure increased accuracy.

Increasing accuracy is important for future warfighting. Many evolving systems depend on improved accuracy such as persistence surveillance and the use of a small diameter bomb. To obtain the maximum effects using a small diameter bomb, high accuracy is critical in your ability to hit the target.

There are also many civil applications that can benefit from increased accuracy. For instance, modern networking takes advantage of GPS as a timing source. Better timing precision allows a network to process more packets of data. There's a huge commercial economic benefit associated with improved accuracy to industries such as telecommunications. There are several new markets that would come online, thanks to improved accuracy, markets we can't even envision today.

Integrity is another area of enhanced capability enabled by the control segment. Users of GPS need to know that the GPS signal is good and therefore their location is known. This is especially true for critical operations such as aircraft navigation or use of force in military operations. Critical users of GPS need a warning in a short period of time indicating that a signal is potentially misleading and should be disregarded. Raytheon has developed the only FAA certified satellite navigation system in the

Wide Area Augmentation System (WAAS). Our solution applies this experience to offer the Air Force a cost-effective implementation of integrity.

Hartley
How will the selection of the GPS III spacecraft contractor impact Raytheon's bid for the ground control segment?

Robert
Raytheon builds control systems for every U.S. satellite provider. GPS OCX is required to perform with a mixed constellation of vehicles and payloads produced by different vendors. Raytheon IIS's focus and core competency is the control segment. Our company does not have a satellite-manufacturing group, unlike other companies that typically only produce control segments to support their own vehicles. We have supported all of the satellite contractors currently involved in the GPS III spacecraft competition.

We don't have a preference as to the satellite manufacturer. The control segment has to work with any satellite vendor's product going forward. It's that ability to be independent that is a key attribute.

Hartley
What issues exist with the U.S.A.F.'s current GPS technology and how will GPS III seek to combat these problems?

Robert
Since 1983, the U.S.A.F. has continually provided GPS signals worldwide, without interruptions. The number of government, civil and commercial GPS users has increased exponentially. This growth drives system enhancements for improved position, navigation and timing services to the warfighter and civilians by improving accuracy, integrity and resistance to jamming.

Our adversaries realize we have an advantage when it comes to GPS enabled precision operations and being able to jam GPS can have a significant impact. Implementing GPS capabilities to be more resistant to jamming is of critical importance. This is a need for the warfighter as well as for civil and commercial users. Many commercial and civil systems such as communications, energy and banking depend on GPS. To the maximum

extent possible, the GPS system will need to be impervious to jamming. Implementation will require contributions from all segments of GPS.

From the control segment standpoint, better situational awareness for system operators is an important attribute. Situational awareness of system health, status and performance offers a view of the actual performance of the GPS system and a predictive tool of future performance. This includes an understanding of the jamming environment and how to respond. This capability can be enhanced independent of satellite delivery.

Hartley
Who are Raytheon's strategic partners in this endeavor?

Robert
Our teammates on the program include **The Boeing Company**, **ITT Industries**, **Jet Propulsion Laboratory**, **Braxton Technologies Inc**. and **Infinity Systems Engineering**. Our team brings an optimal balance of GPS-unique domain expertise with control segment development expertise.

Hartley
As this is a military sponsored contract, what civilian applications, if any, will the GPS III have?

Robert
GPS has always been a dual use service for military, civil and commercial applications. The commercial GPS market is estimated to be approximately $20 billion per year with a 20 to 25 percent compounded annual growth rate. Some estimate the GPS market can be over US$300B a year by 2020. This market is composed of hardware, software and services such as GPS receivers for automotive and recreation navigation.

The GPS IIR-M satellites started operations in December 2005. These satellites introduce a second civil signal (L2C). L2C signal is stronger, allowing receivers to work better in urban areas, and improves civil accuracy 3-10 meters by compensating for ionospheric distortion. The GPS IIF satellites add a third civil signal (L5) to support the strict requirements for airline and other transportation services. GPS III adds a forth-civil signal (L1C) to augment the original civil signal (L1) that will be common with Galileo.

The first delivery of the GPS OCX control segment takes full advantage of the modernized capabilities on the launched IIR-Ms and the future IIF satellites by activating the new civil signals (L2C and L5) plus the new, improved, military M code. The current control segment does *not* provide this capability. These enhanced capabilities are independent of the GPS III satellite schedule. Improved M code capability does require MUE delivery.


GPS IIR-M satellite

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The USAF invests approximately $1 billion a year in GPS. It is the only program that I am aware of that provides this kind of return on investment.

Hartley
As ITT was recently awarded the contract from the FAA for the new GPS aircraft technology, how will this affect Raytheon's implementation?

