SatCom For Net-Centric Warfare September 2009

MilsatMagazine

(Boeing's 702B)

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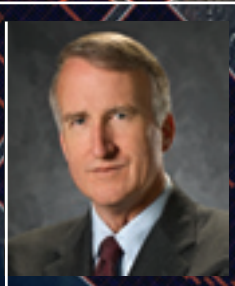
COMMANDER, AIR FORCE SPACE COMMAND



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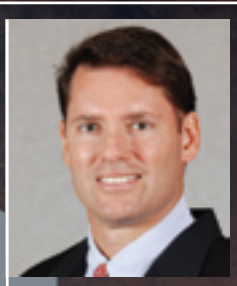

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MASTHEAD CONTENTS

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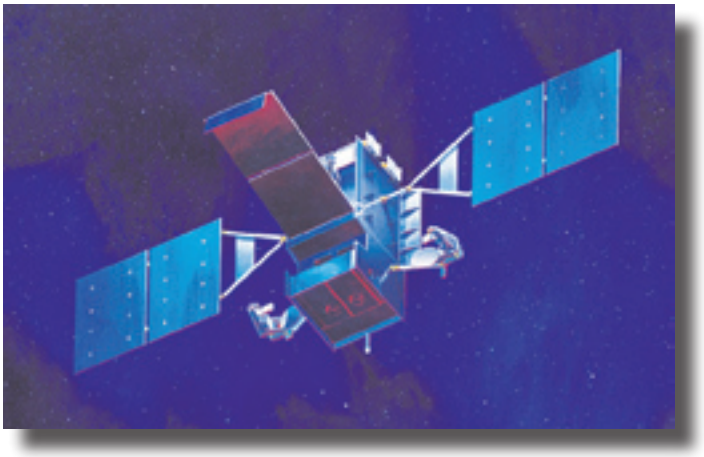
Congratulations are in order to the Space & Missile Center. The U.S.A.F. facility has accomplished two crucial missions — the first is the fully operational status of the final Global Positioning System IIR satellite and the second is the National Geospatial Agency's (NGA) certification and acceptance of the Space Based Infrared Systems, Highly Elliptical Orbit data for use in support of technical intelligence missions.



SBIRS satellite (image courtesy of Lockheed Martin)

GPS IIR-21(M) has been declared operational for military and civilian users worldwide. This step was completed a mere 10 days after the satellite's from Cape Canaveral AFS. GPS satellite (USAF) GPS IIR-21(M) nowjoins the constellation of 30 operational satellites on orbit providing global coverage and increased overall performance of GPS service. This IIR-M satellite brings into the defense mix improved accuracy, enhanced encryption, anti-jamming capabilities, and a second civil signal to provide dual frequency capability and improve resistance to interference.

"The 50th Space Wing is extremely proud of adding this new satellite to the operational constellation and we look forward to continuing to use this spacecraft to help with the current fight as well as to support civil users around the world," said Colonel Wayne Monteith, 50th Space Wing Commander.

In regards to SBIRS, Mr. Dennis Lee, Chief, Overhead Persistent Infrared Systems for the NGA, approved formal certification after a comprehensive review of test results. The purpose of the technical intelligence certification process is to assure all contributing systems provide reliable, timely, accurate, and unambiguous data for use in U.S. intelligence production. This milestone culminates more than two years of test planning and operational refinements, rigorous functionality testing, and data feasibility and characterization assessments by a joint NGA, National Air and Space Intelligence Center, Lockheed Martin, Northrop Grumman and SBIRS Wing team. Technical intelligence is one of four designated missions the SBIRS system supports, complementing the others: missile warning, missile defense, and battlespace awareness.

"Technical intelligence certification of the HEO data is a significant achievement shared by the entire SBIRS team. NGA's certification validates the effectiveness of SBIRS capabilities to the intelligence mission and is a testament to the hard work and success of the combined team. We are very pleased with the growing contributions of the SBIRS system to the broader national security space community" said Col. Roger W. Teague, Commander of the Space and Missile Systems Center's, Space Based Infrared Systems Wing, following the certification declaration. The SBIRS technical intelligence certification closely follows successful certification of the HEO system for missile warning operations by U.S. Strategic Command on Aug 7, 2009.

There was a slight problem with the Landsat 5 satellite — the satellite's power had remained at a critically low level and the extent of any potential damage had not been identified. All is well now, as the USGS is, once again, able to capture data from Landsat 5 — the satellite is now functioning as expected. As a matter of fact, the agency has told us that the one millionth scene of Landsat data is now available for download via the Internet at no cost. This scene, which covers the Grand Canyon, was captured by the satellite on August 17th!

— INCOMING —

Frost & Sullivan has recently released their *European Defence Strategic Communication Market Assessment*, which estimates that the market will earn revenues of $1.08 billion in 2009 and reach $2.37 billion by 2018.

This growth is attributable to the rapidly spreading tenet that SATCOM is a key enabler of networked communication, which is fundamental to Network-centric Warfare (NCW). According to Major Sabbir Ahmed (retired), Frost & Sullivan Research Analyst, "The market is showing signs of rising demand for higher frequencies and wider bandwidths. Networking imperatives for far-flung deployments, improved sensors including unmanned aerial vehicles (UAVs), as well as personnel needs to communicate with their families back home, have all generated a massive increase in bandwidth demand for smooth transmission of voice, data, video and images. This can only be achieved with greater investment in higher frequencies like EHF and AEHF and related SATCOM terminals, among others."

The gradual integration of communication means with elements of situational awareness such as navigation, identification and sensors is the trend of the day. Communications-on-the-move (COTM) terminals have already demonstrated the embodiment of integrated communication and navigation systems, and have the potential to integrate other elements of situational awareness over time. "In the near future we can expect to see every mine-resistant-ambush-protected (MRAP) platform fitted with one such integrated COTM terminal," predicts *Ahmed*.

"From 2013 onward, the Ka band will rapidly acquire market share thanks to increasingly number of satellite launches carrying EHF payloads. Unlike the already widely used X and Ku bands, the sky remains relatively open for the Ka band," remarks *Ahmed*. "In the terminal market, multi-band terminals are replacing single bands to claim an increasing stake in procurement across platforms and are set to grow even more robustly with the onslaught of EHF and AEHF bands in the market from 2013 onwards. The COTM terminals should see significant penetration from 2016 onwards."

Technological and regulatory barriers to greater bandwidth, arresting power losses in higher frequencies, and the increased tightening of space entry are some of the major challenges, besides the credit crunch, that could substantially impede market growth. "Armed forces that rely solely on military satellite communications (MILSATCOM) will find that these no longer suffice in meeting growing requirements," states *Ahmed*. "Commercial SATCOM will continue to play an increasing role in filling the gap."

Companies are likely to gain higher returns from investing in satellites that operate with higher frequency payloads. The current credit crisis may prove a barrier to further investment in such satellites. At the same time, however, it may also provide significant opportunities for new entrants. New and flexible companies that adapt early in the game will likely gain dominance in the integrated communication and situational awareness market. However, traditional giants will need to reduce response time if they want to remain competitive. "Companies might seek strategic partnerships to fill capability gaps in areas such as data links, avionics electronics, payloads, COTM terminals, and network interfaces in order to realise the benefit of an integrated C4ISR," says *Ahmed*. "In this highly lucrative market, a trend-based approach to partnerships and alliances is necessary to develop innovative, market-winning products and securing market entry."

MilsatMagazine — September 2009

— INCOMING —

If you are interested in a virtual brochure, which provides a brief synopsis of the research and a table of contents, please email ***Monika Kwiecinska***, Corporate Communications, with your full name, company name, title, telephone number, company email address, company website, city, state and country. Upon receipt of the above information, a brief brochure will be sent to you by email.

European Defence Strategic Communication Market Assessment is part of the **Defence Growth Partnership Service** program. Frost & Sullivan leverages more than 45 years of experience in partnering with Global 1000 companies, emerging businesses and the investment community from more than 35 offices on six continents.

MILCOM network connectivity has been improved by General Dynamics The Joint Tactical Radio System (JTRS) Handheld, Manpack, Small Form Fit (HMS) team, led by General Dynamics C4 Systems, has successfully added the highly capable Soldier Radio Waveform (SRW 1.0c) to the Rifleman Radio (AN/PRC-154) and the HMS Manpack Radio intended for use in vehicles. This places HMS first in line to bring the JTRS SRW 1.0c to dismounted soldiers for an unprecedented level of network connectivity.

JTRS Manpack HMS (General Dynamics) Next steps for the Rifleman Radio include Security Verification Testing and final certification, followed by a Department of Defense Milestone C decision which is the last step before low-rate initial production (LRIP). The government expects to make its LRIP award for HMS in November 2009. In preparation for initial production, the General Dynamics-led team has qualified four manufacturers as suppliers of HMS radios to the government. Each of the manufacturers — BAE Systems, General Dynamics, Rockwell Collins and Thales Communications — have successfully built and delivered HMS radios to the government for testing and use during military exercises. Keeping soldiers on the ground better connected to their team members and commanders while reducing power consumption and extending battery life is the HMS mission. Using the Soldier Radio Waveform, HMS radios create their own communication network without the use of towers to relay radio signals, linking any platform — such as vehicles soldiers, even robots – into ad hoc networks. This is an advantage when users are in remote locations or have to work around obstructions as one HMS radio will find another, automatically routing the message to the end user.

Harris Corporation (NYSE: HRS) has received certification from the National Security Agency (NSA) for the Harris RF-310M-HH, the world's first tactical radio to use new encryption technology designed to simplify the enabling of communications interoperability within multinational coalitions — Harris and NSA collaborated on the new technology, which is based on a set of commercial algorithms and keying techniques defined as "Suite B."

The Harris RF-310M-HH is a multiband, multi-mission, software-defined Suite B radio certified to transmit voice and data up to the U.S. SECRET level. The objective of the Harris/NSA joint project is to make it easier for U.S. forces and coalition partners to communicate on the battlefield, resulting in improved coordination, easier mission planning and reduced instances of friendly fire. These radios will be commercially available to coalition partners with limited restrictions and will enable secure communications with U.S. troops using other equipment such as the JTRS-approved Falcon III(R) AN/PRC-152(C) handheld and AN/PRC-117G manpack radios.

The RF-310M-HH has also been submitted to NATO's Military Committee Communications and Information Systems Security and Evaluation Agency for NATO SECRET traffic certification.

ITT Corporation's imaging system will e aboard DigitalGlobe's WorldView-2 remote sensing satellite for its launch on October 6th. The WorldView-2 imaging payload is the second such system engineered and manufactured by ITT Space Systems Division for DigitalGlobe.

The ITT imaging system on WorldView-2 is designed to assure the availability of high-resolution imagery for military, intelligence, foreign policy, homeland security and civil applications. The payload includes the electro-optical assembly (camera and telescope), focal plane detectors and electronics, power supply unit and high-speed digital processors. It also provides a flexible and scalable platform that supports virtually any sensor configuration and the ability to customize and enlarge instruments. The sensor is the highest resolution commercially available and boasts the fastest large area collection — up to five GB per second. Once deployed, the imaging system will take pan-sharpened, multispectral images of the earth at 1.8 meter resolution from almost 500 miles above the Earth.

MILCOM, in case you were unaware, is the premier international conference for military communications and attracts the best and brightest with high-level attendance from government, military, industry and academia.

MILCOM 2009 offers our industry the opportunity to promote communications technologies and services to commanders from all branches of the armed forces, Department of Defense, federal government, and the heads of multi-national forces from around the globe. Confirmed featured speakers include:

- ***ADM Thad W. Allen, USCG, Commandant, U.S. Coast Guard***

- ***GEN Peter W. Chiarelli, USA, Vice Chief of Staff, U.S. Army***

Panel Sessions Include:

- ***Challenges of Convergence: DoD J6 Perspective — Moderator: LTG Dennis Via, USA, Director, Command, Control, Communications and Computer Systems, J6, The Joint Staff***
- ***Science and Technology for Future Military Communications — Moderator: Dr. Cynthia Dion-Schwarz, Director, Information Systems, DDR&E/DUSD (S&T)***
- ***Converging MILSATCOM, JTRS and the GIG — Moderator: Mr. Richard Williams, Principal Director, GIG Enterprise Services Engineering, Defense Information Systems Agency***
- ***Migration Toward International Network-Centric Interoperability — Moderator: Representative from the Office of the Assistant Secretary of Defense for Networks and Information Integration***
- ***NATO C4ISR Coalition Planning, Execution and Lessons Learned — Moderator: Mr. Malcolm Green, Chief, CAT 9 Communication Infrastructure Services, NATO C3 Agency***
- ***Unmanned Aerial Systems: Providing Enhanced C4ISR Capabilities to the Warfighter — Moderators: Mr. Henry J. Muller, Jr., Director, CERDEC – Space and Terrestrial Communications Directorate and COL Raymond Jones, Program Manager, Airborne Maritime Fixed Station, JTRS***

Classified (U.S. Secret and below) and unclassified sessions will include more than 400 technical paper presentations and there will be more than 200 exhibits, which will be co-located in the World Trade Center exhibit hall. See, touch and try out the latest communications technologies. For additional information and registration, ***head over to the registration website*** or select the graphic on Page 8.

Australian satellite company, NewSat Limited, has formed an important, strategic alliance with channel partner and defense communications provider, Proactive Communications Inc. (PCI). Many SATCOM companies focus solely on the American market. This has been problematic for military operations, as the U.S. has been unable able to find many secure, as well as reliable, options for unified communications, especially as international operations for the U.S. Government requires a very strong global support network.

In terms of military communications, security is paramount. Suppliers and networkers must be trusted and accredited. As NewSat fills both requirements, the company is an understandable choice for the development of military partnerships with PCI. PCI's ability to offer unified communications through NewSat's satellite network has strengthened the Texas-based company in contract acquisitions, especially due to Newsat's teleports in Adelaide (South Australia), with global reach to Southwest Asia — a region that has proven to be challenging for American companies.

This partnership has resulted in high-speed, reliable, and secure satellite communications that are able to facilitate unified communications

for coalition troops or businesses in Afghanistan. In the past, unified communications were difficult to establish for this region — this international partnership managed to achieve this feat a few months ago. NewSat CEO *Adrian Ballintine* said the current two year contract would see satellite communications available to PCI for exclusive use in Southwest Asia. "NewSat's time-tested reputation for providing reliable satcomms coupled with PCI's ability to harness satellite bandwidth, will resolve many communications barriers in the Middle East."

The Australian-U.S. partnership has the ability to expand and evolve as communication needs change for the region. Both companies are **Cisco** certified and experienced in unified communications for military operations, which has definitely gained favor within Defense agencies and selectors. NewSat's satellite network has a strong global reach and currently enjoys worldwide contracts with companies whose focus extends from the mining and exploration sector, to retail, construction, and emergency services.

Northrop Grumman Corp. successfully demo'd Joint STARS and E-2 Hawkeye interoperability between manned and unmanned platforms during a recent virtual joint military demonstration involving U.S. and coalition forces. The demo, *Empire Challenge 09* (EC09), was executed by *U.S. Joint Forces Command* (USJFCOM) revealed how U.S. and coalition forces can better work together to collect, analyze, and share relevant reconnaissance information.

During the month-long exercise, virtual physics-based and operational flight program simulations of multiple Northrop Grumman platforms, including the ***E-8C Joint Surveillance Target Attack Radar System*** (**Joint STARS**) and ***E-2 Hawkeye Airborne Early Warning and Control*** (**AEW&C**) aircraft, worked collaboratively to achieve interoperability between multiple manned and unmanned aircraft via an airborne web services architecture. One key element to the success of this interoperability was an E-2 Hawkeye developmental test bed. The test bed is based on the capability of the U.S. Navy's E-2 Hawkeye mission computing system, which enabled it to successfully operate the *Electrical Optical* (**EO**) sensor onboard both manned and unmanned aerial vehicles (UAVs) in response to requests from ground commanders. Using machine-to-machine command interfaces, the E-2 test bed was able to cue each UAV simulator to provide imagery of both static and dynamic ground tracks for target identification. The image request messages were transmitted via machine-to-machine interfaces, replacing the need for voice and manual chat resulting in an increased response time. The virtual Joint STARS integrated the ***Battle Management Command and Control*** (**BMC2**) architecture providing constellation management along with UAV control and multi-level security capability sets which enabled the platform to demonstrate an expansion of its current ISR role to include automated UAV image collection and development of target quality solutions to support strike engagements.

MQ-5B Hunter UAS (Northrop Grumman)

Sensor imagery received from the UAVs via Joint STARS was provided to an image analyst who examined each image and determined which should be included in the image product library (IPL). Images in the IPL were used to populate the ***Global Command and Control System*** (**GCCS**). Once threats were identified, the E-2 test bed managed airborne attack assets, including F-18s and EA-6Bs, to conduct precision strike missions against those threats, based on Joint STARS ground tracks and correlated imagery supporting threat identification. The net effect of this ISR sensor tasking and command and control network was a reduction in both the

'kill-chain,' the time it takes to find, identify, and engage a target, and the operator workload required to accomplish the task. In addition to the virtual Joint STARS and E-2 Hawkeye platforms, other **Northrop Grumman** assets participating virtually in **Empire Challenge 09** included the ***RQ-4 Global Hawk*** unmanned aircraft reconnaissance system, ***MQ-8B Fire Scout*** vertical takeoff and landing unmanned system, and the ***MQ-5B Hunter*** medium altitude unmanned aerial system.

The virtual, human-in-the-loop wargaming environment used in Empire Challenge was built by Northrop Grumman and developed with the company's ***Cyber Warfare Integration Network*** (**CWIN**). Based at the USJFCOM *Joint Intelligence Laboratory* (**JIL**) in Suffolk, Virginia, the virtual platforms were linked to the "live-fly" exercise at the *Naval Air Weapons Station* (**NAWS**) in China Lake, California, as well as the *Combined Air Operations Center-Experimental* at Langley Air Force Base, Virginia.

Orbit Technology Group was awarded an order in excess of $4 million by the French Navy via DCNS — Orbit will supply the French Navy with Ku-band OrSat and C-band marine SATCOM systems. The French Navy will now obtain continuous, high speed, two-way connectivity for reliable reception and transmission of voice, data and Internet connectivity in harsh environmental conditions.

Avi Cohen, the President & CEO of Orbit, was enthusiastic regarding the new contract. "We are very pleased with this important addition to previous Orbit contracts with other leading European navies. Our success in winning this tender underscores our technological capabilities in the field of satellite communication. We continue to demonstrate that, with Orbit's

antenna systems, navies obtain the dependable and comprehensive coverage, critically important for today's threat filled environment."

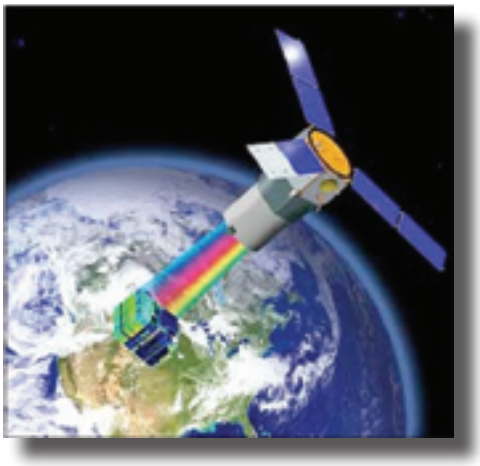
Orbit's off-the-shelf, ready -to-opereate **Marine Satellite Communication** systems offer a number of unique features. Using an exclusive modular mechanical design that is extremely compact and highly efficient, the systems provide high bandwidth, always on, connectivity. OrSat also boasts no keyholes for continuous zenith-horizon communications. With built-in GPS and RF packages, OrSat requires no system balancing and is exceptionally easy to install, operate, and maintain and it possesses **Eutelsat**, **Intelsat,** and **Anatel** type approvals.

Orbit also presented its new and improved **OrSat-G** antenna at ***CommunicAsia*** in Singapore. Orbit's ***Global-Ku Marine Stabilized Antenna*** (**OrSat-G**) can support the connectivity requirements of different satellites under any sea conditions worldwide. It is type-approved by the major satellite companies, whose chain of spot-beams enables coverage for ocean-crossing shipping routes.

The enhanced capabilities of OrSat-G are based on *Automatic Beam Switching* (**ABS**), *Co* or *Cross Polarization*, different power limitations, and *Global LNB*. The new OrSat-G provides non-stop Internet connectivity onboard vessels with international routes. Like its predecessor, the OrSat-G is simple to operate with plug-and-play architecture and is highly cost-effective throughout its life cycle.

In addition to the OrSat-G, Orbit also debuted the **60cm Ku-Band marine VSAT** antenna system and the SATCOM innovative solution that possesses a unique RF-tracking algorithm for high-speed trains that is compliant with satellite regulations and train standards.

Tactical Satellite-3 (*TacSat-3*) has completed its critical calibration phase and the program team is now preparing the 880-pound spacecraft for the crucial validation stage. This stage involves demonstrations of the primary payload, the *Advanced Responsive Tactically-Effective Military Imaging Spectrometer*, and the two secondary trials, the *Satellite Communications Package* and the *Space Avionics Experiment*, occurring the rest of its year-long mission.



Administered by the AFRL's *Space Vehicles Directorate*, TacSat-3 serves as a partnership between the Department of Defense's *Operationally Responsive Space* office, the **Air Force Space and Missile Systems Center**'s *Space Development and Test Wing*, the **Army Space and Missile Defense Command**, the **Office of Naval Research**, the AFRL's *Sensors Directorate* and the **National Geospatial-Intelligence Agency**.

RaySat Antenna Systems has developed the StealthRay 5000 antenna to meet the demanding and diverse needs of SATCOM on-the-move customers. RaySat Antenna Systems' StealthRay line of antennas supports 2-way, low-profile, in-motion satellite communication and is intended for installation on a variety of vehicle types in the military, HLS, first-responder and public enterprise sectors.