Robert
I believe the aircraft will receive the GPS signal and broadcast its location to the FAA as well as other aircraft in its proximity. The location information received will be displayed enabling the FAA and pilots to determine where all other planes are located. That system is dependant on GPS integrity either through GPS or WAAS.

Hartley
And finally, Mr. Canty, has redundancy been a significant issue and how will it be addressed with GPS OCX?

Robert
GPS OCX delivers a primary and backup control system. The primary and backup systems are each fully redundant. Redundancy is a critical requirement for the implementation of integrity. Our implementation uses approaches and designs from our successful implementation of WAAS.

Hartley
We appreciate you taking the time to answer our many questions — thank you.

Mr. Canty joined the former Hughes Space and Communications Company in February of 1984. Prior to assuming his present position as the Director of DoD Systems of Space Systems for the Intelligence and Information Systems portion of Raytheon Company, he was the Raytheon Six Sigma Champion and Expert for Space Systems in the Strategic System business unit of Raytheon.

Raytheon

Mr. Canty has held several, high-level management positions... early in his career at Hughes Space and Communications, he successfully managed complex space systems integration, test and launch activity as Operations Manager and Test Director. He has managed the analysis group for Hughes New Venture Organization, successfully led the 350-person product line at Hughes through 2 years of 140 percent annual growth, and he won the Future Imaging Architecture Mission Control System (FIA MCS) program as the Capture Manager.

CASE STUDY

ANTARCTIC MISSION FOR ROYAL NAVY

Aerial view of James Ross Island and map

Earlier this year, international satellite communications solution provider, **NSSL**, sponsored a crack team of **Royal Navy** personnel from *HMS Endurance*, the Royal Navy's Antarctic ice patrol ship, as they attempted to set a world record by kayaking around James Ross Island, off the coast of Antarctica. The island is 65km in length and is named after *James Clark Ross*, the explorer, who first sighted the island in 1843.

Six serving members of the Royal Navy and one civilian were the expedition members. Their aim was to kayak around the island for a total of 120 nautical miles, resting at night on the island itself and paddling by day.

James Ross Island Expedition

The estimated time to complete the mission was about 8 days, all highly dependent upon the weather conditions. Icebergs and subfreezing temperatures as low as –30C were among the additional hazards that had to be faced. If the team were able to complete this mission, a world record would be theirs... no one previously had ever kayaked this far south, or around, James Ross Island. Plus, these stalwart Royal Navy adventurers were able to illustrate the amazing capabilities of BGAN mobile broadband terminals and Iridium handheld phones; their only means of communication once the mission was underway.

The team set off in February 2007, following many months of training, with individual GPS units and a BGAN kit to assist them in asserting their locations and communicating with the world. Scientific tests were also to be carried out, specifically on the south side of the island. Geological observations would offer data from fossils and rocks as to what life existed when Antarctica was a green paradise.

Circumnavigating James Ross Island in sea kayaks was an extremely ambitious plan. The team paddled as many as ten hours a day and also had to contend with icebergs capable of sinking or crushing their canoes, blinding hurricanes that made paddling impossible, and killer leopard seals.

Team member Russ Abbot in sea kayak as he hacks his way through ice flows

Thanks to the BGAN and Iridium kit, however, these dangers were significantly reduced. The kit allowed the team to:

- Check weather reports independently of HMS Endurance
- Comfortably operate at a considerable distance from HMS Endurance and other inhabited areas
- Call in for emergency help or assistance if anything went wrong
- Update daily blogs with ease
- Remain in contact with friends, family, sponsors and the media in the United Kingdom

According to *Stephen Paris-Hunter*, Fellow**, Royal Geographical Society** (FRGS), and the expedition leader with more than 22 expeditions under his belt, "The equipment supplied by NSSL was robust, reliable and performed brilliantly under extreme conditions and the pre-deployment training and support given by NSSL was absolutely essential. It allowed us to contact the outside world at times when it seemed we were the most isolated individuals on earth. Importantly, the kit was small and portable enough to fit into the confined space of a kayak."

NSSL supplied the BGAN set, which consisted of two Iridium phones and solar panel to recharge the batteries. According to *Danielle Edwards*, Product Marketing Manager, "This expedition really proves how satcoms have evolved to become a must-have necessity for adventurers who want to push the limits of human endeavor."

The expedition members were:
Matthew Twiselton, *Mike Devlin*, *Stephen Paris Hunter*, *Mark Townsend*, *Mark Jameson* and *Richard Abbot*

NSSL was established in 1969 and is an independent service provider for satellite communications solutions as well as one of the top Inmarsat service providers worldwide. With a wide range of services and extensive experience of systems integration and application development, our focus is on the maritime, government, energy, media, finance and corporate sectors. We provide voice, data and broadband solutions anywhere in the world.

FOCUS ON

ADVANCED EXTREMELY HIGH FREQUENCY SYSTEM SATELLITE SYSTEM (AEHF)

The **Advanced Extremely High Frequency** (AEHF) **System** is a joint service satellite communications system providing global, secure, protected, and jam resistant communications for high-priority military ground, sea, and air assets. The system consists of three satellites in geosynchronous earth orbit (GEO). These satellites provide 10 to 100 times the capacity of the 1990s-era Milstar satellites.

Advanced EHF (AEHF), the nation's next generation military strategic and tactical relay system, will deliver survivable, protected communications to U.S. forces and selected allies worldwide.

A constellation of three AEHF, augmented by a **Transformational Communications Satellite** (TSAT), will provide continuous 24-hour coverage. Advanced EHF will allow the National Security Council and Unified Combatant Commanders to control their tactical and strategic forces at all levels of conflict through general nuclear war and support the attainment of information superiority.

Milstar Satellite
Artist rendition by MCSW, SMC

The AEHF System is a follow-on to the **Milstar** system and augments and improves on the capabilities of Milstar. AEHF expands the **MILSATCOM** architecture to support Transformational Communications and Network-Centric Warfare. AEHF will provide connectivity across the spectrum of mission areas including land, air, and naval warfare; special operations; strategic nuclear operations; strategic defense; theater missile defense; and space operations and intelligence.

FOCUS ON

The AEHF system is composed of three segments

- Space (the satellites)
- Terminals (the users)
- Ground (mission control and associated communications links)

The segments will provide communications in a specified set of data rates from 75 bps to approximately 8 Mbps.

In February of 2007 employees at Northrop Grumman Space Technology in Redondo Beach, California, conduct final test and inspection of the payload module for the first Advanced Extremely High Frequency (EHF) military commmunications satellite

The space segment consists of a cross-linked constellation of three satellites. The mission control segment controls satellites on orbit, monitors satellite health and provides communication system planning and monitoring. This segment is highly survivable, with fixed and mobile control stations. System uplinks and crosslinks will operate in the extremely high frequency (EHF) range and downlinks in the super high frequency (SHF) range.

The terminal segment includes fixed and mobile ground terminals, ship and submarine terminals, and airborne terminals, including the Family of Advanced Beyond Line-of-Sight-Terminal (FAB-T), used by all of the Services and international partners (Canada, Netherlands and United Kingdom).

The AEHF satellites will respond directly to service requests from operational commanders and user terminals. They will provide real-time, point-to-point connectivity and network services on a priority basis.

On-board signal processing will provide protection and ensure optimum resource use and system flexibility among the Armed Forces and other users who operate terminals on land, sea, and air. The AEHF system will be integrated into the legacy Milstar constellation. The system will be backward compatible with Milstar's low data rate (LDR) and medium data rate (MDR) capabilities, while providing extended data rates (XDR) and larger capacity at substantially less cost than the Milstar system. Each satellite will be launched on an Evolved Expendable Launch Vehicle (EELV)—the first launch is planned for April of this year.

In 2006, U.S. Air Force and civilian personnel conduct tests at Northrop Grumman Space Technology in Redondo Beach, California, showing current and future military satellite communications systems will be compatible with each other.

The AEHF Satellite Communications System will augment and replace the Milstar constellation, improve DoD EHF capability, and enable Transformational Communications and Network-Centric Warfare. The **MILSATCOM Systems Wing** is responsible for the development, acquisition and sustainment of the AEHF Program.

Information courtesy of:
MILSATCOM Joint Program Office SMC/MC
El Segundo, California

Photos courtesy of:
Northrop Grumman
& U.S.A.F. Space & Missile Systems Center

General AEHF Characteristics

Primary function
Global, secure, survivable satellite communications

Primary contractor
Lockheed Martin Space Systems Company

Satellite Bus
A2100 line

Weight
Approximately 14,500 lbs at launch, 9,000 lbs on-orbit

Orbit-Altitude
22,300 Miles (geosynchronous)

Payload
Onboard signal processing, crossbanded EHF/SHF communications

Antennas
2 SHF Downlink Phased Arrays, 2 Crosslinks, 2 Uplink/Downlink Nulling Antennas, 1 Uplink EHF Phased Array, 6 Uplink/Downlink Gimbaled Dish Antenna, 1 Each Uplink/Downlink earth coverage horns

Capability
Data rates from 75 bps to approximately 8 Mbps

Number of Terminals Supported
6,000

Reconfigurations Time
Minutes

Launch Vehicle
Delta IV and Atlas V EELVs

Inventory
3 satellites ordered

Unit Cost
Approximately $580 Million per satellite

MILSATMAGAZINE PRIORITY BRIEFING WITH...