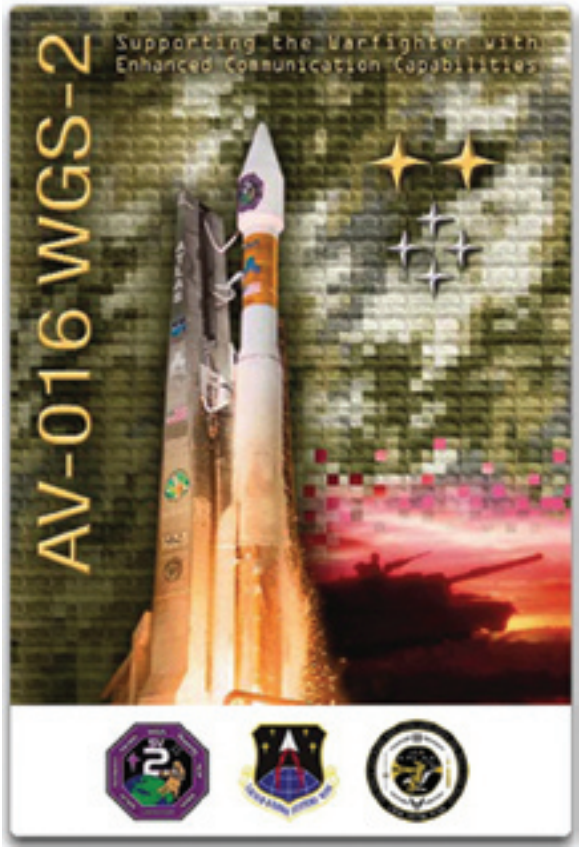
Using flat panel antenna technology, the ***StealthRay 5000*** was specifically designed for customers requiring higher link data rates. The new antenna model has a higher transmit gain, supporting demanding applications, such as the transmission of a high-quality video stream from mobile units in the field to

RaySat's StealthRay 5000 antenna

a fixed station. This antenna model is ideal for government customers that need high bit rate streaming video for defense and security related applications. Another market that will benefit from the StealthRay 5000 is *Mobile Digital Satellite News Gathering* (**M-DSNG**), which is increasingly looking for technology solutions to offer high-quality, high-resolution video transfer while vehicles are in-motion. The StealthRay 5000 maintains the low-profile form factor of the StealthRay product line and has only a nominal increase of 3 cm in the antenna height.

The U.S. Air Force's U.S. Strategic Command has accepted command and control of its second Wideband Global SATCOM (WGS) communication satellite, WGS-2. This significant achievement reflects the successful collaboration between numerous organizations, that include the Space and Missile Systems Center (SMC), Air Force Space Command, Army Space and Missile Defense Command/Army Forces Strategic Command, and The Boeing Company. The Australian Defense Force has also partnered with these organizations to provide worldwide SATCOM coverage and support to the Southwest Asia region with the WGS constellation. WGS provides flexible, high-capacity communications for marines, soldiers, sailors and airmen throughout the world.

WGS is a key enabler of Command and Control, Communications Computers, Intelligence, Surveillance, and Reconnaissance, as well as battle management and combat support information functions. WGS-2 is the second of six planned satellites in the wideband constellation. After launching from Cape Canaveral on the evening of April 3, the Military Satellite Communications Wing at the Space and Missile Systems Center accepted delivery of WGS-2 from Boeing on June 15 after extensive ground and in-orbit testing. WGS-2 was then relocated to its final operational location. WGS and its payload configuration was optimized to support operations, and, upon the recommendations of HQ Air Force Space Command and Army



Space and Missile Defense Command/Army Forces Strategic Command, United States Strategic Command accepted Combatant Command authority for WGS-2 and assumed responsibility of the system from AFSPC.

WGS-2 will be operated by the 3rd Space Operations Squadron at 50th Space Wing, Schriever AFB, Colo., under the operational command of JFCC SPACE at Vandenberg. The JFCC SPACE Joint Space Operations Center will continuously monitor WGS-2's orbital safety and operational status, assisting USSTRATCOM with any performance issues. WGS-2 will bridge a critical gap in military communications supporting troops in Afghanistan, Iraq, and other parts of Southwest Asia. It is the first military communications satellite to provide Ka-band communications in theater, paving the way for Global Hawk and Predator remote aircraft to securely link live, down-range data back to command and control centers.

COMMAND CENTER

General C. Robert "Bob" Kehler is Commander, Air Force Space Command, Peterson Air Force Base, in Colorado. He is responsible for organizing, equipping, training, and maintaining mission-ready space, cyberspace, and missile forces and capabilities for North American Aerospace Defense Command, U.S. Strategic Command, and other combatant commands around the world. General Kehler oversees Air Force network operations; manages a global network of satellite command and control, communications, missile warning and launch facilities; ensures the combat readiness of America's intercontinental ballistic missile force; and is responsible for space system development and acquisition. He leads more than 43,000 professionals, assigned to 86 locations wordwide and deployed to an additional 35 global locations.

General Kehler entered the Air Force in 1975 as a distinguished graduate of the Air Force ROTC program. He has commanded at the squadron, group, and wing levels. He has a broad range of operational and command tours in ICBM operations, space launch, space operations, missile warning and space control. He commanded a Minuteman ICBM operations group at Whiteman AFB, Missouri, and the Air Force's largest ICBM operations group at Malmstrom AFB, Montana. He served as Deputy Director of Operations, **Air Force Space Command**; and commanded the **30th Space Wing** at Vandenberg AFB, California, and the **21st Space Wing**, Peterson AFB, Colorado. Most recently, as Deputy Commander, **U.S. Strategic Command**, he helped provide the President and Secretary of Defense with a broad range of strategic capabilities and options for the joint warfighter through several diverse mission areas, including space operations, integrated missile defense, computer network operations and global strike.

The general's staff assignments include wing-level planning and tours with the Air Staff, Strategic Air Command headquarters and Air Force Space Command. He was also assigned to the Secretary of the Air Force's Office of Legislative Liaison, where he was the point man on Capitol Hill for matters regarding the President's ICBM Modernization Program. As Director of the **National**

General Kehler speaks to Malmstrom AFB Airmen to address issues being faced among the ICBM wings. (U.S. Air Force photo/John Turner)

Security Space Office, he integrated the activities of a number of space organizations on behalf of the Under Secretary of the Air Force and Director, **National Reconnaissance Office**.

MilsatMagazine (MSM)

General Kehler, as the commander of Air Force Space Command, would you please inform our readers as to the breadth of your organization and its responsibilities?

General Kehler

As commander, I am responsible for the development, acquisition and operation of the Air Force's space and missile systems. I also oversee a global network of satellite command and control, communications, missile warning and launch facilities, and ensure the combat readiness of America's intercontinental ballistic missile force. We are also standing up 24th Air Force under the command, which will operationalize the cyberspace mission for the Air Force. We have more than 39,000 talented space professionals in this command who provide combat forces and capabilities to North American Aerospace Defense Command and U.S. Strategic Command. Simply stated, the mission of Air Force Space Command (AFSPC) is to provide an integrated constellation of space and cyberspace capabilities at the speed of need. Our vision is to be the leading source of emerging and integrated space and cyberspace capabilities.

MSM

How were you able to accomplish bringing the various space wings together into more integrated roles?

General Kehler

Space is global and dynamic in nature and the five wings under the 14th Air Force take on the critical space operations missions. The Joint Space Operations Center (JSpOC), located at Vandenberg AFB, California, uses the Joint Space Tasking Order (JSTO) process to help integrate space capabilities and global space effects AFSPC offers to the warfighter. Through the JSTO, the JSpOC operationally integrates the wings and 29 joint space systems to deliver global and theater space effects.

On a daily basis, the JSpOC integrates space capabilities and delivers global space effects to include SATCOM; Positioning, Navigation and Timing; Intelligence, Surveillance and Reconnaissance (ISR); missile warning and defense in support of the combatant commanders and our allies. The JSpOC also works with commercial and foreign agencies by using multiple space sensors to develop the best-possible space situational awareness picture and predict conjunctions and collisions.

Advanced EHF satellite

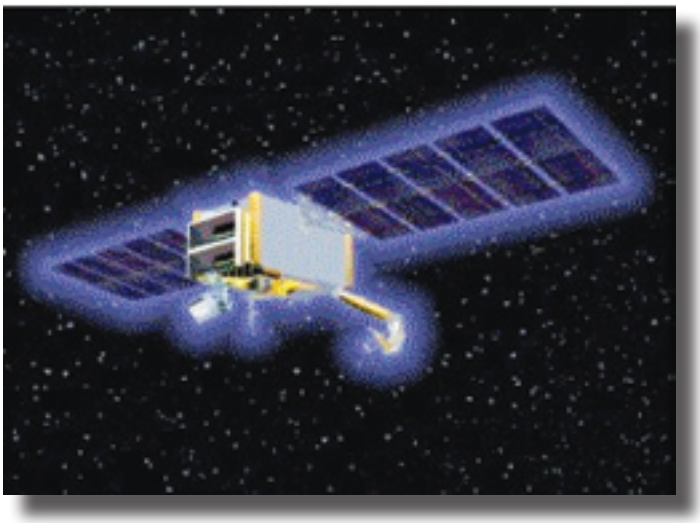
GPS satellite

MSM

In December of 2007 you stated, "The space capabilities we provide today are embedded in all of our combat operations. They're also embedded in our military operations, short of combat, across the board. In fact, we cannot fight the way America fights today without space capabilities." What capabilities were you referring to, and where will these capabilities need to be over the coming years?

General Kehler

The mission of the U.S. Air Force is to fly, fight and win…in air, space and cyberspace. The Air Force has played a central role in the development of space capabilities that are vital to our National security, economic growth, public safety and welfare. Some of our core functions include assuring the Nation's access to space, protecting our freedom to operate in space and providing Joint warfighting capabilities from space. Specifically addressing future MILSATCOM capabilities, the Wideband Global SATCOM (WGS) System provides essential communications services for combatant commanders to command and control their tactical forces. It provides a quantum leap in communications bandwidth for our Soldiers, Sailors, Airmen and Marines. In the same vein, the Advanced EHF (AEHF) system, slated to launch in Fall 2010, will provide more survivable, jam-resistant, worldwide, secure communications with a ten-fold increase in capacity and more than five times the data rate of Milstar.



SBIRS satellite

GPS is the most well known and prolific space capability. The Air Force and AFSPC have been the diligent stewards of GPS since its conception in the 1970s and continue this commitment to such a critical component of our National Infrastructure. The current GPS constellation has the most satellites and the greatest capability ever. We strive to improve service and capability through on-going modernization efforts. The Air Force will continue to pursue an achievable path maintaining GPS as the premier provider of positioning, navigation and timing (PNT) for the military and civilian users around the world.

Today, we have 30 satellites orbiting the Earth, which provide persistent PNT signals across the globe. We also have three spares in orbit and a new satellite going through operational checkout. Since we declared Full Operational Capability in 1995, the Air Force has maintained the constellation above the required 24 GPS satellites on orbit.

Our space-based ISR assets provide critical support to the joint warfighting team. These ISR assets play an integral role in programs including the Defense Meteorological Satellite Program (DMSP), Defense Support Program (DSP), and Space Radar. Many ISR systems were not specifically designed to support tactical battlefield operations as their primary mission, yet their services have become essential to warfighting capabilities. The Battlespace Awareness mission is an area where we can use sensors differently from their original intent delivering capability to the warfighter that can make a difference in the outcome on the battlefield. For example, the Space-Based Infrared Systems (SBIRS) High (HEO) sensor can detect heat or hot gasses from missiles and other

man-made objects as designed. But it can also detect terrestrial events like volcanic eruptions and wildfires, as well as weather data from clouds and storms.

In addition, our weather satellites are absolutely essential in planning and conducting operations given they provide awareness of the space environment for events such as solar flares and solar flux, as well as conditions on the ground. The overall picture these satellites provide our planners afford greater fidelity in planning worldwide operations and establish parameters for critical products such as the air and space tasking orders.

MSM

How can the services protect our space capabilities within hostile environments and, if possible, can you mention some of the vulnerabilities that were overcome to benefit our Nation and our warfighters?

General Kehler

Space is one of many domains through which we conduct activities to support military operations. By building robust architectures (i.e. redundancy, alternative means) for warfighter support functions, we make it more difficult for an adversary to disrupt or deny our military capabilities.

We also continue to increase our knowledge of our adversaries' concepts of space operations to better understand their actions. This increased understanding improves our space situational awareness capabilities allowing us to better monitor and respond to activities in space that may put our systems at risk. We are also looking at concepts to directly protect space systems and, if necessary, rapidly augment or replace critical space capabilities through our Operationally Responsive Space initiative.

Finally, we are taking steps to protect the entire architecture which includes space, link and ground segments. Because the ground segment is the most accessible of the three segments, we employ numerous measures to ensure physical security. These measures mitigate our risk and make it more difficult for an adversary to degrade or deny a space capability.

MSM

Secure satellite communications are important in what ways?

General Kehler

Protecting, sustaining and employing our capabilities while preventing adversaries from deterring or denying our freedom of action during a conflict is central to our mission effectiveness in the Joint fight. We provide protected communication for our Nation's leaders, combatant commanders and warfighters, who will continue to demand space, cyberspace and related capabilities that are responsive, flexible and integrated with other warfighting elements. These capabilities must be assured. Specifically, secure communications give us the ability to exchange information without undue concern that our adversaries will have access or will be able to deny or disrupt our critical communications. Today, all our military satellite communications use encryption to ensure information remains secure. In addition, we're providing more "protected" communications that operate in the presence of jamming, which is a growing threat.

MSM

What links are necessary between the space and ground segments to improve functionality?

General Kehler

The Air Force maintains a worldwide network for control of satellites called the Air Force Satellite Control Network (AFSCN). This network is our primary method for the control and maintenance of all DoD satellites. However, there are far too many satellites for the AFSCN to maintain a continuous link to each satellite, so use of the AFSCN is scheduled and apportioned for our systems.

Many new satellites — especially communications satellites — are designed to be continuously reconfigured to meet user needs. For example, Wideband Global SATCOM satellites and Milstar satellites have complex on-board signal routing and antenna pointing systems that must respond to warfighter needs real-time. To provide this full-time control, each satellite's communications capacity is shared between the communications of the warfighter and the control of the satellite — a process called "in-band satellite control." This creates a control link that parallels and supplements the AFSCN, freeing the AFSCN for the precision orbit control, anomaly recovery and "behind the scenes" maintenance. Each new generation of satellite increases this in-band control as the satellite's mission becomes more complex and response time becomes more important. In the end, both the AFSCN and in-band control are necessary.

MSM

What does the term "land-based strategic deterrent" encompass within your command? What role do satellite communications play?

General Kehler

Our land-based strategic deterrent remains the ultimate backstop of our Nation's security, dissuading our opponents and assuring our allies through extended deterrence. Our Nation's security relies heavily on the enduring attributes of the Minuteman III Intercontinental Ballistic Missile (ICBM) force and the professionalism of those who secure, maintain and operate it. We remain dedicated to ensuring a credible, safe and combat-ready ICBM force that convinces potential adversaries of our commitment to defend our Nation, its allies and friends.

The Minuteman III ICBM force provides AFSPC's contribution to the Air Force's nuclear strategic deterrent infrastructure alongside B-2 and B-52 bomber aircraft. Once Air Force Global Strike Command becomes operational, it will assume responsibility for the Minuteman force. The credibility of the deterrent force depends on the ability for the President to unambiguously command and control U.S. nuclear forces. This is facilitated by a redundant,

assured communications capability. Satellites such as Milstar and, in the future, Advanced EHF, in addition to ground facilities and airborne platforms, all ensure messages are received regardless of adversary attempts to compromise communications links.

MSM

Product procurement has necessitated lengthy approval processes before a much-needed program can be incorporated into a working mission. Do you see the Air Force working to ensure effective space capabilities can be deployed more quickly? How will such be accomplished, given the past procurement process histories?

General Kehler

In today's world of rapid technological advancement and proliferation, we must deliver capability to the warfighter faster. We require a new strategy to develop, deliver and sustain space and cyberspace systems that is more agile and responsive than traditional acquisition processes and management methods. In order to accomplish this, we will have a disciplined, repeatable process to ensure validated requirements are established with users, properly vetted and documented and only adjusted through a deliberate process. This strategy demands a new approach that deploys defined end-state capabilities at the speed of need, within government cost estimates. Since there are no re-visits in space, the necessity of providing the warfighter the best possible system from day one drives the acquisition system to place a premium on performance, sometimes at the detriment of cost and schedule. We are more sensitive than ever to the need to get capability into the warfighters' hands, but as with most acquisition lessons learned over the last decade, this involves a delicate balance between cost, schedule, performance and risk. Over the past decade, the Air Force has been focused on using an evolutionary approach for rapid acquisition of mature technology for our warfighters. We have implemented a "Back to Basics" philosophy and a Block Approach Strategy, which allows us to quickly field new capabilities and deliver improvements in increments.

MSM

During the 2008 Interservice/Industry Training, Simulation and Education Conference, the 711th Human Performance Wing's Warfighter Readiness Research Division demonstrated tools for interactive military training using gaming technology. It resulted in lower training costs, but how effective is the method of training for space career fields? Could such training be used beyond flight and air combat training; for space command training?

General Kehler

We believe the use of gaming technology will be very effective for our Space Operator training needs. With a product we call the Standard Space Trainer, or SST, we are well on the road to implementing this type of technology for our Space Ops simulators training program. We have recently completed a proof-of-concept to demonstrate and validate our SST vision which employs commercial off-the-shelf (COTS) PC hardware and operating systems, in addition to the use of gaming technology. In 2008, we awarded a contract for a full production SST architecture to be delivered in 2010. This framework will enable any space system trainer to be built on a PC-based COTS hardware solution, without reliance on the actual operational mission hardware or software. These are just the first of many steps we are taking to improve our Space Operations training program.

We are also very interested in and supportive of Air Combat Command's initiatives to improve distributed and virtual training. We see a big role for space in these and other "live" training activities conducted by the USAF Warfare Center.

MSM

What are your perceptions regarding the current efforts by much smaller, privately-held companies in the design, manufacture and delivery of launch vehicles for use by the military?

General Kehler

We strongly encourage new U.S. commercial space transportation capabilities that demonstrate the ability to reliably launch intermediate or larger payloads. Further, it is important for AFSPC to support and employ measures to preserve a healthy techno-industrial

base and supporting work force. AFSPC is preserving funding for technology development independent of acquisition programs and considers industrial base implications when making contract award decisions to enhance the health of the techno-industrial base.

AFSPC must have agile and responsive development and acquisition processes in place to meet that challenge and must field new systems that meet or exceed performance, cost, and schedule goals while providing decisive, war-winning advantages. In addition, we must plan and invest wisely, ever mindful of growing resource constraints. Any company that can help us meet these goals will be considered.

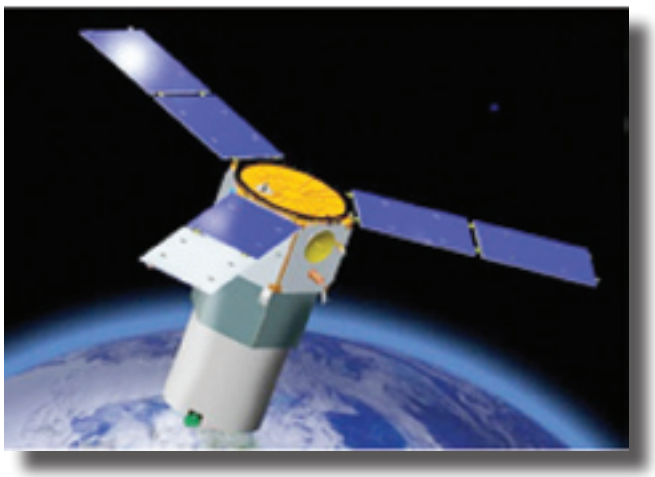
MSM

Do you see the "less costly and quicker into orbit" micro, mini, pico, nano satellites as having a role to play in future space command scenarios?

General Kehler

In the last two years, academia has clearly demonstrated small satellites can be used for science and technology maturation applications. We are working with the labs to conduct our own research across the Air Force.

For example, in May, the Tac-Sat 3, was launched into low Earth orbit. This project being run by the Air Force Research Lab is part of our Operationally Responsive Space Program. While this is a technology demonstration, it shows that we can field and deploy spacecraft for particular theater combatant commander needs. Over the next year, it will demonstrate new technologies, such as hyperspectal imaging, as well as other capabilities.



TacSat-3 satellite

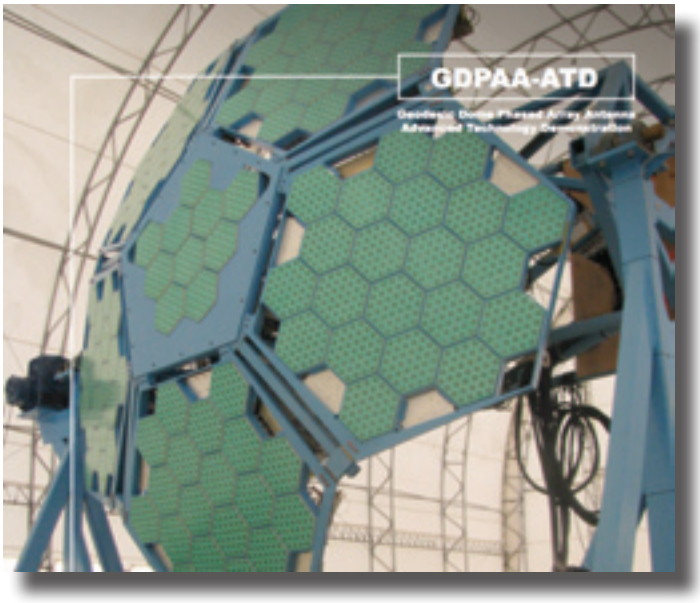
In addition to Tac-Sat, we have another program called ORS-1 responding to an urgent imagery requirement in USCENTCOM. It will use the existing space-ground link the U2 uses today. When the satellite flies over the USCENTCOM theater, this satellite will be received as if it is a high altitude U2.
In many cases, we may be able to do some substantial work with many small satellites. However, in some cases, we are going to need larger platforms. All things considered, we do see tremendous potential in being able to put another strategic bow in our quiver with smaller satellites. They are great for the Nation and for industry, and they give the warfighter potential for "on-call" services downrange. In addition, they provide an opportunity to standardize design techniques and lower our launch costs.