MARC LEGARE
CEO, PROACTIVE COMMUNICATIONS, INC.

Interview with Hartley Lesser, Editorial Director, SatNews Publishers

A true veteran, in every sense of the word—*Marc LeGare* has actual satcom application and installation experience within contested military zones. In addition, he is the CEO of **Proactive Communications, Inc**. (PCI). He possesses senior staff experience with **TRW/Northrop Grumman** as their former Senior Consultant and Operations Manager for the **Force XXI Battle Command Brigade**. Marc served in various command and staff positions for the **U.S. Army** worldwide, including Iraq. We somehow managed to have him pause in his work for a few minutes as we conducted an interview to follow-up his October *MilsatMagazine* article, "*Taking Customization to the Next Level... The Iraqi Connection*".

Hartley
Marc, how did you become involved in the satellite communications business? When did you join PCI? What was your experience prior to PCI (business and military)?

Marc
I moved into the satellite communications business in 2003 after serving as a Battalion Commander for the U.S. military. In that role, I underwent military communications training and gained hands-on experience with some of the most cutting edge digital battle command technology in the world. My battalion was the first digitized, mechanized infantry battalion in the US Army.

Hartley
How is your management philosophy impacted by your military experience as a Battalion Commander?

Marc
Empowering employees so they can make rapid decisions is what I strive to attain, and that requires I work with them in the field to understand exactly what they need to succeed on each project. In this way, they can effectively lead members of the team and work together to complete their missions.

Hartley
How would you describe your experience working with Iraqis employed by PCI?

Marc
Seventy percent of our work force in Iraq is comprised of native Iraqis. They've been an integral part of doing business there

because they've helped us understand the culture and also provided the necessary translation services and labor we've needed to complete various projects. I've witnessed true camaraderie and teamwork between Sunni, Shiite and Christians and would describe them as a real "band of brothers." It's a real privilege to know and to work with them. They are a refreshing reminder of the human resource potential that resides in Iraq.

Hartley
What qualities do you find most necessary when working and leading under extreme conditions?

Marc
In most extreme situations – whether its emergency communications or when you're operating in a war zone – initiative, flexibility, empowered decision making, and a "make it happen" attitude are the most important attributes.

Hartley
What valuable business lessons have you learned from working in Iraq?

Marc
I've learned that it's necessary for corporate leaders to roll up their sleeves and to really get to know the environment and customer with which they're working. Another key factor is building a solid team that can manage the international finance and legal complexities.

Hartley
How did you, and do you, protect your assets in a war zone?

Marc
Our most important asset is our work force. We take great pains to ensure the safety of everyone who supports the different programs in Iraq and Afghanistan. One of the measures I assume is to personally visit the most dangerous sites and understand the asset protection necessary within each working environment.

Hartley
After your active duty, how did you manage the transition to civilian life and the lead role with a commercial company?

Marc
I did a lot of reading on business practices and tried to merge that knowledge with my military leadership experience. As far as leading PCI is concerned, when I started we only had five employees at the time, so I have been able to learn as the company grew.

Hartley
What frustrated you the most during your first trip to Iraq? How could that have been overcome?

Marc
I was most taken back by how difficult the simplest tasks could become. Just getting food, water, and fuel could be a struggle. I thought my military experience would have prepared me for this, but I had to learn a new set of rules as to who to talk to, and how to emplace resources. Now we embrace the friction and are always prepared to be flexible. On the other hand, initiative, teamwork, and a sense of humor can overcome this friction. In fact, I started using the Staples "easy" button to acknowledge those efforts that made seemingly impossible tasks simple and fast.

Hartley
What major changes have you witnessed within the military satellite communications industry since joining PCI?

Marc
We have seen the ever increasing "untethering" of units from line-of-sight communications and an increasing reliance on satellite based systems. I think this movement will continue for years to come.

Hartley
Where do you see the industry heading?

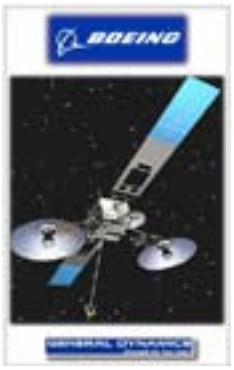
Marc
I believe satellite systems will become more mobile, lighter in weight, and far more capable of being pushed out to the individual on the battlefield.