General Kehler

Are there new technologies coming online that will prove to be an asset to your command? Could you discuss these advances?

General Kehler

We make it a point to support and employ measures that preserve a healthy techno-industrial base and supporting work force. There are several exciting technological advances I would like to highlight. The first is our Space Optical Communications technologies which hold promise of providing significantly higher data rates with a reduced susceptibility to interception and jamming. These increased data rates will support airborne and space Intelligence, Surveillance and Reconnaissance (ISR) platforms and missions, such as unmanned aerial systems with optical data rates 10 to 100 times higher than radio frequency rates.



Second, our Geodesic Dome Phased Array Antenna (GDPAA) is currently in an Advanced Technology Demonstration at Schriever Air Force Base to display technology readiness for S- and L-band phased array antenna to support satellite operations. If successful, the GDPAA will provide many benefits to include greater responsiveness, enhanced flexibility and increased robustness for our satellite operations.

In addition, we continue to demonstrate and develop net-centric and Service Oriented Architectures (SOA) for the Net-Centric Satellite Operations (SATOPS) Enterprise Management, which will enable consolidation of functions and capabilities, reducing duplication and improving interoperability between SATOPS and Space Situational Awareness and Command and Control Enterprises.

Finally, AFSPC is depending on the ingenuity and innovation of industry to provide breakthrough technologies, such as new propulsion systems. We need to look at this idea of having a family of motors which serve a variety of launch platforms across the services as well as organizations outside the Department of Defense. Such an initiative would bring tremendous benefits to our industrial base and would help government to lower costs for system procurement, operations and maintenance.

MSM

Looking ahead, what challenges do you see that need to be addressed/countered as quickly as possible for our Nation to remain secure?

General Kehler

AFSPC has always met today's mission needs while looking to the future, and we have never been content to accept status quo. Tomorrow's national security challenges will demand that we think differently, organize efficiently and that we ensure space and cyberspace power is more responsive, is

Secretary of Defense Robert M. Gates (left) is welcomed by Gen. C. Robert "Bob" Kehler (right) and Gen. Victor E. Renuart Jr. (center) June 9 at Peterson Air Force Base, Colorado (Photo: USAF)

always assured, that it contributes decisively and is developed and wielded by Airmen and civilian professionals who are recognized as both technical and tactical leaders.

The global security environment is dynamic and requires our forces to be flexible to meet the needs of the Combatant Commanders and other national users who may be engaged across the spectrum of conflict or in non-military contingencies at any time.

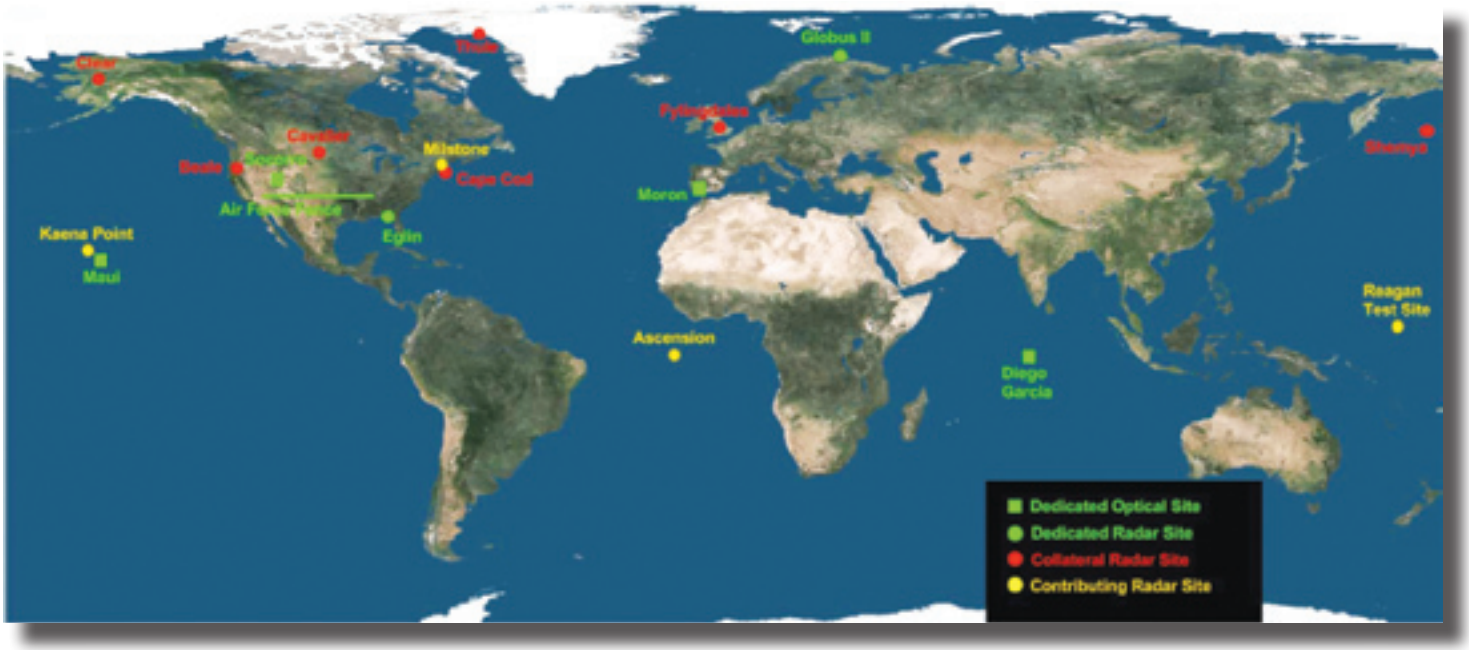
Furthermore, our forces will operate across increasingly contested domains. Protecting, sustaining and employing capabilities while preventing adversaries from deterring or denying U.S. freedom of action during a conflict is central to mission effectiveness in the Joint fight. These capabilities must be protected.

In addition, the cost on new weapons' programs has significantly increased while the share of the federal budget dedicated to defense spending will likely decrease. On top of that, we're facing a decline in our defense industrial base. We're dealing with a crisis in the workforce with estimates projecting a shortfall in experienced scientists and engineers supporting space science and technology development.

Finally, we have continued concerns over system cost, schedule, and performance. Air Force Space Command will require new approaches to rapidly produce the capabilities needed in this Information Age. Agile acquisition to meet requirements at the speed of need will allow our warfighting commands to meet the challenge of protecting our Nation, as well as our friends and allies.

MSM

Thank you for your valuable time, General, and also for your dedication to serving our country.



Current configuration of the United States Space Surveillance Network (SSN). Source: USAF.

Major General Craig P. Weston recently retired from active services with the United States Air Force on June 1, 2005 having experienced years of command service in which he was the U.S. Security Sector Coordinator and Chief, Office of Military Cooperation — Afghanistan, U.S. Central Command, in Kabul, Afghanistan. A graduate of the U.S. Air Force Academy in 1972 General Weston has been a flight test engineer, engaged with satellite operations, commanded a major program office, managed a portfolio of major acquisition programs and guided the daily activities of a large acquisition center.

A few of General Weston's recent accomplishments while on active duty include; Vice Commander, *Electronic Systems Center*, **Air Force Material Command** at Hanscom AFB, Massachusetts; *Director of Advanced Systems and Technology*, **National Reconnaissance Office**; Director, *Corporate Operations Office* and CIO for the **NRO**; and Program Executive Officer for *Command and Control Programs* at the **Pentagon** in Washington D.C. He has received the *National Reconnaissance Office Medal of Distinguished Performance*, the *Supreme Medal of Ghazi Mohammed Akbar Khan* from Afghanistan, the *Defense Distinguished Service Medal* with oak leaf cluster, *Air Force Distinguished Service Medal*, a *Bronze Star*, an *Air Medal* and others, all a testimonial to his love of country and service accomplishments.

Now General Weston is the Chief Executive Officer of a new company dedicated to providing the U.S. government with reliable, cost-effective satellite communications that no longer require years and years of deployment. The name of the company is **U.S. Space LLC** and General Weston joins fellow former command officers and their executive roles with the firm — Lt. General Hamel and Major General Armor — what a superb brain trust!

MilsatMagazine is pleased to have the opportunity to speak with General Weston regarding his career and his current business efforts….

MilsatMagazine (MSM)

General Weston, you served for a commendable 33 years in the United States Air Force — looking back upon your command military career, is there any particular assignment that you are most proud of completing? Which of your many positions do you believe has given you the experience necessary to build a new company?

General Weston

I am fortunate to have had four assignments during my career that I really treasure. I was a flight test engineer firing the high energy laser on board the Airborne Laser Laboratory, the predecessor to today's Boeing 747 Airborne Laser. Also, I was the Mission Director for classified satellite operations during some very trying times during the launch stand-down after the space shuttle

Challenger accident. Additionally, I was a major acquisition program director and created the Space Based Infrared System during a period in which the Department of Defense tried new business practices for which we were one of the pathfinders. And my last assignment in Afghanistan, in which I guided our coalition team in helping the Afghans create an entire department of defense from scratch, was particularly satisfying. From these and my other assignments I took away key learning experiences, so by the end of my career I had a toolkit of skills that help me work with others in building U.S. Space.

MSM

With the Office of Military Cooperation under your command in Afghanistan, and the need to develop and train as well as sustain tens of thousands of individuals, how does this equate to your command of U.S. Space LLC?

General Weston

The two positions are obviously of a different scale, in terms of people, infrastructure and funding but the common theme is the need to create an organization and its business processes, establish goals and then measure progress towards the goals. In both cases, the key ingredient for success is a group of talented, hard working people.

MSM

In March 2006, you joined SRA International, a technology and strategic consulting services organization providing solutions to the federal government. You were the Vice President of the C4ISR command center, which worked closely with DoD and the intelligence community. Is this where you began formulating your ideas for a new, more flexible company that could supply communications' solutions to the government, with lower costs of entry, maintainable ROIs, and expeditious delivery?

General Weston

I was recruited to U.S. Space by our two founders, Ed Horowitz and Mark Piegza. Ed was inspired to create the company after hearing a talk by General Cartwright when he was the commander of U.S. STRATCOM, in which he articulated the need for new business and operational models to more rapidly and effectively build, launch and operate our nation's military satellites. In turn, I was attracted to the company by its unique business and operations model, the benefit of working with the extremely talented people associated with U.S. Space and the opportunity to serve the nation in another fashion by providing a much needed military capability.

MSM

From the warfighter to the command officer, regardless of service, all desire the newest technologies delivered "yesterday" to help them counter opposing forces and to produce mission successes, all the while protecting our nation from hostile incursion. With communications' deployment requiring many years, sometimes as much as a decade to fully implement, why do you believe U.S. Space can reduce such time requirements and bring solutions to the "boots on the ground" in a more immediate fashion?

General Weston

To get to space more quickly we are taking a low risk approach with proven technology, using a stable design and teaming with industry partners who have shown they can reliably deliver space hardware that works on orbit. We adopted designs and components that have already been successfully used in space, which will make building and operating our satellites faster and easier.

Also, we intend to produce a number of satellites of the same design and apply the benefits of the learning curve to further reduce the time to orbit. And, we want to use solid propulsion rockets to lift our satellites to space, since solid rockets are far easier and quicker to get ready for launch than liquid fueled boosters. The warfighter will still get the benefits of technology infusion, because once a technology has been demonstrated on orbit elsewhere we can include it in our next block of satellites, like a technology refresh or update.

MSM

How will U.S. Space accomplish their charter, and what roles do General Armor and General Hamel play within the company? What other personnel resources do you have in your possession to help bring your company to successful fruition? Are there any commercial firms at the ready to help U.S. Space reach its goals?

General Weston

U.S. Space relies on a number of individuals who are

deeply experienced in military and commercial space to advise us as we move the enterprise forward. It is great to have individuals on our team of the caliber of Mike Hamel, who sits on our Board of Directors, and Jim Armor, who is an advisor to the firm. To build, launch, and operate our satellites we are drawing on the talents of our All American team of mid-tier space industry partners who are well-known and proven in the military, commercial and civil market place. We are already working with them on systems designs so we are definitely beyond the concept stage.

MSM

With the Pentagon's reputation of not cultivating the services of new companies, rather continuing ongoing relationships how can U.S. Space break this mold and bring their resources to the forefront? With your company's executive team, obviously their contacts and experiences will play enormous roles in helping achieve success — do you have both military and civilian contacts to help bring this about?

General Weston

We have been well received everywhere we've visited in the Pentagon. The decision makers who understand MILSATCOM and work with it on a daily basis recognize and are interested in the benefits our business and operations model can provide.

I think they see us as a much needed complement to government provided MILSATCOM and the commercial SATCOM upon which the Pentagon is now so heavily dependent, both of which in combination are still not enough capacity to meet an ever increasing demand.

MSM

How do you see MILSATCOM playing its crucial role over the next couple of years? Over the next five or so years?

General Weston

There is an almost insatiable appetite for MILSATCOM that will continue well into the future. The information rich battlefield envisioned by Network Centric Warfare has become a reality in the wars in Iraq and Afghanistan. It requires a reach back to the United States for massive amounts of data and information ranging for diverse needs like small unit operations, unmanned and close-in airborne surveillance and intelligence collection on the battlefields and logistics information pipelines for everything from personnel and medical data to spare parts, food and fuel shipment status. Larger fleets of more capable unmanned aerial vehicles and the requirements for communications on the move, demands for video and high definition video at lower echelons and other needs combine to constantly increase bandwidth requirements and the need for more MILSATCOM.

MSM

Your company's tag line reads, "Assured. Adaptable. Affordable. Accessible. American." High ideals, yet the Pentagon is an exclusive society. Even though you were a part of this world, do you, as of this interview, have any contracts in place with government entities or, how quickly do you believe U.S. Space can become an inside agent complete with actual signed agreements?

General Weston

A number of us who are a part of U.S. Space were also a part of the "exclusive society" of the Pentagon and have credibility within it, in offering a complement to the existing big military and commercial satellite programs.

With the recent cancellation of TSAT, the rapid degradation of the UFO program, the still pending first launch of MUOS and with little excess bandwidth available on multi-user commercial SATCOM, the Pentagon is looking for alternatives like ours to help fill in the continuing gap between demand and available capacity. In this light, I think serious consideration is being given to our offerings.

MSM

When your company indicates it will provide small satellites, what do you have in mind? Micros, Minis, Picos, Nanos?

General Weston

Our satellites will be small but provide medium capacity communications. We will be very cost competitive when the Pentagon considers our short production and launch timelines, ability to plug into the existing DoD MILSATCOM operations infrastructure, compatibility with existing military terminals and the means to place our satellites anywhere the DoD has open orbital positions.

MSM

Will the satellites eventually become a new constellation for military and government purposes?

General Weston

U.S. Space will not replace the big military or commercial satellite constellations, which both fill vital roles for the DoD. Commercial satellites satisfy the DoD's need for high bandwidth and throughput needed for much of the military's daily activities, for which the DoD does not have enough of its own assets to meet the demand.

Military satellites provide protected communications (low probability of intercept, anti-jam and hardened) for specialized warfighting situations where there is no equivalent commercial demand or capability. There still remains the great need for unprotected MILSATCOM, where the DoD doesn't have enough capacity to satisfy the continuing and increasing demand. It is here that U.S. Space intends to augment or supplement the DoD's existing capability as long as there is a shortfall.

MSM

How is your business and/or operations model different than that of other government or commercial satellite communications providers?

General Weston

Our hybrid business and operations model captures the best of both the military and commercial satellite worlds and adds something extra neither can easily provide. From the military aspect, we will produce military frequency payloads that can be placed in military orbit locations and managed just like any other DoD payload, in which operational users can use their existing terminals. These military features will help us easily integrate into DoD networks and ongoing operations.

From the commercial side, we will use low risk, proven technology in productions lines that will enable us to deliver satellites relatively quickly. Also, we will privately finance the acquisition and launch of satellites so the government doesn't need to make any investment up front but merely pay a fee for service once the satellites are on orbit and available for use.

The extra features we will bring to this unique business model is an operational model with the ability to launch on very short timelines using solid rocket motor boosters, to quickly replace a satellite on orbit or fill a contingency need and the means to relocate our satellites once on orbit should the military need our capability in a different part of the world. You can see our hybrid business model and responsive operations model will give the government the benefit of a combination of the best features of MILSATCOM and commercial SATCOM

MSM

How did you manage to raise your family while raising the level of professionalism within your command? How did you find the time to accomplish these major tasks? In addition, how does your family feel about your new position as the CEO of U.S. Space LLC?

General Weston

Like many in the military, I am fortunate to have a family that looked on our many moves around the country as an adventure that exposed them to new places, new people and new experiences. And it helps that they learned to be self-sufficient so they could survive and thrive during my many business trips and months long separations. I don't think my family is exceptional in that regard and we are asking much more of many of our military families today with repeated time away from home in the long deployments of our soldiers, sailors, airmen and marines. It is important that we recognize the sacrifice of their families, too!

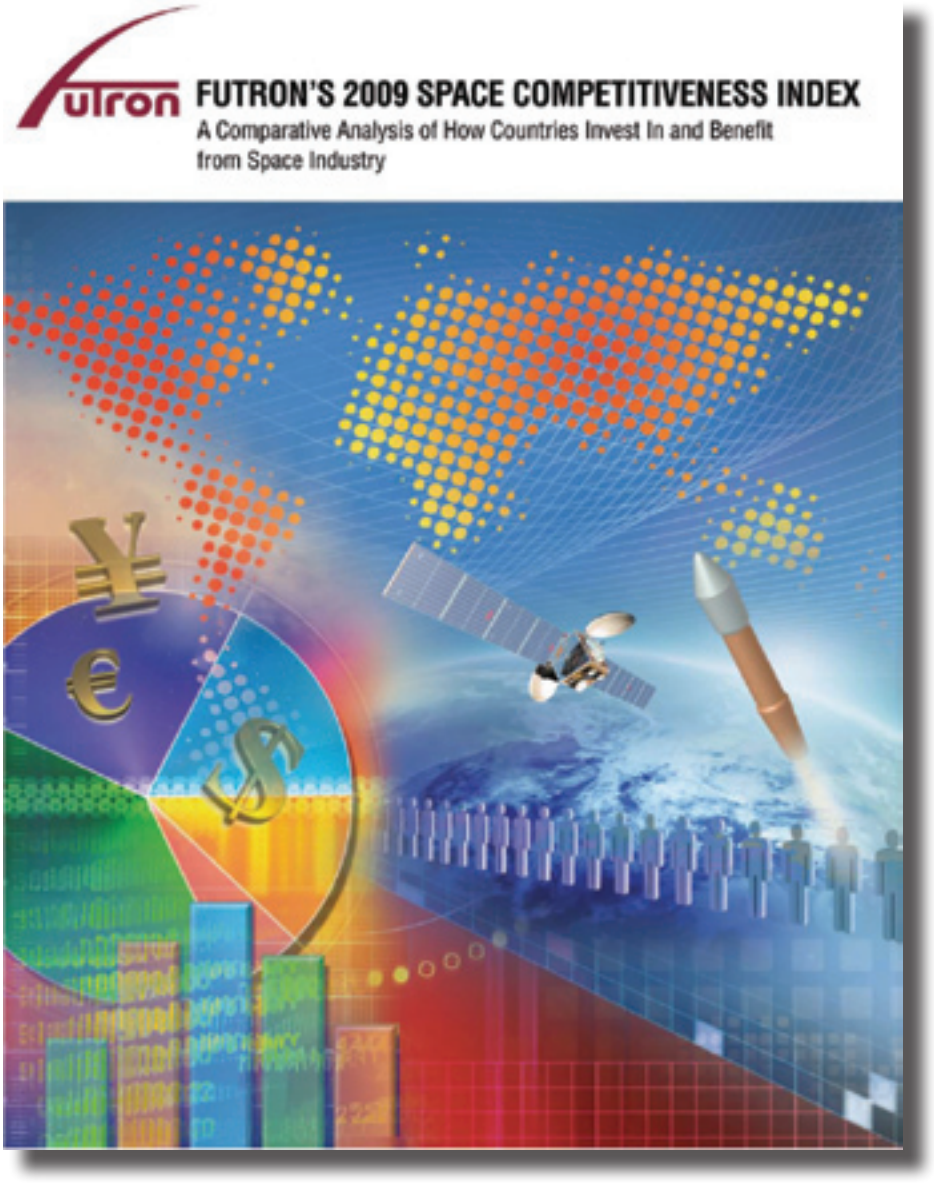
INTEL

One of the most widely appreciated analysis firms with a 20-year track record is Futron. The Company provides premier Decision Management Solutions and products to a variety of complex technology industries. Futron offers architectures and solutions that transform data into valuable intelligence for informed decisions, to substantially improve judgments in business, program, and project management and engineering. We thank Futron for allowing us to reprint one of the most critical segments of their recently published 2009 Space Competitiveness Index (SCI) — Global Military Space. Again, this is but one single index within their exhaustive report.

This year's report greatly expands upon their landmark and inaugural 2008 study and examines, in greater depth, 10 nations currently leading in space and space-related activity: Brazil, Canada, China, Europe (considered as a single entity), India, Israel, Japan, Russia, South Korea, and the United States. Futron's 2009 Space Competitiveness Index evaluates these nations across 50 individual metrics that represent the underlying economic determinants of space competitiveness in three major dimensions: government, human capital, and industry.

GLOBAL MILITARY SPACE

Militaries and intelligence forces fully realize the value of space capability and consequently, invest significant resources in developing and utilizing space-based assets. The clearest validation of its importance is the sheer number of military or dual-use satellites — 232 out of a total 903 satellites at the end of 2008. Investment in military space also drives innovation, research and development of new space technology. As a case in point, the procurement by the U.S. military of so-called communications on the move (COTM) products and services has resulted in technological innovation that is now migrating into civilian and commercial applications. Protecting these technologies via export controls has evolved into a controversial tug-of-war between the need to project technological advantage and the need for continued R&D and the generation of product sales. Just as the debate of U.S. export controls heats up, Israel, a leading exporter of defense and space products, has introduced new export regime.



For many countries, spending on military space outpaces investment in civilian and commercial activities; in other segments such as launch, PNT and Earth observation, platforms are dual-use in nature. Since military space spending continues to constitute a significant portion of space investment, organizational resources, and governmental focus, the purpose of the ***Global Military***

Space Competitiveness Index is to understand and quantify the relative position of military activities of leading space powers.

Military programs and assets provide distinct force-multiplying capabilities to armed forces, and consequently, military organizations worldwide have steadily increased reliance on space assets for communications, surveillance, and tracking. This increased usage can create asymmetric threats whereby a weaker power or near-peer could exploit the space dependence of its stronger adversary as a force equalizer.

Given the importance of military space, understanding the relative positioning of a country's military space program — from strategy and doctrine to spending, technology, and assets — is a critcal component to understanding a country's relative space competitiveness overall.

The interaction between the military space sector and its civilian and commercial counterparts is multifaceted and varies from country to country. In addition to its pure national security benefits, military space can also facilitate development of the commercial and civil space sectors both directly and indirectly.

Military space investment can also yield advantages in other areas of national space competitiveness, including advanced technology development and the creation of spin-off industries such as GPS and imagery services.

Increasingly, militaries and intelligence forces seek partnerships and collaboration — both domestically across government agencies as well as via international joint assets, interoperability, and sharing information outputs. This trend in military doctrine supports the broader belief that space must be recognized as and treated as a shared resource, *e.g.*, a global commons. The growing issue of space debris, as highlighted by the first-ever collision of satellites in early 2009, now poses a strategic military threat. As a result, governments will seek to identify a solution that spans military, civilian and

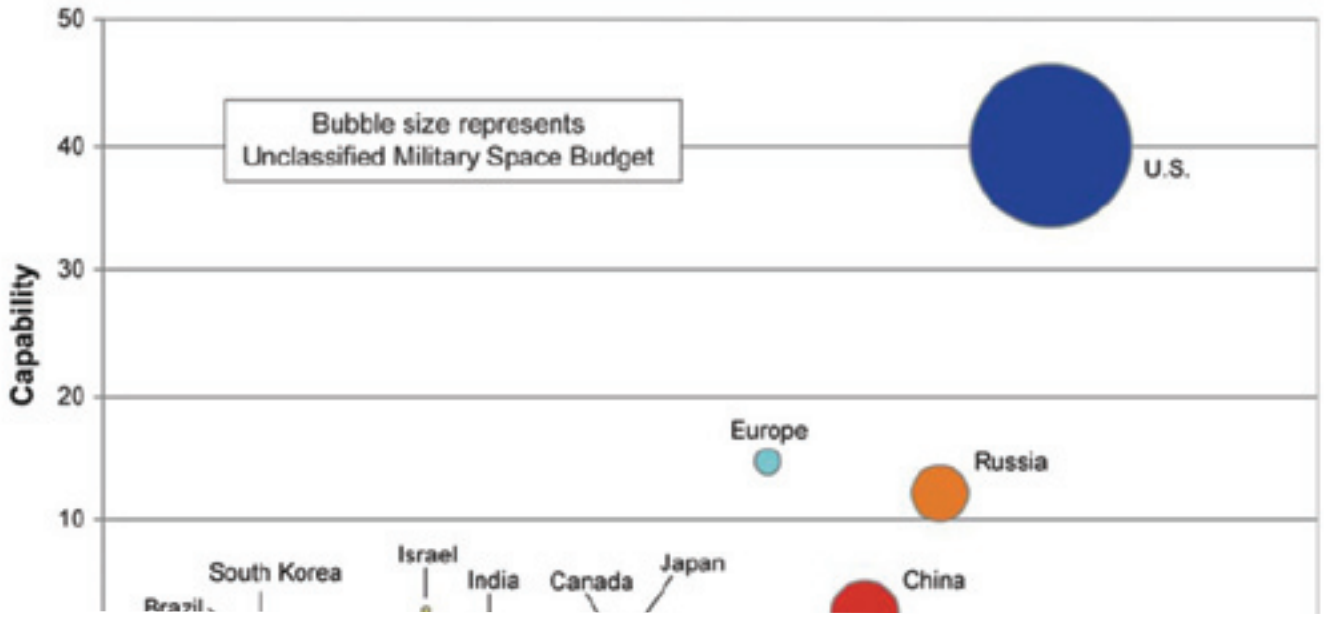


Figure 1 — Global Military Space Segment: Comparative Positions by Country

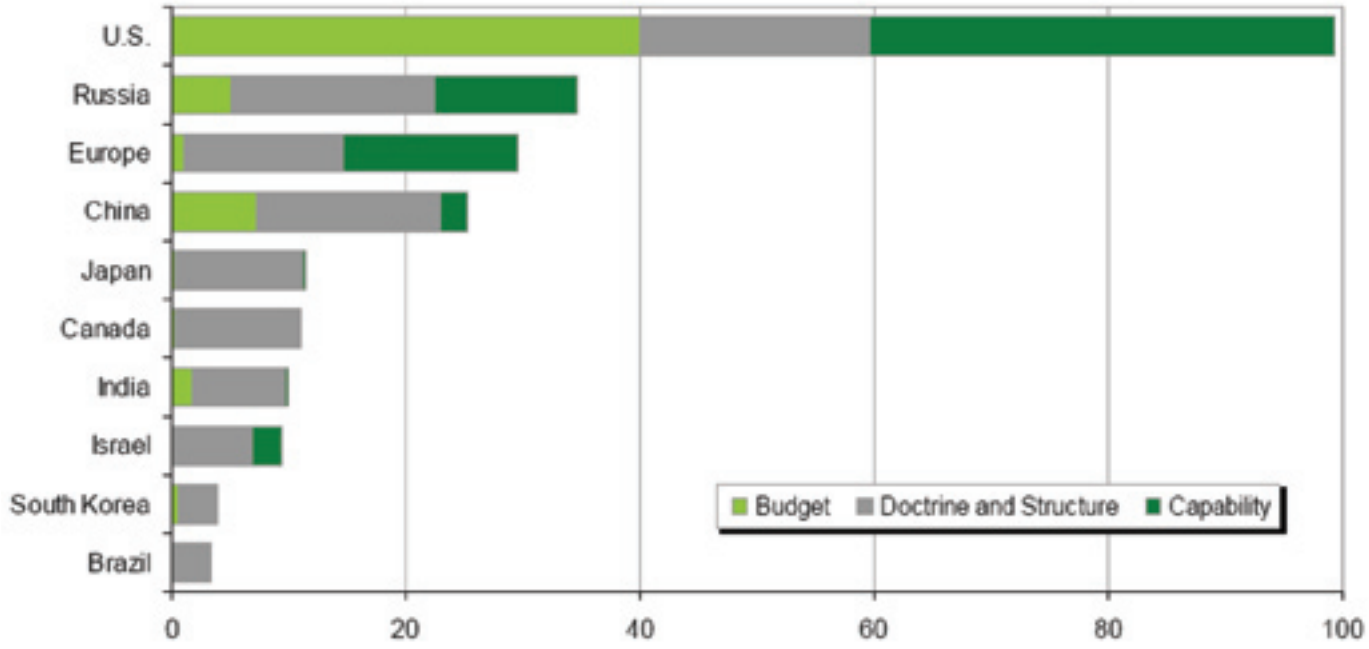


Figure 2 — Global Military Space Segment: Aggregated Scores by Country

commercials users. Related, is the need for enhanced space situational awareness. When combined with tighter militaries could offset costs and optimize military space capability through increased reliance on international relationships and more partnering with friends and allies.

[1] *Countries that do not provide advanced information about military launches are penalized is the category of 1-yr Backlog of Military Satellites.*

Military space has recently received renewed attention. The prospect of anti-satellite weapons has moved to the forefront since China (in early 2007) and the United States (in early 2008) deployed missile technology to destroy satellites. These activities, considered alongside the unprecedented use of space to support war fighting by the U.S.-led coalition in Iraq and Afghanistan, have caused officials the world over to take notice. Meanwhile,

countries in all regions continue to fund and develop systems to boost their own ability to compete in the global military space segment. Using a combination of quantitative and qualitative assessments, this section of **Futron's** ***2009 Space Competitiveness Index*** provides a focused analysis of the comparative positions of the 10 leading space participant nations in the global military space segment. The analysis identifies the current key trends underlying military space competitiveness as follows:

- ***The U.S. leadership in military space remains significant based on a significant head start, large budgets, organizational capacity, asset base and capability.***
- ***U.S. military space leadership position will likely be reduced as near-peer challengers Russia and China continue to commit increased resources for military space.***
- ***The U.S. could offset the gains of near-peer rivals by developing and deepening military relationships with friendly governments and allies, particularly with Europe, Japan and India.***
- ***Passage of Japan's new space law, when combined with North Korean ballistic activity will result in increase focused on military space.***
- ***Europe has codified a coordinated military defense regime, which in the near-term could result in increased collaboration through and with NATO.***
- ***India has procured new military space assets from Israel and, continues to institutionalize military space doctrine and command structure.***
- ***Israel has emerged as the leading provider of Indian military space technology (and indeed a variety of military technology exports).***
- ***To reduce vulnerability from anti-satellite weapons, blinding, and orbital debris, there will be near term development and procurement of technologies related to***

Military Space Budget	
Country	Score
U.S.	40.00
China	7.26
Russia	5.19
India	1.70
Europe	1.08
South Korea	0.53
Japan	0.33
Canada	0.25
Israel	0.10
Brazil	0.05

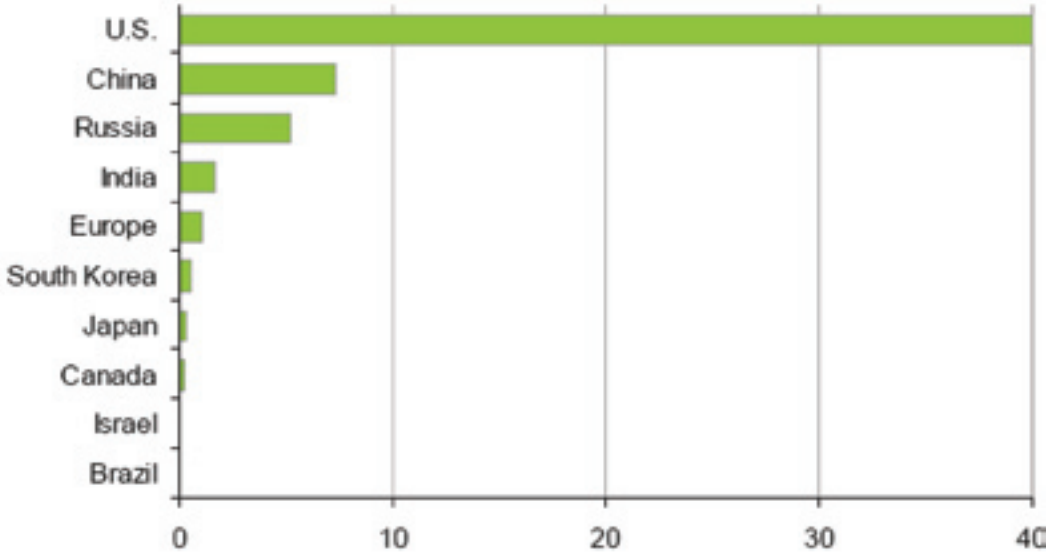


Figure 3 — Military Space Budget: Scores By Country

space situational awareness, "hardening" technology, and directed energy weapons.

- ***Other "winning" military space technologies include COTM, Earth observation for intelligence and counter-terrorism, and the integration such as sensor networks and unmanned vehicles on the ground, air and sea.***
- ***Political and economic limits reinforce military reliance on the commercial and private sector for a broadening array of military space services, and within U.S. and European spheres a large proportion of military space technology is derived from the private sector.***

Futron seeks to use this focused segment analysis as a baseline for ongoing discussions regarding the relative competitive positions of national military space actors.

About The Global Military Space Segment Index

Futron's Military Space Index currently employs three drivers to compare military space power among the 10 leading space participant countries. In subsequent versions of its Space Competitiveness Index, Futron will add additional metrics as more data becomes available or unclassified. We welcome feedback and suggestions on specific additional indicators. Together, the three metrics listed next provide a high-level perspective into how national military space actors use their resources to maximize competitiveness. These three metrics are:

- ***Military Budget: The amount of money allocated for military space activity within a country's national budget (adjusted for PPP), which offers a relative ranking based on a quantitative measure of the resources made available for military space activity. Military Budget is weighted at 40 percent of the model findings.***
- ***Military Doctrine and Structure: A qualitative indicator measuring consistent policy, strategy, planning, thought, and applicable organizational hierarchy for the development, operation, and application of military space. Military Doctrine and Structure accounts for 20 percent of the model outputs.***
- ***Military Capability: The number of operational military satellites in orbit, plus military satellites planned for launch in the next year. This figure provides a quantitative indicator of a country's military space capability. Military Capability is valued at 40 percent of the model.[1]***

Futron selected these three metrics as they provide both quantitative and qualitative comparisons of the issues necessary to create a competitive program in this sector. When the decision is made to implement military space activity, the first critical step is to allocate funds. Thus, the budget metric seeks to quantitatively rank the estimated military space spending that is imperative for creating competitiveness in this sector. Funding priorities change based on the maturity of the country's military space organization and asset base. The second metric in the segment examines the

existence of military space doctrine and structure—the policy, strategy, and hierarchy which defines how each country conducts its military space activities. Assessments of military space doctrine and structure, while qualitative, allow an evaluation of the extent to which military space budget and capability are used towards defined military space goals.

Space capability, the final metric, includes factors such as organizational development, ground assets, in-orbit assets, applied technologies, and processes such as command and control. Collectively these assets bridge the entire use of space by the military, from the satellite operator to the spacecraft to the ultimate user. For the purpose of this study, assets are limited to the number of space-borne assets that a country has in orbit; future reviews may include ground assets as well.

While Futron extensively researched the space military segment for our 2009 Space Competitiveness Index, an overarching assessment of this sector requires further examination and a more thorough reflection of competing schools of thought on military space power theory. Themes or questions that remain to be discussed or examined in future focused military space segment analysis include the following:

- ***What are the limits of space-based force multiplication? A recent, public assessment on the limitations of space assets by the Israeli Air Force during the recent Gaza offensive highlighted both the importance and the limits of space capability.***
- ***What is the asymmetric strategic threat of militaries that highly leverage space assets? Our assessment does not directly assess such asymmetric implications.***
- ***Futron's military space analysis includes the assets of quasi-civilian organizations involved in national security operations, intelligence, counter-terrorism, secure communications, and paramilitary operations.***
- ***Where sufficient information on dual-use assets—those that combine military-civilian or commercial-military space capabilities—was available, Futron incorporated these dual-use into its focused segment analysis, scaling their capabilities accordingly.***
- ***Although "competitiveness" still applies in the military world, the outcomes of this analysis could be compared to "superiority" or "effectiveness" when discussing the disposition of different nations.***

While Futron is confident in the underlying facts and analysis of our findings, we view our framework as basis for additional assessments and study.

Segment Findings

Using the metrics of military space budget, capability, and doctrine and structure as a baseline, the two figures on ***Page 30*** compare the 10 countries analyzed in Futron's 2009 Space Competitiveness Index in their respective military space segments, highlighting both the current leadership position of the United States as well as the relative positions of its near-peers. While the U.S. retains military space preeminence, near-peers such as China and Russia continue to gain ground.

Military Space Budgets

Military space budgets are estimated from unclassified official sources and select non-official sources, or based upon overall national space spending or overall military budget trends. A clear distinction between military space and civil space spending is often blurred in the case of dual-use programs and applications. The ranked comparison, therefore, represents a best-estimate examination of military space funding in each of the 10 countries.

Futron estimates that the top 10 space powers spend more than PPP-adjusted **US$71B** annually on space, with the U.S. spending nearly **US$50B**. The percent of military spending allocated for space ranges from below 1 percent for Brazil, India, and Japan up to nearly 100 percent in the case of the Israel space budget. Our estimate for the U.S. is around 60 percent. These figures, of course, are estimates due to the classified nature of some spending, the complexity of dual-use assets, and spending on multinational alliances such as **NATO** and **NORAD**.

Europe represents a special case for the military space budget metric, as there is a collective European budget as well as individual country budgets. The total European military space budget metric examined all relevant budgets, whether national or collective, and assigned a ranking that balanced

Doctrine and Structure	
Country	Score
U.S.	19.50
Russia	17.22
China	15.67
Europe	13.67
Japan	10.72
Canada	10.56
India	7.94
Israel	6.66
South Korea	3.22
Brazil	3.11

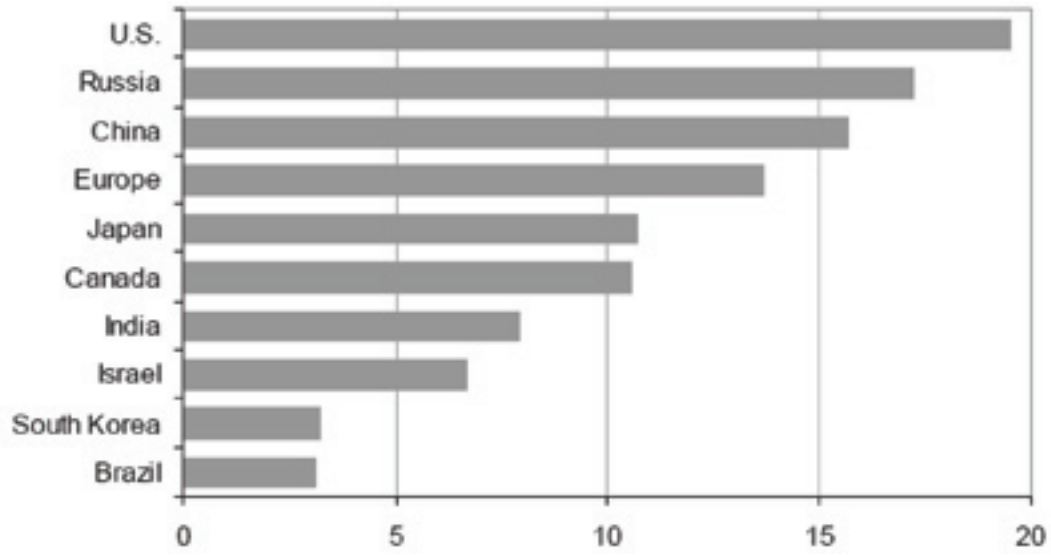


Figure 4 — Military Space Doctrine and Structure: Scores by Country

aggregate European military space spending against the need to compare Europe — as a militarily collaborative and politically integrated supranational region — equitably against other individual nations that feature a centralized military space budget. It is also important to note that Europe, under the auspices of the European Defense Agency, for the first time in 2008 publicly allocated money for European space initiatives. The rankings for this metric follow below.

Military Space Doctrine And Structure

The military space doctrine ranks countries according to whether they have a developed doctrine, strategy, or policy that is used to coordinate a country's military space activity. Some military space actors, such as the U.S., Europe, and China, have rather clear-cut doctrines and policies, while others have less formalized coordination mechanism within the government that are sometimes not codified or are not publicly available. Secondary doctrines, such as overall military doctrines — or a nuclear doctrine with space linkages, as in the case of India — can also assist in prioritizing and coordinating the military space activities of a given country.

This metric also examines a country's organizational structure for military space — to the extent that one exists — and compares whether that structure indicates a greater or lesser competitive position. For countries that have well-developed military space units, two models of organization are prevalent. The first model is dispersal of units and activities throughout different parts of the government, typical of the various commands, units, and offices within the U.S. The second model is centralizing all military space activities within a single unit, typical of Russia's independent space forces.

In evaluating the competitiveness of a country in space, it is challenging to assess which model provides a government with the most effective organization. Questions of efficiency, bureaucratic politics and processes, successful adoption of lessons learned, and implementation of programs all play a role in this determination. As these gradations are beyond the scope of this inaugural edition of Futron's Space Competitiveness Index, this ranking considers the centralized Russian-style model to provide an organizational framework for military space activities that is the competitive equal or nearequal to the more dispersed U.S.-style model. During 2008, several countries enhanced their military capability — and ranking — by developing new military strategies and/or doctrines as well as making organizational changes.

Japan passed a new law that enables military space activity, and quickly crafted a strategic report highlighting military space objectives. Canada reconstituted its military space organization and began updating its military strategy. Finally, Europe made some operations improvement is the way the continent defines, invests and procures military space assets. Not surprisingly, these activities positively impact each country's rankings.