Hartley
What is your vision for Proactive Communications? What future plans do you have for the company?

Marc
Our plan is for PCI to be at the forefront of secure communications for our customers, in the most demanding of environments. I don't see PCI becoming a "Club Med" telecommunications company. Our role is to be the desired partner for any "away game" whether that's a combat zone, disaster assistance, or beyond the reach of line-of-sight systems.

About Proactive Communications, Inc.
This company offers satcom, enterprise, IT consulting and field support services around the world. Marc, by the way, has a B.S. from the United States Military Academy at West Point, a Master of Science from the Air Force Institute of Technology, and a Master of Military Arts and Sciences from the School of Advanced Military Studies. The company website is located at: http://www.proactivecommo.com/solutions/default.asp

NASA Back On Familiar Turf With Boeing



NASA has returned to **Boeing** [NYSE: BA] for its nexgen series of **Tracking and Data Relay Satellites** (TDRS), continuing the communications satellite line that started with the launch of TDRS H in 2000 and, coupled with Boeing's other work for NASA, spans more than four decades. Valued at US$695M (US$1.2B if all options are exercised), the contract calls for two spacecraft and increases Boeing's satellite backlog to 27 spacecraft. The **TDRS-K** satellite will be ready for launch in 2012, and **TDRS-L** will be ready for launch in 2013. Boeing has teamed with **General Dynamics**, which will update and modify the existing TDRS system ground terminals, located near Las Cruces, New Mexico. The ground terminals, known as the **White Sands Complex**, are the primary two-way communications link between the TDRS satellites and the ground-based elements of the TDRS system communications network.

The satellites incorporate a modern design based on flight-proven performance. The three previous TDRS satellites were based on Boeing 702-class electronics, which are still the standard for the newest spacecraft Boeing is building today. Additionally, Boeing has modernized the technologies in the payload, power and propulsion subsystems to current state-of-the-art technologies being used in other Boeing-built spacecraft. This will expand the capabilities of NASA's Tracking and Data Relay Satellite System as this communication signal relay system provides tracking and data acquisition services between Earth-orbiting spacecraft, such as the **International Space Station** (ISS), the space shuttle, the **Orion** crew exploration vehicle, and their respective control and data processing facilities.

Boeing has also formed a brand new division. Called the **Intelligence and Security Systems** division, this unit will focus on government customers. Developed by the department will be a variety of integrated intel and security programs. Coming in as the Vice President and General Manager of this new division will be former astronaut, and U.S. Naval Reserve Rear Admiral, Steve Oswald—*St. Louis, Missouri*

ITT Brings Home The Demo Ahead Of Schedule

Lockheed Martin is filled with happy folk over the **ITT Corporation** delivery of a new demo payload for a modernized **Global Positioning System Block IIR** (**GPS IIR-M**) satellite to their Valley Forge, Pennsylvania, facilities. The payload will be integrated onto the spacecraft and final system level testing will occur in preparation for next year's launch. This major milestone was accomplished by ITT two months ahead of schedule. In fact, it was only nine months ago that the Air Force awarded Lockheed Martin the US$6M contract to develop the demo payload which will temporarily transmit a third civil signal from a GPS IIR-M satellite.

The signal, located on the L5 frequency (1176.45 MHz) will comply with international radio frequency spectrum requirements. Future generations of GPS spacecraft will include an operational third civil signal to improve the accuracy and performance capabilities of the system. The spacecraft with the demonstration payload, known as **SV 09**, is one of the final three Block IIR-M satellites planned for launch in 2008. **Lockheed Martin Space Systems**, Valley Forge, Pa., is the prime contractor for the **GPS IIR** program. The company designed and built 21 IIR spacecraft for the **Global Positioning Systems Wing**, **Space and Missile Systems Center**, Los Angeles Air Force Base, California. The final eight spacecraft, designated **GPS IIR-M**, were modernized to enhance operations and navigation signal performance for military and civilian GPS users around the globe. ITT supplied all 21 navigation payloads for both the IIR and IIR-M spacecraft—*King of Prussia, Pennsylvania*

ULA Delivers A 5th Into Space

United Launch Alliance successfully launched a **Delta II** expendable launch vehicle on Thursday, December 20th, from **Space Launch Complex 17-A** at 3:04 p.m., EST. Carried aloft was the **U.S. Air Force**'s **GPS IIR-18(M)** satellite. This launch marks the fifth mission for the Air Force this year and the 13th and final mission for ULA in 2007. Following a nominal 1 hour and 8 minute flight, the rocket deployed the GPS IIR-18(M) spacecraft. This is the fifth modernized NAVSTAR Global Positioning System Block II R-M military navigation satellite. Designed to operate for 10 years, GPS satellites orbit the Earth every 12 hours, emitting continuous navigation signals. With the proper equipment, users can receive these signals to calculate time, location, and velocity.