Military Space Capability	
Country	Score
U.S.	40.00
Europe	14.82
Russia	12.17
Israel	2.62
China	2.34
India	0.36
Japan	0.27
South Korea	0.18
Brazil	0.18
Canada	0.18

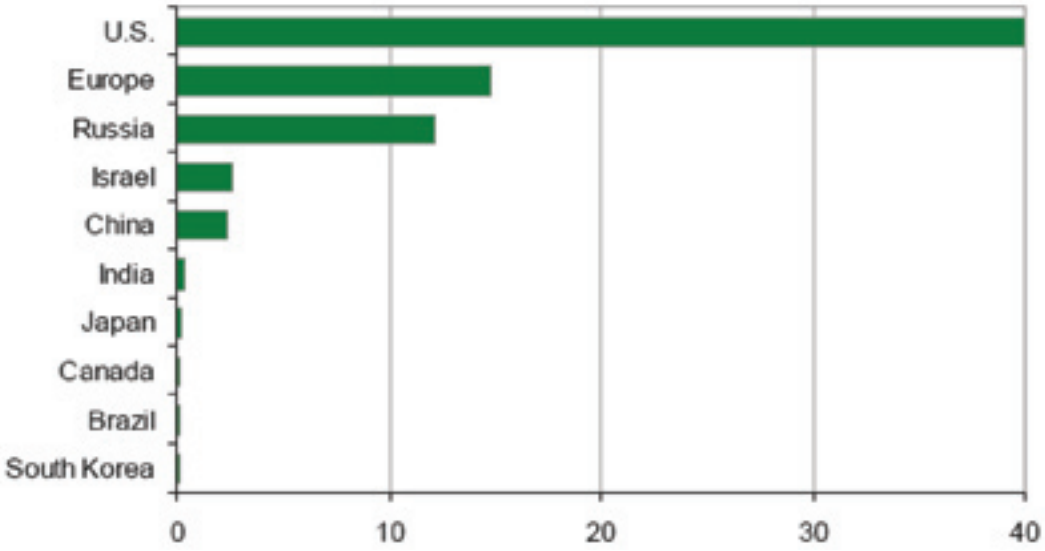


Figure 5 — Military Space Capability: Scores By Country

In terms of doctrinal innovation, the United States military is the furthest along in two pioneering advancements: the use of hosted payloads; and operationally responsive space (ORS). The concept of hosted payloads disaggregates the traditional satellite value-chain and manufacturing process by placing military payloads on commercial and civilian platforms. By focusing on the payload only, military planners are able to orbit assets more quickly and cheaply.

Time is condensed because the military payload are simply added to satellites currently in the planning or production phase — and presumably already have a scheduled launch slot. Ideally, using standardized interfaces, these payloads could be incorporated into "whichever" satellite is available. Cost is reduced because the secondary military payload shares a satellite bus, launch and some operational costs with the primary payload operator. The U.S. military has already piloted this concept and is discussions with several commercial and civilian entities to embed additional hosted payloads.

The ORS concept, which is driven forward by an independent office within the U.S. military, focuses on rapidly providing assured space power and assets to military commanders in a timely period. The end state of the ORS concept is capability to address emerging, urgent, and/or unanticipated via rapid augmentation, reconstitution and exploitation of assets. The ORS doctrine would use small satellites, gap fillers, standardized components, open architectures, etc., to quickly field space assets. The ORS doctrine differs from traditional processes for requirements setting, procurement, cost, and capability.

Europe has a unique doctrine and organization situation due to the complexity of European institutions and their overlapping relationships with a collection of countries. Within this institutional framework, European companies tend toward highly collaborative and supranational relationships, as well as individual country membership in **NATO** and the ***European Defense Agency*** (**EDA**). Futron includes these factors in our analysis of organizational structure, both has fundamental benefits as well as complications. The benefit of shared assets reduces costs and augments soft and hard power, but at the same time, decision-making is fragment as there no centralized military space command for Europe.

Against this analytic backdrop, *Figure 5* above reveals the rankings in the military space doctrine and organizational structure metric.

Military Space Capability

The number of operational satellites serving military applications is a quantitative metric that counts those satellites believed to be currently active and serving a primary military function. Dual-use satellites and the unclear status of certain satellites posed minor challenges in counting.

For example, China does not clearly delineate its satellite functions in terms of military, civilian, or commercial use as other countries do, so the count of active Chinese military satellites may overlap with the count of Chinese satellites for other user types. The model of a commercial satellite being used by the military — not uncommon in the U.S. experience — is often reversed in the case of China: some Chinese

or NATO assets, or some combination of the three. Despite such counting challenges, Futron was able to make comparisons among countries that it believes reflect space competitiveness in the metric of military on-orbit assets with high fidelity. The results are as follows.

Military Space Summaries By Country

The following section provides in brief information on military space for each country in the Space Competitiveness Index.

BRAZIL

Officially headed by the ***Comando-Geral de Tecnologia Aerospacial***, or **CTA** (*Brazilian General Command for Aerospace Technology*), there is little apparent official articulation of military space doctrine — although arguments by policymakers in favor of space spending have featured the military advantages of independent space access. In practice Brazil's military space activity is very limited, focusing on international security issues such as border control and contraband. Toward that end, the military uses dual-use Earth observation products to monitor its large border and the Amazon, *e.g.*, use of the two-satellite ***CBERS*** constellation, a joint China and Brazil program. The military's communications requirements are met via the dual-use ***Brasilsat B-2*** satellite.

CANADA

After several years of drift, the Canadian government has reinvigorated its military space strategy, policy, and planning — and plan significant future developments. The previous policy effort, now more than 10 years old, responded to military requirements associated with the first Gulf War. Essential to the current plans are the reconstitution of the ***Directorate of Space Development*** (**D Space D**) in 2008.

The Canadian military see space as both force multiplying, as well as central to the country's integration with NATO and its special relationship with the United States, which include integrated participationin NORAD. D Space D will coordinate a number of on-going programs such as the ***Joint Space Support Program*** (**JSSP**), the ***Sapphire Program***, the ***Near Earth Orbit Surveillance Satellite*** (**NEOSsat**), the ***Military Maritime Messaging Satellite*** (**M3MSat**), and ***Project Polar Epsilon*** (**RADARSAT-2**). The government also understands the national defense implications — and benefits — of the ***RADARSAT Constellation Mission***. The Canadian military space policy has two primary objectives: exploit space as a medium to enhance military capability, domestically as well as in partnership, and project international leadership through an integrated capabilities-based policy of responsive space. While formalized, the Assistant Deputy Minister for Policy is leading an effort to finalize a new military space policy. D Space D has some 25 officers and contractors representing each of the branches of the Canadian armed forces.

CHINA

Over the last several decades, China has consistently and effectively invested in developing military space capability through a robust program focused on developing technological capability and expanding regional coverage. While many Chinese programs are dual-use, China has built a sophistical organizational infrastructure supported by an research and development facilities, a robust industrial base, and has publicized its technical prowess in areas of launch vehicles, sensor capability, command and control know-how, anti-satellite technology, and a variety of other essential — and advanced — military space technologies. Supported by a strong organization and doctrine — most of which remains secret — the Chinese military is likely to continue with its high level of investment in space platforms and capabilities. While the force multiplication of these assets impact regional power — and gain ground with leaders of military space capability — in the near-term will lag the United States and Russian in terms of overall space capability.

EUROPE

While European military space capabilities lag their U.S. allies, there is growing realization in the significance of space assets, and importantly, a commitment to minimize the gap through increased investment, coordination and planning. Following an agreement between the ***European Commission*** (**EC**), the ***European Space Agency*** (**ESA**) and the ***European Defence Agency*** (**EDA**), and supported by national initiatives, European militaries are keen to improve the broadest range of space capabilities — from communications and Earth observation to positioning, navigation and timing. In late 2008, the

EDA sponsored a joint workshop with participants from 20 countries coordinate development of space technologies ensure non-dependence of strategic space technology, and position itself as a major space power and credible international partner. The EDA has several ongoing planning processes for military communications satellites, emerging satellite technology trends, industry trends, and a utilization study. Additional areas of EDA interest in include: *multi-spectral imaging systems* (**MUSIS**), space situation awareness, and data relay system.

On the communications front, coordination between NATO allies is driving consolidation of satellite communications systems. Currently, NATO, France, Germany (planned), Italy, and the U.K. maintain dedicated military communications satellites. The need for further coordination, coordination, has been supported by experience in Iraq and Afghanistan, where shortages in communications capacity, problems of interoperability and high cost of independent systems are pushing continued integration of allied communications platforms. Similar to the U.S., Europe is also increasing its dependence on commercial providers, with the U.K. having developed a public private partnerships with **Paradigm**, a subsidiary of **EADS**) to own and operating the ***SkyNet 5*** communications satellites.

Funding — rather than technology, organization, or market structure — is the limiting factor to Europe's military space capability, and the current financial crisis magnifies the issue and threatens announced increases in investment. Estimates for European military space spending range from **€500M** to **€1B** (**US$705M** to **US$1.4B**) annually — significantly less than the U.S.; the largest budgets includes France, Italy and Germany which is investing in reconnaissance satellites. To meet their strategic needs, based on recent comments from the French Defense Minister, Europe will need to double its spending in the near term.

As a way of stretching money further, a number of European countries are pooling their assets. The U.K.'s ***SkyNet 5***, France's ***Syracuse 3***, and Italy's ***Sicral*** satellites will jointly provide NATO's new communications satellites and NATO has inked a long-term lease of about a third of Syracuse 3A's nine transponders of *super-high frequency* (**SHF**) transmissions under a contract with France, Britain, and Italy. France and Italy are also looking at a largely military dual use geosynchronous satellite called ***Athena-Fidus***. It would be capable of very high rates of data transmission and could augment or even replace some of the Syracuse and Sicral satellites.

In a development that parallels the U.S. organization of the ***Defense Information Systems Agency*** (**DISA**), the EDA is preparing the establishment of a ***Procurement Cell*** to coordinate the EU Member States' orders of commercial satellite communications services. The ***European Satellite Communications Procurement Cell*** will be a three-year pilot project (2010 – 2012) to gain practical experience with centralizing commercial SATCOM procurement at the EU level. The cell's activities could reach a business volume of at least **€30M** (**US$42M**) per year.

A central booking office would initially be hosted at EDA's premises. It would manage the technical and financial aspects of the requests and orders placed by the Member States with the capacity and service offers by satellite operators and telecom companies. After the end of the pilot period, the SATCOM Procurement Cell activities are intended to be transferred to an appropriate entity for permanent operations for the EU Member States. The U.K. uses an outsourced model with Paradigm, and this business model may spread to other countries such as France, and Germany. It is estimated that only 20 percent of European military communications capacity is procured commercially.

INDIA

Military space in India is tied to a large revamp of the country's armed forces that includes significant new investment and organizational change. As India procures new air, ground and sea platforms, satellite communications requirements will dramatically increase, which in turn could drive equipment markets for COTM. Increased interest in and purchase of UAVs are core the country's planned projection of power and capability along its frontier. Purchase of commercial space segment by the military, however, for two critical reasons: India's commercial satellite communications market is closed, so international commercial providers have not focused on the market; and second, India's military requirements in the near term are likely to remain in region.

During 2008, India announced plans to create an ***Integrated Space Cell***, a nodal agency within the Government of India that coordinates space-based military and civilian systems. A key factor in the creation of the Cell was China's anti-satellite test. The Cell, formed in June 2008, is under the command of the ***Integrated Defence Services Headquarters***, and is responsible for coordinating activities of **ISRO** and the Indian Armed Forces. On the EO front, India has targeted enhanced military capability — a process that is distinctly tied to the country's growing military relationship with Israel. India has both launched military satellites for Israel, ***TECSAR***, and launched a similar Israeli-built, Indian-operated, ***RISAT-1*** payload in early 2009.

ISRAEL

Israel's military space activity focuses mainly of the ***Shavit*** small launch vehicle and the ***Ofek*** reconnaissance satellite series. In the past two years, Israel has begun to transition both its launch and satellite development programs toward partnership with India. The future of Israeli military space investment is highly contingent and as of early 2009, the question was in effect tabled by Israeli decision-makers pending the outcome of the Israeli elections.

JAPAN

Japan's ***New Basic Space Law*** (August 2008) overturned a 40-year prohibition on any military space activity. The Basic Law for Space Activities, which formally allowed Japan to use space for national security purposes and is the result of a series of meetings conducted from September through December by a ***Japanese Ministry of Defense*** (**MoD**) committee chaired by ***Seigo Kitamura***, Japan's senior vice minister of defense, according to *Takashi Sekine*, director of MoD's International Public Affairs Office. The law also required the formulation of a report, the *Basic Guidelines for the Development and Use of Outer Space*, which was published in January 2009. While short on detail, the report is a first step in identifying systems and technologies that Japan will seek to develop as part of its emerging military space strategy. The document identifies a number of space capabilities including:

- ***More and higher-resolution imaging satellites to complement the nation's existing fleet of fourInformation Gathering Satellites (IGS).***
- ***A dedicated military communications satellite.***
- ***A missile warning satellite — or a missile warning payload hosted aboard another satellite — to support the nation's Aegis ballistic missile defense system.***
- ***Small, low-cost satellites and rockets that can be launched on short-notice, perhaps from aircraft.***
- ***A signals intelligence satellite.***
- ***An independent navigation and positioning capability.***
- ***Satellite protection and space situational awareness capabilities.***

As these changes cascade, the new space law will have a dramatic impact of Japanese military space activity. Driven in part by activity in North Korea, the government's new policy allows for the use of space in national self-defense. This change in policy comes on the heels of broader changes in the Japanese military mission that place new information and communications demands on the military.

As Japan's forces evolve in the near term, there will invariably be increased demand for advanced communications, which may drive military purchase of commercial capacity for overseas missions. Also

in response to policy changes, there have been a number of inter-governmental discussions about dual-use assets and programs. The full impact of this new military space doctrine will take several years to understand, but over the next several years, the Japanese military will place increasing importance on and resources in military space activities.

RUSSIA

Russia maintains a long-standing history and organization of military space activities, included an integrated command and control hierarchy with the military establishment. The **Russian Space Force**, a centralized military command structure overseeing some 40,000 personnel, supports the country's long-standing military space doctrine. Central to Russia's space doctrine is a ***Kosmos*** series of military surveillance and communications satellites. Overall, however, military doctrine lacks transparency and there is discourse surrounding Russian military doctrine.

The Russian military — like the U.S. military — is highly dependent on space-based communications services. Russia employs a satellite-based early warning detection system. Russia's ***GLONASS*** system is central to military space strategy, providing positioning, navigation, and timing services. Russia also operates the ***Strela*** LEO constellation and the ***Raduga*** GEO network. Overall, the Russian military has approximately 38 active satellites providing communications, PNT, and reconnaissance services.

SOUTH KOREA

Futron research was not able to locate any publicly available reports that articulated South Korean military space doctrine or official military space policy. That said, the South Korean military is likely to become a major implementer of COTM technology, particularly in response to recent North Korean missile activity. South Korea does operate a dual-use communications satellite, ***Koreasat 5*** (***Mugungwha 5***), launched in 2006. The payload reported carries 12 military relay terminals and 24 commercial terminals, with military coverage from the Malacca Strait to the central Pacific Ocean areas.

UNITED STATES

The U.S. has a developed, transparent, and evolving military space doctrine, aligned with a complex operational structure. There is an ongoing discourse surrounding unclassified portions of military space doctrine and related subjects — such as *Space Power Theory* — although significant portions of the strategy remain classified. U.S. military doctrine is somewhat integrated into the country's larger national space strategy. In general terms there is emphasis on retaining a national lead in space situational awareness, military reconnaissance, and responsive space in order to combat *anti-satellite weapons* (**ASATs**) and asymmetric threats. The focus is on development of state-of-the-art technologies to maintain comparative national advantage in space. In addition, the U.S. military space doctrine is the one that overtly aims at "leading" the world.

Without going into detail of the complexity of the U.S. military space organization, several important happenings occurred during 2008 and early 2009. First is the establishment of the ***ORS Office***, which as discussed, represents a potential paradigm shift that could cascade throughout the entire military space organizational. Second is the cancellation of two large military programs — ***BASIC***, which was focused on high-end observation satellites, and the termination of the US$26B transformational satellite program, ***TSAT***; the military, instead, will purchase two more advanced extremely high frequency satellites as alternatives. Looking forward, these decisions will facilitate the continued and increased reliance on commercial vendors for imaging and communications solutions, as well as expand plans for hosted payloads and ORS activity. The U.S. is also a leader in the use of COTM as well as the use of commercial satellite capacity, and it is estimated that some 80 percent of U.S. communications activity is procured commercially.

Future Global Military Segment Study Goals

The purpose of the Global Military Index is to distill the debate about military space and the balance of space-based capabilities in both war and peace. In the future, Futron plans to enhance its focused analysis of the global military space segment in the following ways:

- ***Expand capability metric to include ground and application technologies, as well as new technology development and the quality of the assets.***
- ***Improved information on worldwide military space budget trends, with a focus on distinguishing between the often non-exclusive relationship between military and civil government activity.***
- ***Identify a group of leading experts to provide additional qualitative insight and analysis to support the data.***
- ***Identify appropriate metrics to measure the value of human resources with respect to military space capacity through skills, training, and career progression.***
- ***Identify ways to quantify asymmetric military space vulnerability.***
- ***Review information regarding defense spending on space R&D efforts***

Thanks from Futron...

Futron Corporation would like to thank those people and organization who supported (and continue to support) our ongoing efforts to characterize global space competitiveness, including those providing information on background and confidentially. Futron would like expressly thank a few external contributors in particular:

*Canada-based **AppSpace Solutions**, for providing insight into Canada's space sector. The mission of AppSpace Solutions is to assist space industry leaders and organizations in making informed decisions about spacecraft applications. The company is led by Wayne A. Ellis, BSc, MSc, CD, who has more than 20 years of Canadian military experience, primarily in space systems education and applications. He has designed, developed and delivered space-related educational content for audiences from grade school children to senior government officials, and has provided space expertise to multiple levels of the Canadian military.*

*Dr. Young-Keun Chang, for reviewing the sections on North and South Korea. Dr. Chang is a professor in the Department of Aerospace and Mechanical Engineering and a director of the Space System Research Lab at **Korea Aerospace University**, South Korea. He is also a Program Director of **National Space R&D of Korea Science and Engineering Foundation** (KOSEF), a government-funded institute. Dr. Chang was previously a principal researcher responsible for the development of **KOMPSAT-1** in **Korea Aerospace Research Institute** (**KARI**). His current projects include development of nano- and micro-satellites, including **Hannuri-2** and **Hannuri-3**, and training future aerospace engineers at **Korea Aerospace University**.*

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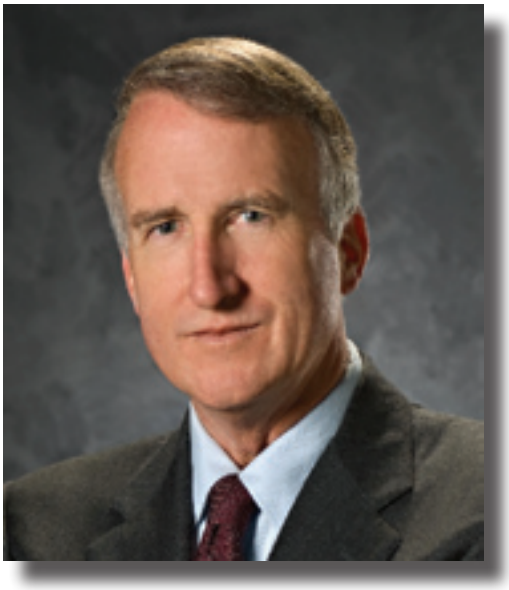
Futron would also like to thank others that provided confidential feedback to our 2009 edition, and we look forward to comments and suggests from our readers to enhance the Space Competitiveness Index in the future.

COMMAND CENTER



Craig Cooning, Vice President and General Manager, Boeing Space and Intelligence Systems, is responsible for the leadership of the people, programs, and assets of the company's military, civil and commercial satellite systems, as well as the Spectrolab subsidiary. Prior to joining Boeing in September 2005, Cooning, a retired Major General from the United States Air Force, was Director of Space Acquisition in the Office of the Under Secretary of the Air Force. He provided acquisition support to the Under Secretary and program management direction to field organizations for the development and procurement of Air Force surveillance, communications, navigation and weather satellites, space launch systems, information warfare capabilities, ground-based strategic radars, communications and command centers and sustainment for the nation's land-based strategic nuclear missile systems.

General *Cooning* was commissioned in 1973 through the ROTC program at Auburn University. He served in a broad range of acquisition and logistics positions and as Program Executive Officer for all Air Force space programs, twice as a major weapon system program director, as a commander, and a warranted contracting officer. Cooning earned both the space and master acquisition badges. Cooning earned his bachelor's degree in aviation management from the School of Engineering at Auburn University in Alabama and his Master of Business Administration degree from the University of Alabama. He is married and has two sons and managed to chat with us regarding the latest news from Boeing, that being the 702B bus.

MilsatMagazine (MSM)

Boeing has been a stalwart in the satellite bus business with their 702 model for years... and the 702 has proven to be a highly reliable product. Why did Boeing decide it was time to update the bus?

Craig Cooning

The 702B is designed to cost effectively accommodate the 6-12 kilowatt class of fixed satellite services — broadcast satellite services (BSS) satellite market. This system relies upon flight-proven technology and capabilities from our original Boeing 702 platform and other technology proven in the satellite industry, but uses a new structure and liquid propulsion systems to enable economies of scale. The current 702 system is still a critical element for geo-mobile satellite systems and our customers that have either very complex payloads or demand power in excess of 12 kilowatts.

MSM

What are the leading improvements with the 702B? Please tell our readers what those technologies bring to the bus.

Craig Cooning

The modular design of the 702B results in improved production efficiencies and the ability to accelerate the delivery of the satellite to the customer. The satellite bus structure is based on a central thrust tube design for better stiffness and weight efficiency. The

bus is scalable using different propellant tank configurations and power system elements to optimize it for each mission. There is a simplified, all-liquid propulsion system that can be augmented with high ISP electric propulsion when required. And the 702B offers a more efficient payload layout and antenna configuration.

By varying the propellant tanks and power system elements, the bus is actually scalable to a variety of configurations that adjust size, weight, and years of service. Stated simply, this makes it easier for customers to purchase exactly what they want, without buying "too much" or "too little" of a satellite and having to either use it longer than desired or augment it sooner than planned.

MSM

Who championed the 702B internally at Boeing? What is her/his background?

Craig Cooning

We invested four years in the development of the 702B, so it's unfair to single out any one contributor. Right now our focus is on program execution, and our Intelsat program manager is *Mike Neuman*, a seasoned, highly respected Boeing professional with more than 35 years of satellite experience. He reports to *Steve O'Neill*, president of Boeing Satellite Systems, International.

MSM

What, exactly, is Boeing's "Lean" manufacturing process? How does it make the 702B easier to manufacture and assemble?

Craig Cooning

Lean manufacturing, or better stated, Lean enterprise, focuses on satellite design that not only meets the customer requirements but also is designed for manufacture and test through reduced part count, reduced assembly steps, more efficient operational layout and an enhanced supplier management philosophy based on a product line rather than program approach. Because its design is modular, enabling us to leverage common manufacturing processes, such as a pulse line and manufacturing line production, manufacturing cycles are accelerated and will often lead to a shorter manufacturing time and therefore a faster delivery is anticipated.

MSM

Please tell us more about what the 702B means for Boeing's satellite business. Can you give us a little more color on your strategy for the fixed and broadcast satellite services market and how you expect Boeing Space & Intelligence Systems to finish in 2009?

Craig Cooning

The significance of this contract is that it re-establishes Boeing in the mainstream fixed satellite services and broadcast satellite services (FSS-BSS) market. We cannot be specific here, but hosted payloads clearly are a capability we intend to market more aggressively. As military satellite operators seek to meet service demands, and commercial operators look for business relationships that provide alternative sources of funding, hosted payloads become an area of high interest to Boeing, especially as we've been a leading payload provider for more than 40 years.

MSM

Is Boeing looking to develop additional medium-level satellites, or will the company's future concentrations be small birds for multiple payload launches for customer cost savings? Is there a future for larger satellites like the 702?

Craig Cooning

There has always been a split in the market's demand for satellites. The majority of the FSS-BSS satellites fall in the 6-12 kilowatt range, which is the sweet spot for the 702B. Single purpose missions or customers with known markets of a discrete size can both benefit from smaller satellites that take advantage of the cost of the smaller buses and smaller launch vehicles.

Boeing's current focus is in the medium-to-large class of satellite systems. In some cases, such as broadband applications, geo-mobile systems or more sophisticated digital-processed satellites, the mass and power requirements drive the use of a larger satellite such as the original Boeing 702. We intend to continue to market the 702 for customers requiring satellites that operate in the 12 kilowatt and higher ranges.

MSM

What launch vehicles will be able to boost the 702B into orbit? How did Boeing decide which launch

models would be the most viable for their product, and what was entailed in bringing those vehicles into the bus design process?

Craig Cooning

The 702B is designed to accommodate all of the medium-and large-class launch vehicles, including, but not limited to, dual-manifested Arianespace, Proton, Atlas V, Delta IV, Sea Launch, Japan's H2A and others. Our objective was to provide the greatest breadth of launch vehicle compatibility in order to assure launch availability.

MSM

Do you have any comment on the recent partnership between Intelsat and SES to win support to launch U.S. commercial satellites on Indian or Chinese launchers?

Craig Cooning

We have no comment.

MSM

Where will the 702B be manufactured, and what does this new bus mean for the local economies? How does this help stimulate the employment picture and economics of your region, and do you foresee it as long term? If so, it certainly puts a positive picture on all aspects of your projects.

Craig Cooning

The 702B will be assembled in El Segundo, California, with suppliers dispersed throughout the United States, Canada, Europe and Japan. Every new contract award preserves jobs, but it's important to explain that our satellite organization is a factory, and our design experts are not assigned to a single program, but cross-train to support multiple programs. We address our staffing levels in the aggregate for all of Space & Intelligence Systems.

MSM

When did Intelsat initially show interest in the bus and did that FSS firm have any input into the design process? How does Boeing assist customers with business planning when they investigate the 702B as their platform?

Craig Cooning

We believe that Intelsat considered all of the commercial spacecraft available today and decided to order four Boeing 702B satellites due to its reliability of service, affordability, capability and adaptability

702B DIMENSIONS

In Orbit	H, 5.6 m (18.3 ft) to 8 m (26 ft) W, antennas: 8.6 m (28 ft) L, solar arrays: 33.3 m (109 ft) to 48.1 m (158 ft)
Stowed	H, 5.6 m (18.3 ft) W, 3.7 m x 3.3 m (12 ft x 11 ft)
Mass at Launch	5,400 kg (11,900 lbs) to 6,160 kg (13,580 lbs)
Mass in Orbit (beginning of life)	3,400 kg (7,500 lbs) to 3,820 kg (8,420 lbs)

POWER

Solar Panels	13.5 to 20.2 kw, beginning of life 10.8 to 16.4 kw, end of life
Construction	Two wings each w/three to six panels of Ultra Triple-Junction (UTJ) gallium arsenide solar cells
Batteries	24 to 40 cell Li-Ion, 236 Ahr

for hosted payloads. Intelsat also chose the 702B because it met its fleet diversity requirements. With the 702B, we are able to take advantage of many economies of scale that reduce price and improve delivery. As the 702B is based upon technologies already serving other commercial customers, the risk associated with this model is very low.

MSM

How did Boeing woo Intelsat away from other contenders? You have a 33-year history of supplying satellites to Intelsat. Was the 702B a tough sell?

Craig Cooning

No sale is ever easy, especially in this competitive marketplace. However, we worked with our Intelsat customer to understand their needs and requirements, and explained how we could accommodate these needs. Through an iterative process, Intelsat determined that Boeing was the right fit to support their business needs.

MSM

Other than Intelsat and its commercial needs, what other market segments does Boeing believe will be interested in the 702B?

Craig Cooning

The 702B has applications for commercial, civil, DOD and the Intelligence community. The satellite system is designed for communications applications but can accommodate hosted payloads to support space situational awareness, communication, scientific and other missions. We anticipate the 702B being a key element in our long-range business plan.

MSM

When you think about Boeing looking forward into the changing political and budgetary environment, how do you view the competitive positioning of your satellite business? What do you think is the right way forward for Boeing?

Craig Cooning

Boeing's focus is to understand the mission and the available architecture to support the missions before anything else, and through mission analysis we determine how to best support our customer's needs. Focusing on these mission needs enables us to be viable, as they account for the politics as part of the environment. Our satellites are developed to accommodate their missions and support our customer needs, whether they are commercial-, civil-, DoD- or intelligence-driven.

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ON TARGET

Cisco Skips into the Military Satellite Market

by Nick Yuran, VP, Business Development, Global Protocols, Inc.

Leave it to Cisco to enter a new market segment and instantly become a market leader. Although not a traditional market for Cisco, that's precisely what they have managed to do with their recent entrance into the military satellite acceleration arena. With the addition of Global Protocols' SkipWare® software to Cisco's WAAS WAN optimization technology and router line, this combined product is making immediate inroads into the military SATCOM market and popping up in networks throughout the U.S. DoD.

By focusing on the value of reduced *size, weight and power* (**SWaP**) to the tactical warfighter, **Cisco** has reinvented the concept of the *performance enhancement proxy* (**PEP**) and imbedded this functionality directly into the *Integrated Services Router* (**ISR**) in the form of a plug-in networking module. Branded by Cisco as the ***Application Extension Platform*** (**AXP**), this module is capable of running **Global Protocols'** ***SkipWare*** either in conjunction with WAAS or as an independent SCPS-based accelerator. By eliminating the need for a separate, standalone accelerator and the SWaP it carries, Cisco is redefining the notion of the PEP in satellite architectures and altering SATCOM configurations throughout the DoD.

Weighing only 1.5 lbs, the SkipWare AXP is, nonetheless, a fully functional SCPS-based accelerator with all the power and performance of its full-sized appliance counterparts. The AXP module is essentially a blade, with dedicated computing resources separate from the router, that can be plugged into an open slot on a ***2800*** or ***3800*** series Integrated Services Router. The AXP is accessed through the standard Cisco router configuration process, with a user experience that will be very familiar to anyone conversant in Cisco-speak. The SkipWare AXP is currently available in two speeds, 15 and 45 Mbps, but in response to early customer feedback, a 155 Mpbs version is already in the works.

Deployed on its own, the SkipWare AXP overcomes performance loss associated with the environmental and operational effects of tactical satellite communications. Loss due to weather effects, high round-trip times, interference, path interruptions and blockage are quickly remedied by SkipWare, rapidly returning the link to bandwidth-efficient, line rate operations. The SkipWare AXP's performance has also been tuned to work seamlessly with common military modem technologies, such as **DVB** and **TDMA**-based systems. This makes the SkipWare AXP especially well-suited for tactical SATCOM architectures, such as transit case-based or vehicle-sheltered terminals, where space is at a premium and the requirement for high-fidelity links is essential. The SkipWare AXP makes it possible to implement SCPS-based satellite acceleration wherever there is a Cisco router, which in DoD networking is just about everywhere. And, as with all SkipWare-enabled devices, the SkipWare AXP has optimized interoperability with any other SkipWare system, such as those commonly deployed throughout the tactical DoD community and DISA satellite services facilities.

Already universally known in the enterprise WANOp market for their WAAS technology line, Cisco's go-to-market strategy for entering the military satellite space was ideal. By leveraging the strength of the SkipWare brand and install base in the military SATCOM market, the AXP instantly meets DoD standards requirements and carries all the military credentials of other SkipWare-based platforms. Users can deploy the SkipWare AXP either with WAAS, another WANOp technology, or as a standalone SCPS PEP and have instant interoperability with SkipWare's market-leading DoD install base.

Although only recently introduced to the military market, the SkipWare AXP is rapidly finding its way into networks throughout DoD, primarily among the Army and USMC SATCOM communities. The systems integrator community, already very confident in the Cisco brand and prolific users of their router technologies, has been among the first to adopt the SkipWare AXP. Specified by contractors for architectures ranging from aircraft to submarine-based SATCOM deployments, the SkipWare AXP has proven to be the ideal form factor for tactical environments with severe space and power constraints.

Norfolk, VA-based **Mission Mobility, LLC**, a communications products company specializing in mobile, tactical comms kits, has been quick to identify the value of the SkipWare AXP to their customers. A long-time proponent of SkipWare, this new form factor has had a great appeal for their tactical customers.

"This is the form factor that the tactical community has been waiting for," said Mission Mobility Sr. VP of Engineering *Dave Huisenga*. "Cisco routers are already being deployed throughout the DoD SATCOM community. It makes sense to take advantage of this platform to imbed other network services, and satellite acceleration is the ideal candidate to include in the router."

Jeff Houle, a senior engineer at **Lockheed Martin Tactical Systems** in Eagan, MN, has a similar view. His organization has been working with SkipWare in a variety of forms, and has been particularly impressed with the flexibility and ease of use of the AXP module. "Having the ability to host SkipWare in a Cisco ISR chassis and configure it through the IOS CLI provides the obvious reduced SWAP and LTS (lifetime support) from having another independent device," said *Houle*. "Additional real estate (in the network) is already hard to come by, whether refreshing COTS components, adding additional functionality to existing baselines, or designing a new system. "With SkipWare running on an AXP, it is another step

At 1.5 lbs, the SkipWare AXP offers a significant SWaP savings over traditional PEP appliances

forward in the evolution of networking components." Houle also notes the value of the inherent reduced training and maintenance costs of the SkipWare AXP. Because Lockheed Martin's clients are already well versed in Cisco configuration and maintenance, there is a very small learning curve required in implementing the AXP.

In a recent satellite acceleration bakeoff conducted by a DoD systems integrator on behalf of U.S. Central Command, the SkipWare AXP proved to be the star of the show. When run in conjunction with other WANOp technologies, its catalytic properties were made very apparent by the significant performance improvements that were gained over running WANOp products without SkipWare. When the SkipWare AXP was paired with Cisco WAAS, for example, overall WAAS performance over a standard tactical satellite channel nearly doubled for each networking application tested. For the various WANOp technologies included in the test, running with SkipWare proved to be the difference between scoring at the top of the pack and being an also-ran.

While it may be daunting to the incumbents in this space to see a dominant name such as Cisco taking an interest in their niche market, there is an upside that should be reassuring to everyone that makes their living in military SATCOM. It is a testimony to the economic viability of this market that an industry behemoth like Cisco would choose to enter it.

The SkipWare AXP installed in a pair of Cisco 3845 ISRs, both as a standalone PEP (top) and with a WAAS module (bottom)

There are few better indicators of the growing prosperity of the military satellite market than the recent entrance of Cisco Systems as a major milsat technology vendor. While their presence may provide a competitive pressure that will compel all players to continue to improve and innovate their technologies, it is encouraging to see that this market has grown big enough that it can accommodate even Cisco.

About Global Protocols' SkipWare

The flagship product of Global Protocols, SkipWare® was the industry's first commercial implementation of the Space Communications Protocol Standards Transport Protocol (SCPS-TP). Recognized today as the worldwide leader among SCPS implementations, SkipWare boasts the largest install base and the broadest set of host platforms in the industry. Licensees range from satellite hardware vendors to DoD systems integrators to networking giants. American-owned and American-made, SkipWare is the name warfighters and networking professionals have come to trust for SCPS acceleration.

Since the initial release of SkipWare v. 1.0, Global Protocols has focused on providing customers with architectural flexibility, high-performance and ease of use, while remaining true to the original open-source SCPS standard. In addition to providing the highest bandwidth efficiencies of any SCPS implementation in the market today, users of SkipWare-powered devices can be assured of full standards-compliance and the highest level of cross-vendor interoperability. Self-tuning and transparent to the network, SkipWare devices can be dropped into a network and provide instant acceleration with no user configuration required.

Global Protocols

Joan Grewe is the Vice President of Corporate Business Development at Integral Systems and she is a recognized subject matter expert in assessing U.S. telecommunication vulnerabilities. Most recently, prior to joining ISI, Ms. Grewe was TerreStar Network's Director, Department of Homeland Security (DHS) Services, responsible for business development within the DHS and DoD communications security arena. While with TerreStar, Ms. Grewe chaired the DHS-sponsored Communications Sector Coordinating Council.

Before her career in the private sector, Ms. *Grewe* served more than 21 years as a commissioned U.S. Army officer, specializing in priority communications programs. Her efforts included serving as the Chief of Staff for the ***Defense Information Systems Agency*** (**DISA**) and as the Battalion Commander responsible for communications as the first **NATO** headquarters in Bosnia. Ms. Grewe sits on the ***Satellite Industry Association***'s Board of Directors, and she is also a member of both the *Armed Forces Communications and Electronics Association* and the *National Defense Industry Association*. She holds a BA in Business Administration from **Loyola University** and an MS in Business Administration from **Wesleyan University**.

MilsatMagazine (MSM)

A pleasure to speak with you, Ms. Grewe. Having experienced a 21-year career with the U.S. Army in a variety of responsible positions, how was your move to the private sector? Are you enjoying your transition? Could you tell us about your work as the Chief of Staff for the DISA as well as your experience in Bosnia as the Battalion Commander responsible for communications at NATO?

Joan Grewe

I retired 10 years ago and the move to civilian life seemed to be easier than most experience (but still a scary leap from the known to the unknown) as I always had a life outside of the Army. I always felt it was important to have an identity separate from my career, which helped in my transition. Networking and staying in touch with old friends and colleagues along the way is critical to prepare for life after the military. An old Army buddy at MCI connected me to my first private sector job.

Working as the DISA Chief of Staff was a wonderful opportunity. Under General Edmonds, there were a lot of exciting changes underway and I was able to touch a wide variety of issues during a time of transition. I really enjoyed the opportunity to work with the National Communication System (an organization which is now located inside the Department of Homeland Security (DHS) vice DISA) as well as assist in the design of communications strategies for disaster recovery, and priority programs for the warfighter and first responders. All of these programs are still in use by the Federal government.

MSM

NATO communications during your time in Bosnia must have been a real challenge — what demands did you encounter and what solutions did you bring into play?

Joan Grewe

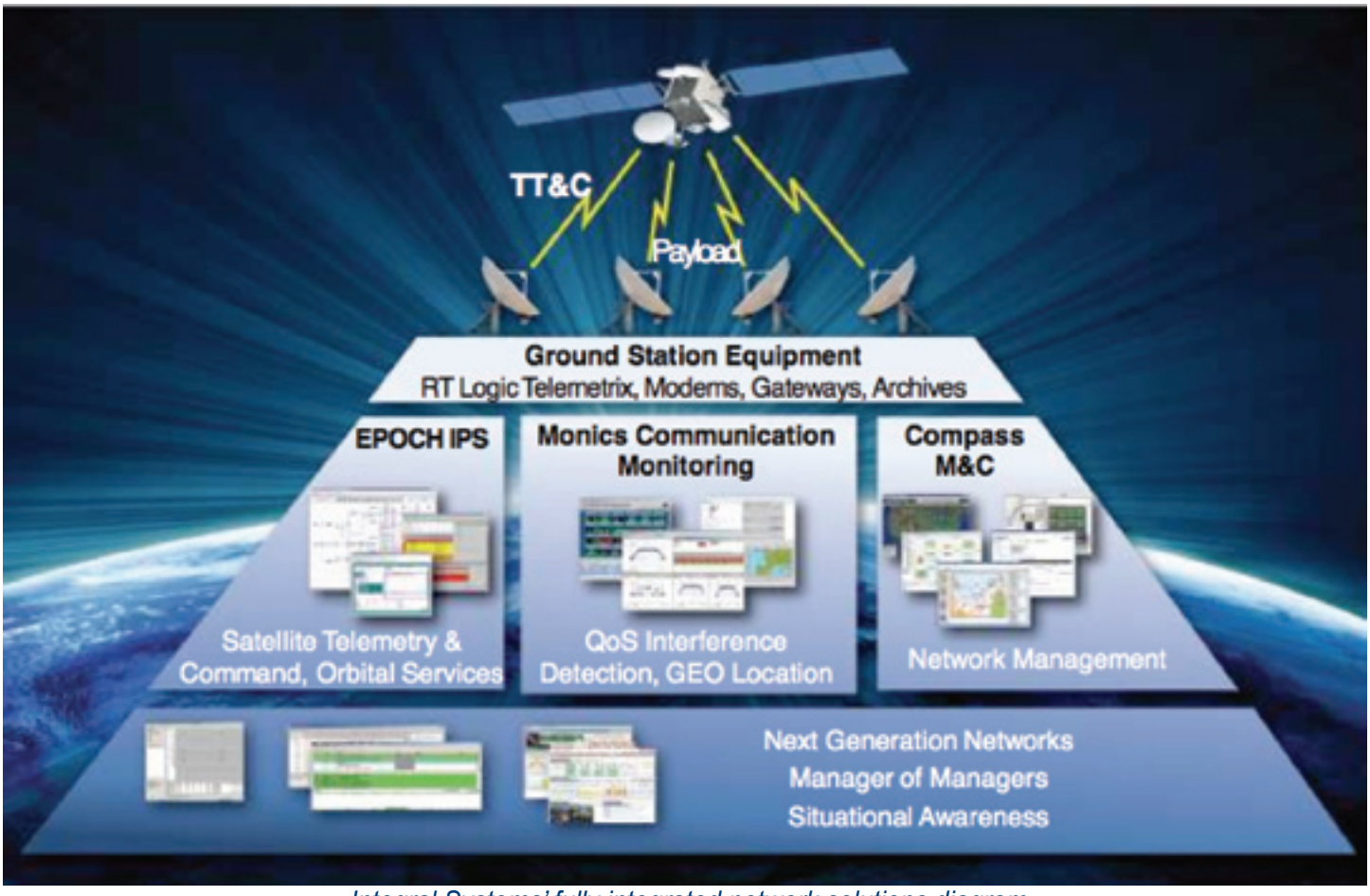
My time in Bosnia was actually my second tour in NATO. It's a great experience to work with our allies and partners in peace. I commanded the U.S. ARMY Element, Land Forces Central Europe (LANDCENT) permanently stationed in Heidelberg, Germany. My Battalion deployed to Bosnia in December of 1995 to support the 4 Star NATO Headquarters in Sarajevo, Bosnia. Additionally we were responsible for all U.S. personnel serving in the French and British Sectors. One of the companies under my command, the 414th Signal Company, provided the backhaul communications for NATO operations and was among the first group to relieve U.N. forces in Sarajevo.

My greatest challenge was to find a way to provide routine administrative communications for all the national support activities (postal, laundry, supplies, etc.) as we moved about the theatre of operations. The secure communications infrastructure put into place by the 414th Signal Company and the SHAPE Signal Group, was for tactical use only. Early in the deployment I resolved this issue by signing a contract with Deutsche Telecom to provide cell phones for unclassified, day-to-day communications needs. This worked so well that the 4 Star insisted I provide him and his immediate staff with cell phones too.

The lesson here is that as the commander on the ground I had an immediate need that I was able to meet by having my assigned contracts person enter into a valid, approved contract with a vendor who I knew could provide service to my unit.

MSM

Prior to joining Integral Systems, you spent time as MCI's National Security Liaison, served as Vice-Chair, then Chair, of the TSP Oversight Committee, served as Senior Analyst and Program Manager at National Security Research (now CACI), and lead the Department of Homeland Security Services for TerreStar Networks. How did these experiences prepare you for your current position



Integral Systems' fully integrated network solutions diagram

as the Vice President of Business Development at Integral Systems?

Joan Grewe

I became familiar with commercial terrestrial communications companies while working at MCI as their National Security and Emergency Preparedness (NSEP) Liaison. I learned more about the capabilities and limitations of commercial terrestrial communications, those companies (AT&T, Verizon, Qwest, etc.) are the ones providing the first level of communications to the Federal, State and Local government and first responders. Working with agencies that have responsibility for national security communications such as the FCC, DoD and DHS, I gained a wide understanding of customer requirements for the first responder and warfighter.

A major portion of my responsibilities in all of my positions prior to ISI was the coordination with the highest levels of the Federal Government for the commercial recovery and repair of the network after a catastrophic event (train wrecks with HAZMAT spills, wild fires, major hurricanes, large geographic power outages, and terrorist attacks). The very priority programs that I worked on while in uniform at DISA were instrumental in assisting the commercial communication companies in prioritizing the repair and restoration of services that existed before the disaster (fire stations, hospitals, National Guard armories, Wall Street) as well as provisioning new services in new locations after the disaster (FEMA Disaster Field Offices, Red Cross shelters, etc.).

Throughout my work on every domestic disaster from the Louisiana Train wreck of May 2000 through September 11, 2001, up to and including Hurricane Katrina in 2005, I became aware that satellites provided the only communication link when terrestrial networks are overloaded, damaged, or destroyed. Similarly, when military operations take our personnel into environments where there

is no terrestrial infrastructure, the need for satellite communications is key.