The **ULA Delta II 7925-9.5** configuration vehicle featured an ULA first stage booster powered by a **Pratt & Whitney Rocketdyne RS-27A** main engine and nine **Alliant Techsystems** (ATK) strap-on solid rocket motors. An **Aerojet AJ10-118K** engine powered the second stage. A spin-stabilized Star-48B solid-rocket motor built by ATK boosted the third stage. A 9.5-foot-diameter metallic fairing encased the payload. ULA began processing the Delta II launch vehicle in Decatur, Alabama, nearly two years ago. Next

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year, ULA currently has 23 scheduled launches on the manifest from six launch complexes, which include 16 from Cape Canaveral Air Force Station, Fla., and seven from Vandenberg Air Force Base, California—*Cape Canaveral, Florida*

New U.S. Spy Plan To Be Presented

Greater access to satellite images is part of a domestic spying plan the **Department of Homeland Security** intends to reintroduce to our federal legislators. This revised plan includes a charter that states the federal government will:

- Abide by the law
- Develop a new spy unit named the **National Applications Office**
- Add a new US$15B program to protect computer nets throughout the U.S.

Additionally, this new legislative plan includes guarantees that all necessary warrants will be obtained prior to an action and voice comms will not be intercepted—*Washington, DC*

ESA Celebrates GIOVE-A Anniversary

It will be have been two years on December 28th since the first **Galileo** satellite, **GIOVE-A**, was launch from Baikonur in Kazakhstan on a **Soyuz** rocket. Galileo signals have been broadcast by GIOVE-A since January of 2006 and the signals have been received all around the globe. A lab at the European Space Agency's research and technology center in The Netherlands continues to check the instruments on board the spacecraft that broadcast the signals as well as the ground stations. The next step in the Galileo program is under way—GIOVE-B—which is undergoing launch prep in ESA's test facilities. This second Galileo satellite will pack the most accurate atomic clock flown in space, which will contribute to the overall quality of the performance of this system. To reach operational status, Galileo requires a constellation of 30 satellites and an associated network of ground stations all around the world. This phase has just been confirmed with the decisions taken by the European Union... all have agreed on a financing package of 3.4 billion euros and will entrust ESA with the full deployment of Galileo by 2013.

A Joining Of Forces... EDO + ITT

EDO Corporation designs and manufactures products for aerospace, defense, intelligence, and commercial markets and the shareholders of that corporation have voted overwhelmingly to approve the merge with **ITT Corporation**. This vote, 77 percent in favor, satisfies the final condition for completion of the transaction. The merger should become effective on December 20th. EDO shareholders will receive $56 in cash for each share of common stock—*New York, New York*

iDirect Gets Patent-ized...

iDirect, Inc. has received a series of intellectual property patents protecting critical aspects of its **Intelligent Platform** for satellite IP communications. The patents secure proprietary algorithms that govern iDirect's industry leading **Deterministic Multi-Frequency TDMA** (Time Division Multiple Access) satellite transmission scheme and its popular **Network Planning Tool**. Deterministic Multi-Frequency TDMA, or **D-TDMA**, is an IP data transmission scheme offered exclusively by iDirect, which delivers bandwidth efficiencies and responsiveness. iDirect's D-TDMA algorithm monitors user demand up to 10 times per second, instantly and continually prioritizing bandwidth allocation based on real-time conditions such as queue depth, Quality of Service (QoS) configurations and other data prioritization requirements. This feature is critical for shared TDMA networks that support real-time traffic or IP applications spanning multiple remotes and that must balance total network demand with dynamic user requirements governed by guaranteed service level agreements. iDirect has also patented the analytical methodology that underlies its Network Planning Tool. This is a proprietary analysis tool that enables service providers to gauge more accurately their capacity, hardware and carrier requirements. Using the tool, service providers specify their unique network criteria such as number of terminals, applications supported, data rates, oversubscription ratio and other information. The iDirect Network Planning Tool then determines how a network should best be designed and supported including full hardware, software and system features—*Herndon, Virginia*

PlanetSpace Making Space At Canaveral

PlanetSpace is moving ahead with plans to establish an orbital launch facility at **Cape Canaveral**, Florida, as well as the associated manufacturing, training, R&D, and integration facilities. PlanetSpace's proposed Florida economic activity could generate approximately 346 jobs annually with a cumulative economic impact to the State of Florida estimated to be $313 million. The launch, training, R&D and manufacturing facilities are to fulfill delivery of PlanetSpace's commercial launch business plan and will include any potential contractual effort under a *Space Act Agreement* with **NASA** for **Commercial Orbital Transportation Services** (COTS)—*Kennedy Space Center, Florida*