MSM

Would you explain your duties at Integral Systems and how they can assist in securing MILSATCOM for our armed forces?

Joan Grewe

Integral Systems is a vendor-neutral network integrator and ground system control developer that provides cost-effective solutions to both commercial and military satellite operators. I joined Integral Systems to expand our reach into new and adjacent markets. Our government work is primarily with the U.S. Air Force, and I know we have a capability that would be of interest to the other branches of service, Army, Navy, Marine Corps and Coast Guard. ISI offers several unique applications that enhance the Quality of Service of the satellite provided bandwidth. We can monitor the RF for strength of signal (are you getting all the bandwidth and power you paid for), monitor for interference, identify that interference, and locate the interferer: all within a matter of minutes.

MSM

Do you find yourself once again interfacing with DHS and DoD? If so, are you able to apply your military experience to the private side of such partnerships?

Joan Grewe

Military bandwidth is at a premium and the government will have to start securing commercial bandwidth through integrated networks. Currently, we are dealing with a stove-piped procurement process that hinders our ability to implement these systems quickly. The warfighter doesn't care how a communications system works — just that the system works efficiently when it's needed.

DISA and GSA just announced that they have agreed on a joint strategy for a new acquisition of satellite communications. The strategy will be announced at the Future COMSATCOM Services Acquisition (FCSA) Strategy Industry Announcement Event on 6 August. I am very excited and hopeful about this event.

MSM

You recently participated in a panel at ISCe 2009 that focused on the new administration's priorities and that impact on MILSATCOM users, currently and in the future. Would you please tell our readers what your, and the panel's, thoughts were concerning this subject?

Joan Grewe

The focus of the conversation was on how the current bandwidth procurement process does not work. Especially in a tactical environment where there is no terrestrial communications infrastructure.

For example, commercial vendors would like for DoD to sign a long term (for example five years) contract similar to their commercial customers. Five years in advance is too long — communications needs are immediate and constantly in flux. Commanders need to be able to request and receive communications support almost instantly. From there, we can prioritize mission use.

MSM

How do you see the MILSATCOM environment becoming even more responsible for our warfighter over the next few years, especially as we see budgetary concerns from all industries... military, NGO, agencies and so on. How can we ensure our warfighters receive the technologies they need to prevail in the various, active theaters?

Joan Grewe

As the warfighter moves into austere environments with little or no terrestrial capabilities, satellite communications (either commercial or Military) are vital for the ability to communicate.

From a technology standpoint we in industry need to continue to do R&D into bandwidth compression, development of multi-band modems, get more peripherals NSA type 1 certified, and reduce the weight and size of all of our form factors.

From a procurement processes standpoint we must reduce the distance between the operators and the contracting offices. In addition to streamlining the procurement process, more staff in the government contracting offices is key to keeping up with the warfighter's needs in a fast paced environment.

Satellite Services for Public Safety and Emergency Response

For any public safety agency, the ability to ensure communications continue to operate in the face of emergencies or natural disasters is critical. On-scene personnel must have constant access to voice and data, even when local network services are down. The Missouri Department of Transportation (MoDOT) has experienced firsthand the importance of a reliable emergency communications network. In 2008 alone, Missouri dealt with disastrous situations including major flooding and ice storms that were declared state emergency situations. By providing emergency communications services during situations like these, MoDOT helps save lives.

In order to fulfill its mission and insure public safety in any situation, **MoDOT** was seeking to expand its emergency communications network. It needed a comprehensive and reliable backup and emergency communications system to ensure critical communications always stay online and to enable coordination with other agencies and support personnel. In addition, it needed a solution with the capability to tie its radio bridges together and seamlessly provide mixed backhaul when terrestrial lines were down, without compromising their ability to deliver full network interoperability.

After originally testing other leading satellite networks, MoDOT realized that many of the solutions were too costly, or just didn't work properly, and none of them supported all of their requirements. After careful research for leading technology vendors, MoDOT teamed with **ODN**, the Missouri state contractor for satellite services, and **Spacenet**, a leading provider of satellite networking services, to design and implement an innovative satellite solution, enabling it to successfully fulfill its mission of protecting the public, no matter what.

Requirements

MoDOT concluded that it needed an upgraded communications solution that could support its full range of requirements, including support for converged **VoIP** (*Voice over IP*), **RoIP** (*Radio over IP*), video, data, and radio backhaul. The system needed to be mobile, independent of terrestrial networks, provide interoperability between state agencies, as well as offer access to the PSTN to integrate efforts with **FEMA** or other federal agencies. Most importantly MoDOT needed a solution that was easy to manage, deploy and operate, and would be cost efficient from both a *capital expenditure* (**CapEx**) and ongoing *operational expenditure* (**OpEx)** perspective due to tight budget constraints.

Leveraging lessons learned from past experiences, including hurricanes *Katrina* and *Rita* in 2005, MoDOT determined that the ideal network would utilize broadband satellite connectivity as its core network. During Katrina and Rita, critical voice and data communications were offline. Wireline circuits were damaged, and wireless and cellular technologies were knocked out since they are dependant on terrestrial communications. *Land Mobile Radio* (**LMR**) systems experienced blackouts as they are also dependant on the local land-based infrastructure. Unlike these traditional connectivity solutions, satellite networks completely bypass the local terrestrial infrastructure and provide a completely independent, wireless last-mile solution that provides ultra-reliable services.

VSAT (*Very Small Aperture Terminal*) satellite provided the perfect solution. In addition to bypassing the terrestrial infrastructure, VSAT's offered the benefit of mobility as well as ease and speed of deployment to provide instant communications and support for affected communities. VSAT's are also easily maintained on an ongoing basis, and can be deployed for days or weeks at a time depending on the emergency situation.

As another important requirement, MoDOT determined that it needed to own the total solution. Rather than use outsourced emergency response units or hire on demand third-party backup services, MoDOT needed to manage the total solution and have its own on-scene personnel trained and capable of deploying the systems. Using these other outsourced alternatives would most likely increase costs, and would also lead to network downtime for at least a few hours, if not far more. It has been proven that assets that can not get to an emergency scene in a timely manner are of no use. MoDOT wanted its emergency communications network to be deployed by trained MoDOT employees, accessible within key areas in the state, ready to go.

Solution

MoDOT officially implemented its upgraded satellite emergency network in 2008, with the goal of providing a reliable communications outlet in the face of unforeseen events across the state. Understanding that reliable support and network integration would be keys to success, MoDOT ultimately teamed with ODN, the Missouri state contractor for satellite services, and Spacenet, a leading provider of satellite networking services, to design a reliable solution for MoDOT's emergency network.

The innovative solution supports full VoIP and RoIP capabilities with *Quality of Service* (**QoS**), Internet access, and can interface with trunked radio systems

When highway and bridge infrastructure is threatened and poses a public risk, emergency communications had better be viable to prevent further injury to property — and life!

and analog systems. The solution enables seamless transmission capabilities and control to communicate and interconnect remote tower sites by satellite, and interoperability with legacy radio systems. Currently, seven of MoDOT's main radio towers are equipped with the satellite systems. The emergency network can be operated and controlled from virtually any location that has access to a high-speed Internet connection, enabling communications over radio across the world.

In addition, the team developed an innovative telephone solution, referred to as STAC (satellite transport audio circuits), that provides a reliable voice service that is more efficient and cost-effective than alternative phone services. Traditional satellite telephones have high contention ratios, which lead to dropped calls during high volume periods, and higher bandwidth requirements that lead to increased costs. The **STAC** system, however, connects directly to MoDOT's satellite network to avoid the issue of high contention ratios for shared satellite phone users. In addition, its advanced design uses significantly less bandwidth for voice services, making it more efficient and cost-effective, and reduces the effects of latency (the amount of time it takes for a packet of data to get from one designated point to another).

MoDOT is using both fixed and transportable systems, and Spacenet's flexible backup satellite service that can be instantly deployed, providing a more cost-effective solution for units that can remain in standby for extended times. ODN provided comprehensive technical support and training for deploying and maintaining the satellite-based emergency response communications system, and ensured that the solution operated properly with the legacy systems that MoDOT depends on. Innovative engineering and first-rate on-sight support enabled MoDOT to expand the use and capabilities of its network.

Customer Value

Since the implementation, MoDOT's emergency communications network has been put to use numerous times for real-time deployments, and consistently allowed Missouri emergency response units to communicate better and ultimately perform at peak efficiency. The system has been used to support numerous government agencies including police and fire departments, city governments and the military.

MoDOT used the advanced emergency management network in Missouri to help government agencies and community organizations resume data and voice communications during the aftermath of severe flooding in 2008. With damaged terrestrial networks and with cellular towers down, MoDOT provided a transportable and rapidly deployable satellite network to local communities at the request of ***The State Emergency Management Agency*** (**SEMA**). The emergency communications network provided support for VoIP, radio backhaul, and VPN Internet access.

The system was tested again in the winter of 2008 when ice storms damaged certain regions of the Midwest. MoDOT responded with its flexible communications network that enabled reliable radio transmissions and working voice services based on its STAC system to support critical and time-sensitive conference calls with state and federal agencies coordinating the relief efforts.

Overall, the emergency communications network services were invaluable during these disastrous events. With widespread wireline outages, MoDOT's radio and telephone communications were uninterrupted.

Final View

The advanced emergency communications network solution provides numerous benefits to MoDOT, including an easy to deploy, versatile, and scalable transportable solution that supports all of its applications. The solution is critical for public safety measures, providing a high reliability communications system in the case of a crisis or disaster. In addition, MoDOT has access to readily available satellite training, ensuring complete support for their communications network before or during an emergency situation.

The CEO of ODN, Greg Heifner, was able to offer us his personal insight into his company and their work in the first responder/NGO/emergency services arena.

MSM

Greg, could you give us a brief overview of ODN?

Greg Heifner

Orbital Data Net (ODN) was formed after a long (30 year) career in the commercial satellite industry and the realization during the 911 events that what I knew a lot about was the capability of commercial satellites and how they would be of great effect during times of natural or manmade disasters. I sold my cable operations to fund ODN in an effort to provide a satellite network that agencies could use to restore their existing communication systems. My target was not necessarily commercial interests trying to maintain business continuity (although we have done a lot of this), but emergency organizations trying to save lives.

For example: post Katrina, we were involved with Motorola and the Louisiana Department of Public Safety in deploying our system to handle P-25 digital Land Mobile Radio calls for State Police and other agencies. Using this system, agencies have been able to keep alive, or rapidly restore, their legacy LMR networks and provide seamless continuity without resorting to means of communication outside their normal operation center. This removes the risks associated with security and firewalls as their end of the network is under their control.

Our satellite network provides access for low latency LMR, basic telephone circuits and data/Internet access off of one dish antenna. Emergency responders don't necessarily want to be handed a new communications technology such as a specialized cell phone or handheld satellite phone during an emergency — they would prefer their radio network continue to operate and their data centers stay hooked up. That is what we provide.

ODN is a privately held company in Columbia, Missouri. Our system is now in seven states and is widely deployed from NASA's use as a mission critical launch item in their radiation monitoring network at the Cape, to Motorola and Raytheon radio networks.

MSM

Why was ODN suited to be the best provider for the MoDOT?

Greg Heifner

ODN is the official state contractor in Missouri for all satellite delivered services. MoDOT was already involved with a major VSAT supplier when I entered the scene and was told their attempts at using satellite had been flawed and deeply disappointing. It was an uphill battle, but we managed to prove in short order that we understood their issues and had not only the technology to solve the problems, but the will to do so. The ODN network just in the State of Missouri has spread to...

- ***Missouri Hospital Association***
- ***University of Missouri***
- ***State Emergency Management Assn.***
- ***Missouri Highway Patrol***
- ***Missouri Department of Corrections***
- ***City of Kansas City Emergency Management***
- ***Missouri Department of Natural Resources***
- ***Missouri Department of Conservation***
- ***St. Louis Red Cross***
- ***MoDOT***

Many other communities and fire departments have single units. Using our resource, all these agencies have means of direct emergency communications with each other and the other states that have joined our network.

MSM

Why is the MoDot application unique?

Greg Heifner

It was our first attempt at making a low cost LMR interface work on the popular JPS/Raytheon ACU radio bridges. MoDOT, like most of all the DOT's didn't have a lot of money to throw at this problem. They wanted an agile solution that worked for them and wanted to be certain they could afford to feed the network bandwidth over the long term. We did this using a blend of low cost shared circuits with the capability of automatically sensing the needs of the radio bridging equipment and activating those circuits only when needed.

MSM

How are you providing ongoing support to MoDOT to maintain the networks success?

Greg Heifner

It is a continuous process, similar to raising a family. They have come to depend on our ability to solve the inevitable problems that arise in a living, breathing network such as this one. We provide training that, frankly, doesn't end during the term of the contract. As they become more familiar with using satellite technology, we push more training towards them. The more they know, they more robust the emergency response is, and the more confidence the first responders have in the operation of our network.

MSM

Can this application apply to other DOT's, first-responder's, and ßemergency management teams?

MSM

Absolutely. The point is that every agency that joins this network becomes automatically able to communicate with each other at whatever level they choose to. It might be as basic as secure email that doesn't depend on Internet access, making a dial up phone call over our secure smart switch at the teleport, or to bridge LMR circuits.

For additional information...

Ka-band SATCOM For Transportable + OTM Apps

by Peter Woodhead, EM Solutions

The Ka-band (20/30GHz) satellite offers excellent potential for transportable and mobile communications due to the wide bandwidth available and the high gain achievable with small antennas. There are some difficult technical challenges in realizing this potential. While relatively small antennas, such as 500-1000mm parabolic reflectors, give high gain of the order of 40dB the beam widths are quite narrow, of the order of 1deg, and the antenna has to operate at both the 20GHz receive band and the 30GHz transmit band.

Compact, high efficiency, high linearity power amplifiers are required to minimise the size, weight, power consumption and the heat dissipated. At 30GHz, gain, power and linearity of available FET devices are much more constrained than at other satellite bands such as X and Ku so flexible, low loss combining techniques are necessary. For the receive side, the antenna noise temperature is relatively low due to the narrow beam width, and so the noise figure of the receiver must be as low as possible to avoid degrading the signal. The performance of a satellite channel is partly determined by the phase noise of the local oscillators used to upconvert and downconvert the IF signals onto the satellite frequencies. Low phase noise becomes more difficult to achieve as the frequency increases so it is essential to employ low phase noise, high stability design techniques for the 20/30GHz oscillators used in the converters.

This article describes suitable antennas, solid state power amplifiers (SSPAs), low noise amplifiers (LNAs) and local oscillators developed for transportable and mobile Ka-band satellite terminals.

Antenna

The parabolic reflector antenna offers the best compromise between antenna size, gain and bandwidth of all the various competing technologies. It has a further advantage compared to some of the planar array type antennas that have attractive flat layouts. This is that the transmit and receive beams are precisely aligned on the same bore-sight at all frequencies in the transmit and receive pass bands so that pointing/tracking is considerably simplified. A 500mm reflector is electrically large enough to permit a Cassegrain type feed to be used with good efficiency. In this case, a wideband feed horn to cover the 20-30GHz range can be designed so that a single feed is possible. Furthermore, it is possible to design the feed for linear and/or circular polarization and to make it switchable between the two which offers a degree of flexibility not often possible with other types of antennas. The full circular symmetry of the antenna and the antenna beam reduces the complexity of tracking and alignment for mobile and transportable systems.

SSPA

The saturated power level of single solid state 30GHz devices currently available is less than 10W. The “linear” power is considerably less than this at typically 2 to 3W as 30GHz devices are significantly more non linear than X and Ku devices.

To obtain moderate levels of 10-20W of linear power, as is typically required for Ka-band terminals to provide say 2Mbps data with small (500mm) antennas, requires a number of these devices to be combined. There are several ways of doing this including “free space” combining, radial/parallel plate networks and rectangular waveguide networks. For combining small to moderate numbers of devices, rectangular waveguide networks are very suitable at 30GHz for both electromagnetic and mechanical reasons. The networks can be accurately designed, the insertion loss is low, additional elements such as filters, phase adjusters etc can be integrated into the networks and the physical

circuit can support the modules and act as a heatsink and part of the overall package.

A conventional combining technique is to use 3dB quadrature couplers arranged in a parallel network. This has advantages for simplicity of design, good phase tracking and isolation properties and reasonable bandwidth. It is inflexible in terms of the number of modules to be combined (2, 4, 8 etc.) and the layout. A serial combining technique involves some electromagnetic compromises but offers much more flexibility in terms of the number of modules that can be combined and the physical layout of the modules. Using a combination of serial and parallel combining techniques, it is possible to combine up to 100 modules at Ka-band (>200 modules at X band) before the waveguide insertion loss becomes too high, but for small terminals more typical numbers are 4 to 10 modules.

The photographs on the next page show power devices on a conventional combiner and the combiner network.

Linearizer

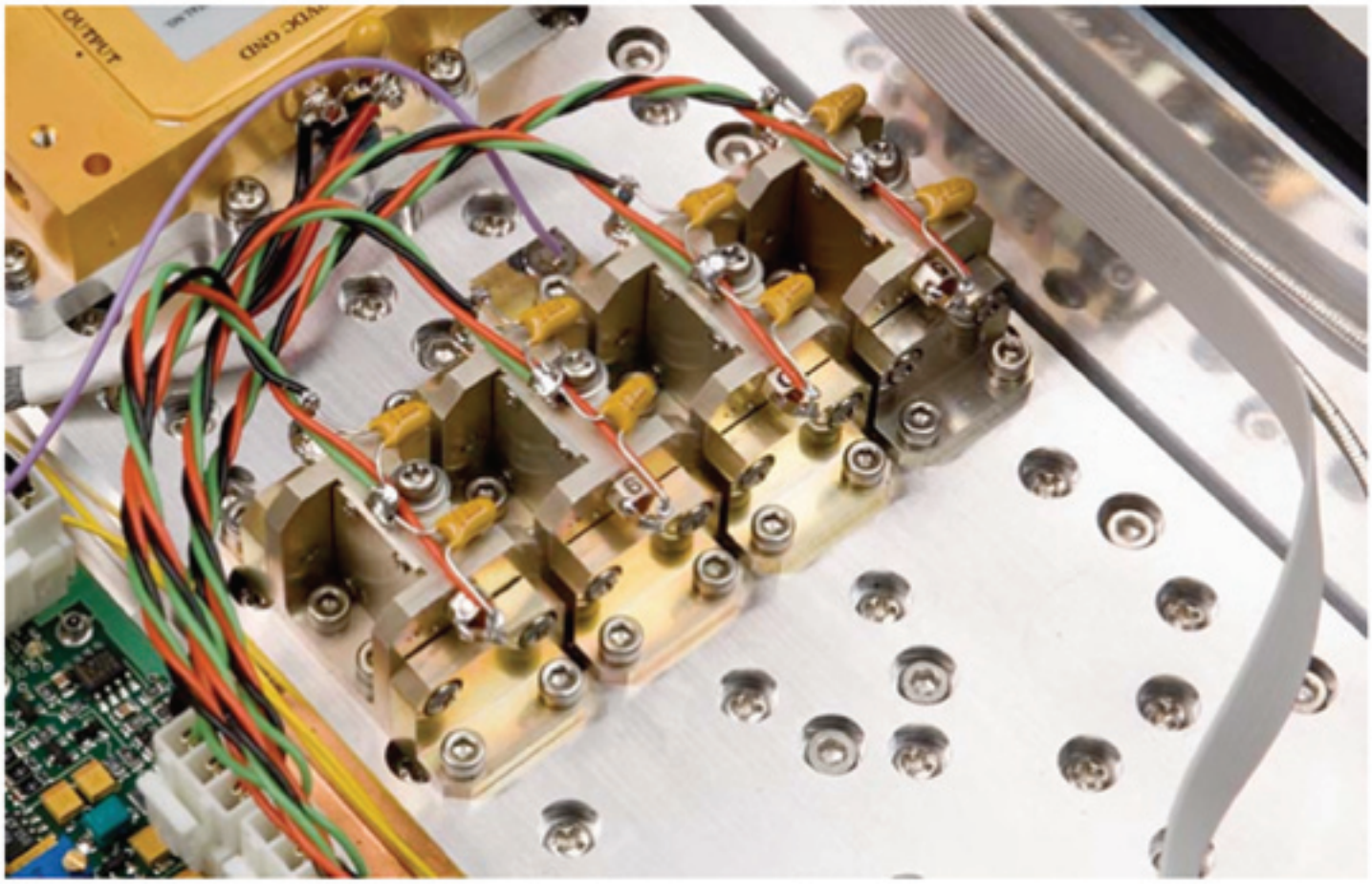
While it is always possible to increase the linear power by adding modules and increasing the saturated power, at least up to the limit of about 100 modules, this is not an effective technique for portable/mobile terminals where size, power consumption and heat dissipation are strong constraints. Another option is to add a linearizer to the SSPA to improve the linear power for the same saturated output power.