Russian Angara Engines Brought Into Spotlight

Being developed at the **Khrunichev Space Center** is the **Angara** launch vehicle family. These will be environmentally clean vehicles. They are based on a core booster module with liquid oxygen/kerosene propulsion technologies. **NPO Energomash** is

developing the state-of-the-art, single-chamber RD-191 engine for the first stage of the Angara. Tests have been performed successfully on the first-stage propulsion system and they were conducted at the Energomash **Glushko** facility. The steering drive and plumbing were tested in near-flight conditions. The next test is scheduled in about a week and will include sine tests of the steering actuators.

The **RD-191** engine program is on track to deliver engines for firing tests on schedule. The RD-191 developmental tests will be completed in accord with the Angara master schedule, approved by **Roskosmos** and the **Russian Ministry of Defense**. The Russian Federation government signed a decree on August 26th, 1995 to create the Angara rocket system, and flight tests for the launch vehicle are set for 2011. All standard systems, including the launch pads, should be in place for the entire family of boosters. Angara will have the capability to deliver payloads to any required altitude and inclination—*Moscow, Russia*

Boeing Brings Demo On Home For TSAT

The third demo of their nexgen processor/router (NGPR) for the **Transformational Satellite Communications Satellite Communications System** (**TSAT SS**) has been successfully accomplished by **Boeing** [NYSE: BA]. The NGPR Spiral tests used realistic, operational scenarios designed to show increased functionality and performance of Boeing's Path-to-Flight NGPR Brassboard. This replicates the function and configuration of the operational space segment payload. Boeing collaborated with the **Massachusetts Institute of Technology**'s **Lincoln Laboratory** to conduct the tests in September and October, which are part of Boeing's **Risk Reduction System Definition** phase contract. Previous demonstrations of the router include **NGPR-1** in March 2006 and **NGPR-2** in February 2007.

Boeing's **TEAM TSAT** completed the spiral demonstration ahead of schedule, allowing additional tests to be conducted, and extending the risk reduction value of the demonstration. Boeing's TEAM TSAT consists of **Cisco**, **Hughes**, **IBM**, **Harris Corp.**, **Ball Aerospace & Technologies Corp.**, **LGS Innovations**, **Raytheon**, **General Dynamics C4 Systems**, **L-3 Communications**, **BBN Technologies**, **EMS Technologies**, **SAIC** and **Innovative Communications Engineering** (ICE). The Boeing team submitted its TSAT Space Segment proposal to the Air Force on July 30. The Air Force is expected to announce the winner of the multi-billion-dollar TSAT space segment contract in 2008.

DoD Can Buy Into Norsat Terminal Goodies

Norsat International Inc. [TSX: NII and OTC BB: NSATF] has been awarded a $750,000 Indefinite Delivery/ Indefinite Quantity (**IDIQ**) contract by the **United States Department of Defense** (**DoD**). The contract establishes terms under which the DoD can purchase Norsat's portable satellite terminals as well as associated support and maintenance through March 2008. The company has fulfilled $500,000 in task orders in association with the IDIQ to provide the U.S. Army with satellite terminals, maintenance and support services. An IDIQ contract does not require the Government to make any purchases above a specified minimum over the life of the contract. While there is no minimum purchase requirement under the terms of Norsat's IDIQ contract, Norsat has fulfilled and delivered 67 percent of the total contract value to date—*Vancouver, British Columbia*

Sat's Non-Space Flight From Lockheed Martin To Vandenburg

The shipment of the **DMSP Flight-18** spacecraft has successfully been completed by the **Defense Meteorological Satellite Programs Systems Group**. The spacecraft was moved from the **Lockheed Martin Space Systems** facility in Sunnyvale, California to **Vandenberg Air Force Base**, also in California. A C17 Globemaster from the **21st Airlift Squadron** at Travis AFB was used to ship the **DMSP Flight-18**. The spacecraft is now in the Payload Integration and Testing Facility at Vandenburg. All environmental testing has been completed. Final launch preparation processing is now underway.

The 30th Launch Support Squadron is responsible for the care and handling of the vehicle from the moment it arrives at VAFB until its launch. Integration of the ultraviolet sensor from **Northrop Grumman** and flight battery integration and checkout are on the processing schedule. The spacecraft will be transported to an encapsulation facility where it will be mated with the **Atlas V** booster. F-18 is scheduled to be launched next summer and will replace **DMSP F-16**, which was launched in 2003—*Los Angeles Air Force Base, El Segundo, California*

Upper Hand For Upper Stage Avionics For Boeing

The Boeing Company [NYSE: BA] has been awarded an initial **NASA** contract valued at approximately $265 million. The company will produce the **Ares I** crew launch vehicle's instrument unit avionics (IUA). This award follows Boeing's selection as the

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Ares I upper stage production contractor last August. The IUA provides the guidance, navigation and control hardware for the new Ares I crew launch vehicle. It also serves as the "brains" behind the rocket's ascent. The Ares I launches the Orion crew exploration vehicle, which will join other elements of NASA's Constellation program to help propel astronauts to the moon by 2020.

Boeing will produce three IUA flight test units and six production units, with an option to produce four additional units per year from 2014 to 2016. Under the contract, Boeing will employ up to 100 technical personnel to support NASA's **Marshall Space Flight Center** in Huntsville, Alabama. The center will lead the design for the upper stage and instrument unit avionics for Ares I, while Boeing provides production and engineering support. Boeing also expects to employ up to 20 production workers at NASA's **Michoud Assembly Facility** in New Orleans, Louisiana, where the IUA will be added to the upper stage—*St. Louis, Missouri*

Hauling Cargo & Crew Is Andrews Space' Goal

Andrews Space has released details of the company's **Andrews Cargo Module**. This is a cargo logistics system capable of addressing **NASA**'s International Space Station (ISS) cargo logistics requirements, as well as the needs of emerging customers such as **Bigelow Aerospace** and the **Department of Defense**. The Andrews Cargo Module is a reusable spacecraft capable of delivering 3.7 metric tons of cargo to and from the ISS. It is comprised of a common Service Module, a Pressurized (PCM) or Unpressurized Cargo Module (UCM), and a Recovery Module. This modular approach allows the system to cost-effectively address a wide range of mission requirements and customers.

The Cargo Module incorporates design features and system elements from previous efforts into a low-risk cargo module design. Andrews previously worked on crew and cargo logistics systems under contract to NASA as part of the **Alternate Access to Station** (**AAS**) and **Concept Exploration and Refinement** efforts. In 2005, Andrews developed a full-scale mockup of its design for the **Crew Exploration Vehicle** (CEV) to verify internal packaging for crew and cargo transport. This mockup was transferred to NASA's **Johnson Space Center** and has been used by NASA to conduct **Orion** design studies.

The Cargo Module will be launched by Andrews' **Hercules** family of launch vehicles. In November, Andrews submitted a proposal to NASA as part of the COTS recompete. Partners in the COTS proposal include **MacDonald Dettwiler and Associates** (MDA), **Alliant Techsystems** (ATK), **Reynolds Smith and Hills** (RS&H), **Draper Laboratory**, **Odyssey Space Research**, **Aerojet**, **Irvin Aerospace**, and **ILC Dover**. During the past year, a team of engineers has been engaged in developing the system design and maturing subsystems. In October, Andrews acquired an avionics and guidance, navigation and control (GN&C) company that will provide the fault-tolerant avionics and power subsystems. Andrews has several other funded research and development efforts that are demonstrating critical cargo module subsystems and technologies.

Lockheed Looks To New Lab For Orion Support

Lockheed Martin [NYSE:LMT] has opened a new space **Exploration Development Laboratory** (EDL) that will support **NASA**'s **Project Orion** and **Constellation Program**. Orion is the nexgen human spaceflight vehicle for transporting as many as six astronauts to and from the International Space Station, and as many as four astronauts to the moon, all starting in 2015, after the space shuttle is retired. The new 10,000 square foot lab is a state-of-the-art facility. **Lockheed Martin** and teammates **United Space Alliance** and **Honeywell** all are part of the funding for this integrated EDL network that includes facilities in Denver, Colorado, Glendale, Arizona, and Arlington, Virginia. The EDL in Houston is located adjacent to NASA Johnson Space Center.

Initial testing of critical systems will be done in the EDL, including the **Guidance, Navigation, and Control** (GN&C), **Automated Rendezvous and Docking** (AR&D), crew interfaces, and software development processes. Avionics system testing will be performed to reduce risk prior to abort flight-testing at **White Sands Missile Range** and NASA's **Kennedy Space Center**. EDL testing also will include system integration tests and mission tests that employ the team's "test like you fly" philosophy. The Lockheed Martin team also is working closely with NASA on a Human Engineering mockup that will be used to perform fact finding activities, such as reach zone, panel displays, internal lighting assessment, seat mockup and development, docking hatch development, crew stowage, hand controller development, and other human interface devices—*Houston, Texas*