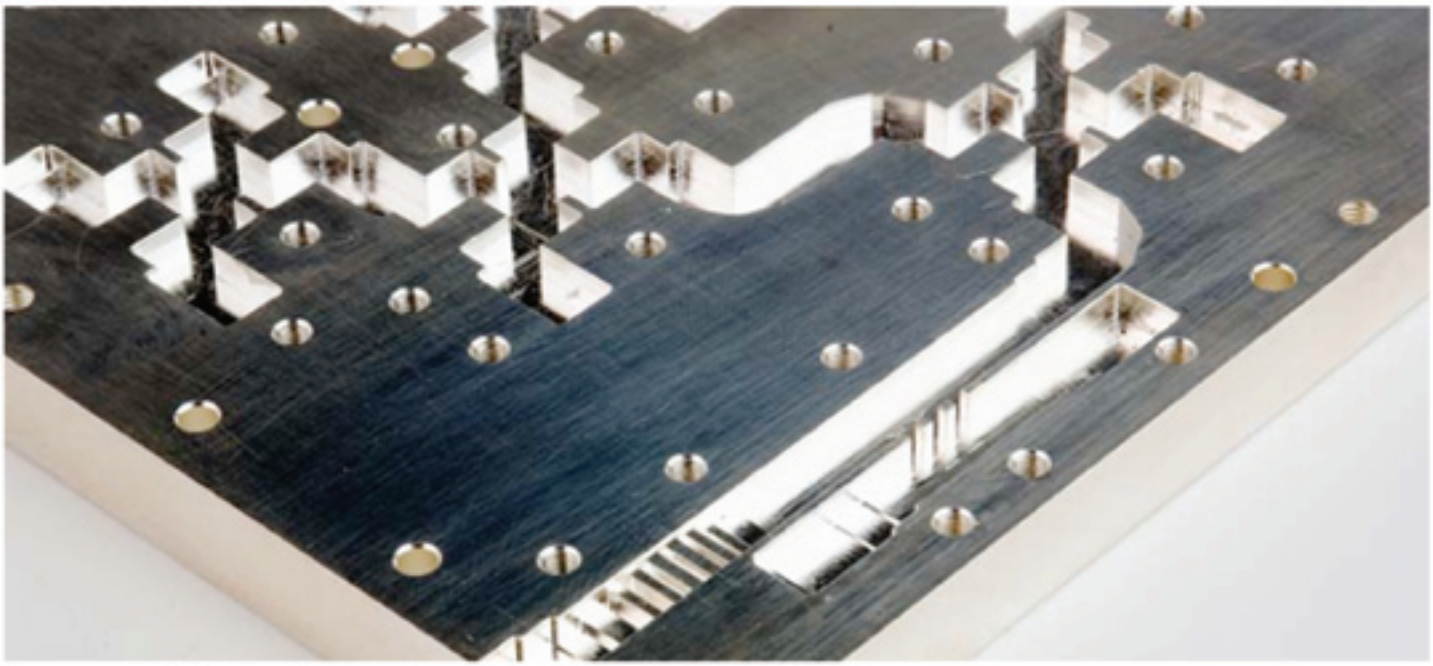
A 20W saturated power SSPA using 4 modules for example can be operated at 10W linear power when a linearizer is added. Without the linearizer, the saturated power would have to be increased to about 40W which would mean using 8–10 modules so doubling the size, power consumption and heat dissipation. A well adjusted linearizer can reduce the intermodulation levels by around 10 dB over a wide power range and the effective power level can be increased by 2 to 4 times depending on the particular operational parameters selected. The improvement in intermodulation level (IM) over a wide power range when a linearizer is added to the SSPA is clear from

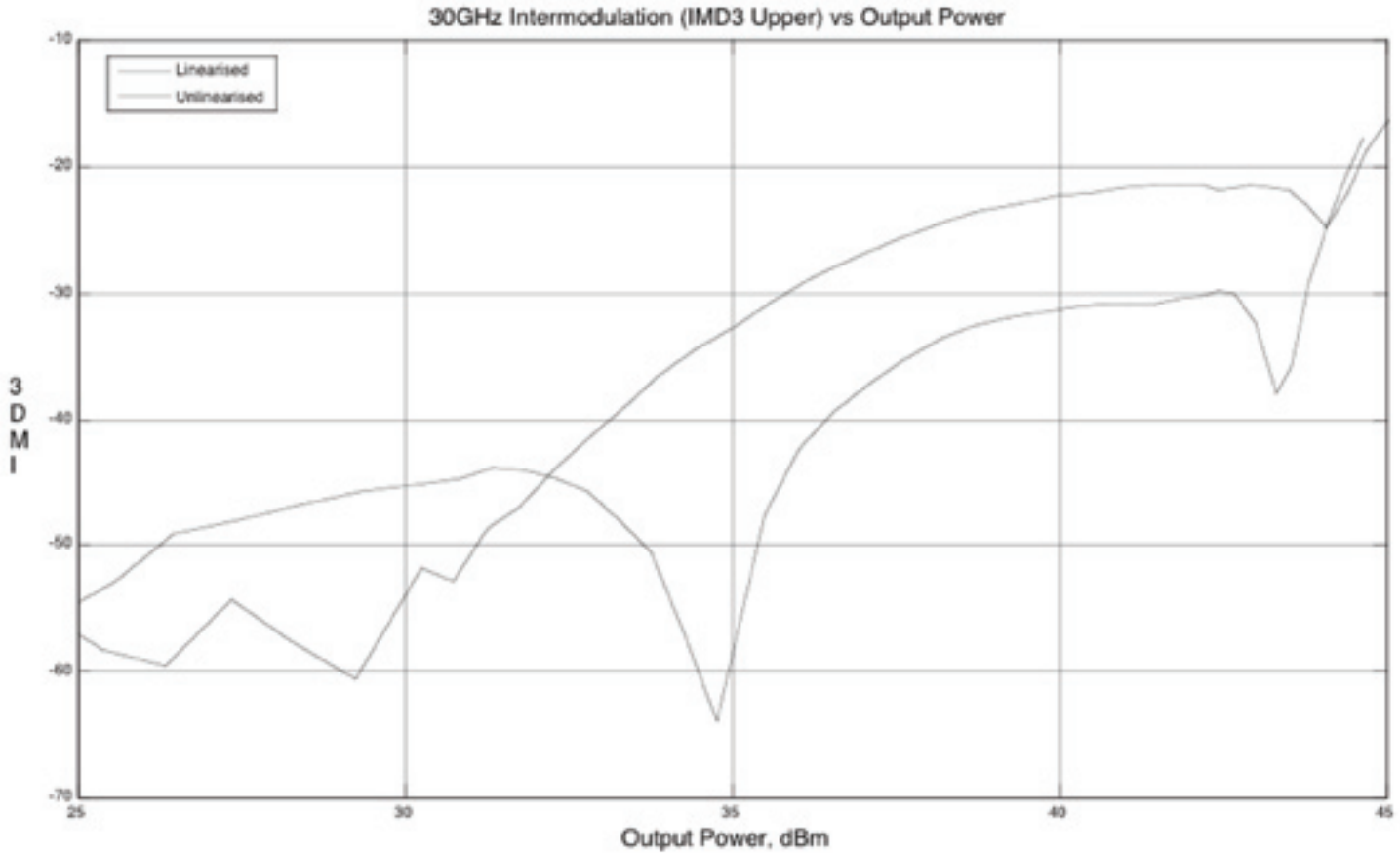
the following plot. (*See diagram on the next page.*)

Low Noise Amplifier (LNA)

A miniature LNA with a noise figure of 1.3dB across the 20-21GHz receive band is suitable for transportable of mobile terminals. The LNA has sufficient gain of around 30dB so that the rest of the receiver does not degrade the noise performance. To lower the noise figure further by a significant amount would require the LNA to be cooled to -20C or less which is not practical for these types of terminals.







Local Oscillators (LO)

The LOs in a mobile Ka-band terminal that operates with data rates from say 9.6kb/s to 2Mb/s must have good phase noise, high stability and low microphonics if the satellite link is to be stable with vehicle motion. To obtain good phase noise at high frequencies, fixed frequency LOs are used in a block conversion method with the IF frequency range being typically 1-2GHz. A low phase noise *voltage controlled oscillator* (**VCO**) is multiplied up to the final frequency of around 29 and 19GHz for the up and down converter respectively. A special multi loop phase lock loop design is used to reduce the vibration sensitivity (microphonics), and the VCO is locked to a 5MHz or 10MHz reference to deliver the high frequency stability necessary. All of this can be done in a compact, low power circuit consistent with the demand for small size, low power consumption and heat dissipation of a mobile terminal.

Smaller Solutions

The short wavelength at Ka-band means that satellite terminals can be manufactured with small antennas and yet reasonable data rates can be achieved of 2Mbps or so, under clear sky conditions. The high frequency of Ka terminals places additional design and performance limitations on the active devices available and on the passive networks but these limitations can be significantly reduced or even used to advantage to reduce circuit size and increase packing density. Linearizers have a greater benefit at Ka-band than at lower frequencies not only because the non-linearities of the Ka-band devices are greater, but also because increasing power is much more expensive at Ka-band in terms of the number of devices required, and the increased DC power and thermal load to get even small increases in output power. These modules can be combined into compact terminals that are suitable for tracking and mobile applications where moderate data rates (~9.6kbps to 2Mbps) are required.

About EM Solutions

EM Solutions has been contracted to develop a Ka-band On-The-Move Satellite Communications System from Round 12 of Australia's Defence Capability & Technology Demonstrator (CTD) Program. EM Solutions will partner with BAE Systems Australia on the CTD Project. The CTD Program supports priority defence capability development by funding Australian industry to demonstrate new technology. The technology demonstrations inform Defence of the potential performance and technical risk associated with future implementation.

Leveraging COMSATS To Support Space Situational Awareness

by Timothy L. Deaver, Director of Air Force Programs, AMERICOM Government Services

Within the space industry, there is a growing concern over how safe operations are in space. The Iridium incident this past February illustrates the fact that satellites are at risk of an accidental collision. Even though very little can be done about the number of objects already in space, the risks of future collisions can be reduced by a more precise and timely cataloging of these objects. Improving Space Situational Awareness (SSA) is an increasing priority across the space community. Owners and operators are investing in mechanisms to share their spacecraft positional data with each other while countries around the world are increasing their capabilities to find and track the objects in space.

Of particular interest to the *geosynchronous orbit* (**GEO**) satellite communication (SATCOM) operators, is the ability to detect and track objects at or near GEO. Within the past month alone, there have been several occasions where two satellites have come within 3 km of each other as predicted by **USSTRATCOM**'s ***Joint Space Operations Center***. The 3 km separation may seem like plenty of distance until one realizes that, in many cases, the accuracy of the measurements exceeds this distance. Today, when the SATCOM operator is notified of these close approaches, there is very little they can do to help this situation — operators watch nervously for any indication of a malfunction on their spacecraft that would indicate a collision. Everyone agrees we must improve our ability to find and track these objects. This article discusses how sensors could be "hosted" on the GEO commercial satellites themselves to improve the location accuracy of objects in or near GEO.

There is no disagreement that SSA sensors at GEO would help to address this problem. The only remaining questions encompass how accurate and sensitive do the sensors need to be to truly contribute to the SSA mission. The answers to these questions are guided simply by how much one wants to spend on the sensors. The sensitivity of the sensor determines the size of the object the sensor can detect and how far away the object can be from the sensor. Generally, the more accurate and/or sensitive a sensor is, the more complex the design. Size, mass, power consumption and most importantly the cost of the sensor are directly related to its complexity. Therefore a balance must be found between the desired capability of the sensor and the contribution of the sensor to the SSA mission.

According to a **MIT Lincoln Lab** study, a mid-sized sensor in the 100 Kg range would provide an ability to detect and track microsatellite sized objects at distances great enough to provide meaningful and useful data to meet the established requirements of the SSA community.[1] The MIT study goes on to show that with SSA sensors hosted on as few as eight to 10 spacecraft, you could monitor nearly 100 percent of the GEO belt on a continuous basis. A sensor any larger than this "mid-sized" sensor may be able to provide additional capabilities, but the cost curve quickly increases and the hosted payload concept quickly loses its appeal.

An SSA sensor would need to be able to see objects in the GEO belt within its *field-of-view* (**FOV**). Therefore, the sensor would have to be mounted in an area where it could have a clear FOV of the GEO belt and not interfere with the commercial mission of the host spacecraft. This would generally result in the sensor being placed on a boom tower away from the spacecraft and behind communication antennas pointed towards the earth. Other sensor design constraints include sun-inclusion, thruster plume and jitter effects from the host spacecraft.

Commercial communication satellites do not require a great deal of timing or pointing accuracy when compared to satellites that normally host highly accurate sensors. In general, for a commercial SATCOM mission, if the spacecraft time is accurate within a few seconds, it is usually accurate enough.

Timing accuracy for SSA sensor data will require a much more accurate timing source. This timing source will either have to be incorporated into the sensor or it would have to be an added requirement for the host spacecraft. Similarly, commercial satellites do not have very "tight" requirements for stability or pointing accuracy. The pointing accuracy requirement for a typical communication satellite is driven by the need to maintain antenna patterns on the surface of the earth. If the pointing of the spacecraft is maintained within 0.1 degrees, the spacecraft normally meets the operators' requirements.

This accuracy is easily maintained with Earth sensors and a standard attitude control system. Another by-product of the pointing accuracy required for commercial communication satellite is a higher tolerance of jitter as compared to normal high-accuracy sensor host satellites. The MIT Lincoln Lab study discusses how a proper sensor design can meet SSA performance requirements without increasing the pointing and jitter control requirements of a standard commercial COMSAT. [1] Designing a sensor that can perform with the standard requirements once again keeps the cost lower. There is room for a trade study in this area as most satellite manufacturers offer upgraded *Attitude Control Systems* which greatly improve the pointing accuracy and stability of the spacecraft. These upgrades are available today with known costs.

All the factors mentioned above directly impact the cost and flexibility of hosting such a sensor on a geosynchronous communication satellite. By selecting a relatively light weight, low power consumption sensor which requires a small amount of bandwidth

to transmit its data, the cost of hosting the sensor is kept to a minimum.

Now that we have addressed the type of sensor desired for a hosted SSA mission, let's examine planning timelines. The typical commercial satellite planning and construction program starts about 36 to 48 months before a satellite is available on orbit for commercial service. As depicted in *Figure 1* below, the planning phase is 12 to 18 months in length and then this is followed by a construction and launch phase lasting approximately 24 to 30 months. The optimal time to begin planning hosting sensors on a commercial satellite bus is during the early planning phase.

During this time period the commercial operator is analyzing potential sources of income which will come from operating the spacecraft over its average 15 years of life. This potential income is then compared to the associated costs for acquiring, launching, and operating the spacecraft. Based on this information, the project's anticipated financial performance, usually using a metric such as its Internal Rate of Return (IRR) is calculated. If the projected IRR is not greater than the company's minimum rate of return (typically arrived at by calculating what could be earned by alternate uses of company capital, such as investing in other projects, buying bonds, etc.) then the project is either modified to increase the IRR or, if that cannot be done, scrapped completely.

A typical commercial communication satellite can cost from $250M to $350M including spacecraft, launch, insurance, and on-orbit operations. The commercial models insure that over the 15 year operational lifetime of the spacecraft that the IRR will meet the investors' expectations. The optimum planning window for considering hosting payloads is during the Industry / USG Opportunity Analysis period as shown in *Figure 1*. This time period is the most

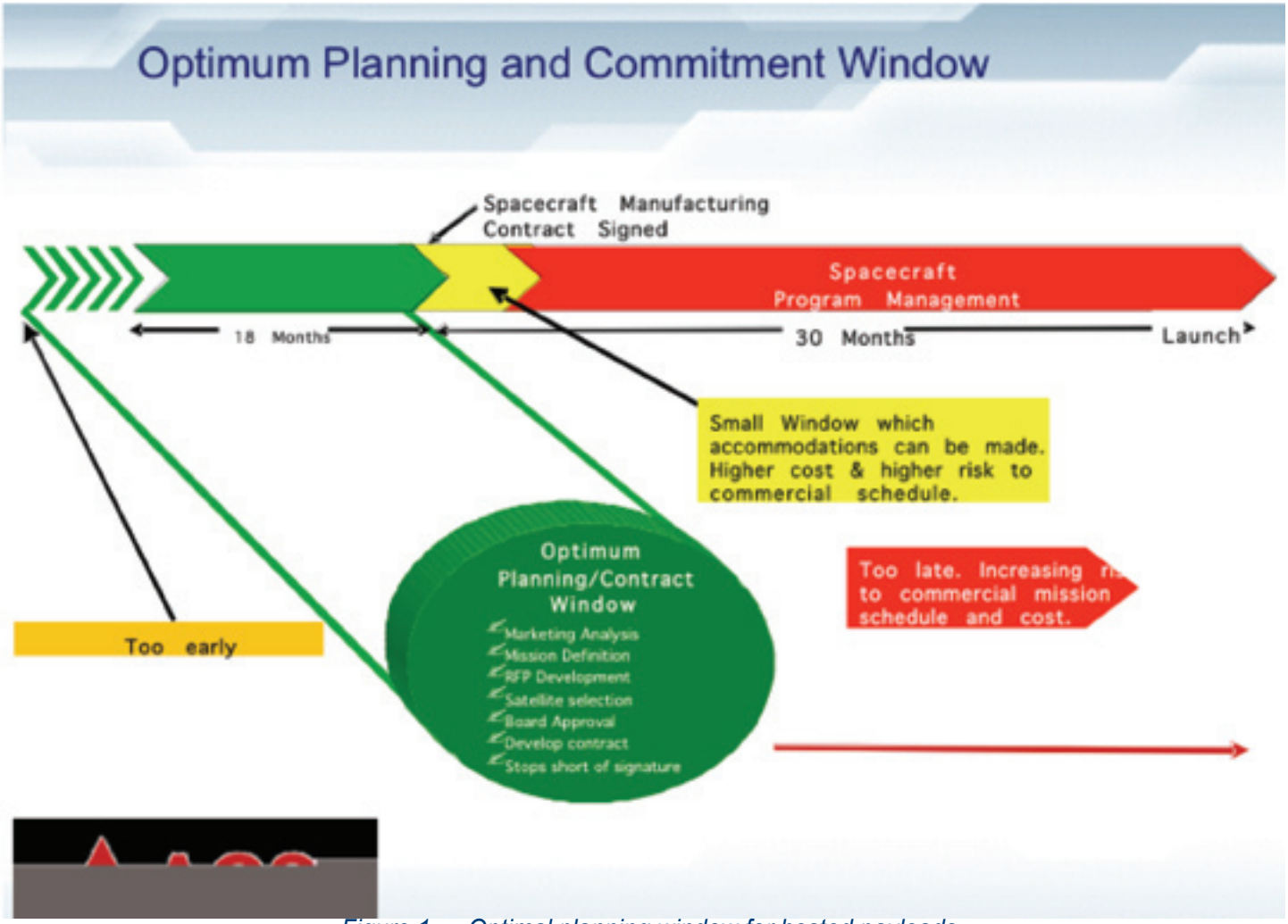


Figure 1 — Optimal planning window for hosted payloads

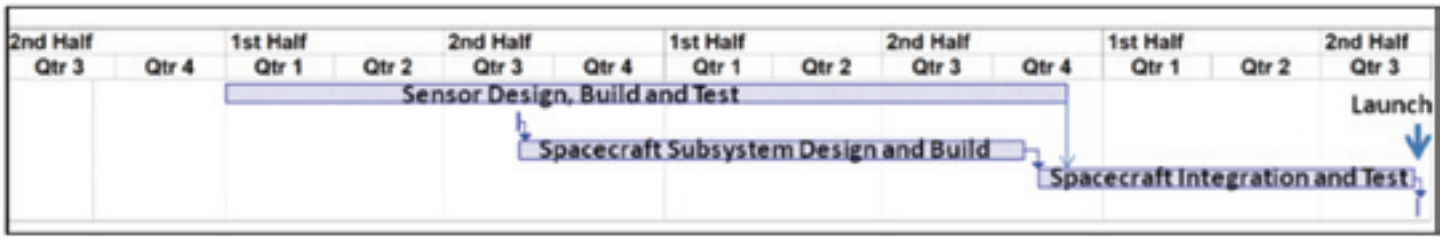


Fig. 2. Typical Commercial SATCOM Spacecraft Design, Build, Integration and Launch Schedule

flexible period in the planning window. Any earlier than this and the plans for a specific spacecraft are too fluid and contain too much uncertainty to be able to establish any design criteria and orbit location. Any later than this, you end up with whatever is available from the host spacecraft and flexibility in design changes is highly constrained.

Discussions with leading sensor builders indicate that their developmental cycle is on the order of 24 months from sensor design through subsystem test and calibration. The design and integration process for a typical satellite construction and launch is illustrated in *Figure 2*, above. The sensor design, build and test can overlap with the spacecraft subsystem design and build, if the sensor design is mature and all interface requirements are known and well documented. These interfaces would include mass, size (to include all control and communications electronics), power, thermal and mounting constraints. If this information is known and incorporated into the design of the host spacecraft, the sensor could actually arrive at the spacecraft manufacture shortly after spacecraft integration begins. Therefore the sensor must be completed approximately 12 to 16 months before the scheduled launch of the host spacecraft. Given these scheduling constraints, the selected SSA sensor would have to be under construction months before its host spacecraft. This type of architecture is achievable if the US Government develops a sensor specification and establishes a sensor procurement pipeline. The sensors would then be provided to the satellite bus manufacturer for integration into the bus at the appropriate time.

Commercial satellites are routinely replaced based on age, lack of available station keeping fuel or to allow a service provider to upgrade its capabilities. Each commercial SATCOM operator maintains a plan of replacing spacecraft. The typical communication satellite is designed to last approximately 15 years. The two largest commercial SATCOM operators in the world, SES and Intelsat, operate about 100 such spacecraft. With 100 satellites combined, each lasting approximately 15 years, it takes six to eight replacement satellites per year to maintain their fleets. Even with this many potential hosting opportunities per year, not every one of these launches is an ideal candidate for hosting an SSA sensor. As discussed earlier, 10 sensors equally spaced around the GEO belt would provide nearly 100 percent coverage of the GEO belt down to the microsat size of object.[1] Using mathematical formulas only understood by rocket scientists, it can be calculated that you would want to host a set of SSA sensors on a GEO spacecraft approximately every 36 degrees (360 ÷ 10).

Commercial spacecraft are not evenly spread out around the GEO belt, they tend to be concentrated in higher numbers in areas with high demand and more sparsely spaced in areas of lower demand. Therefore it is possible that two, three or even four consecutive spacecraft would be going to roughly the same area in the GEO belt and only one or two of them would be adequate candidates for hosting an SSA sensor.

Spacecraft that are going to be launched in 2011 or earlier are more than likely already designed and under construction. Based on the optimal planning timeline presented above, hosted SSA plans should

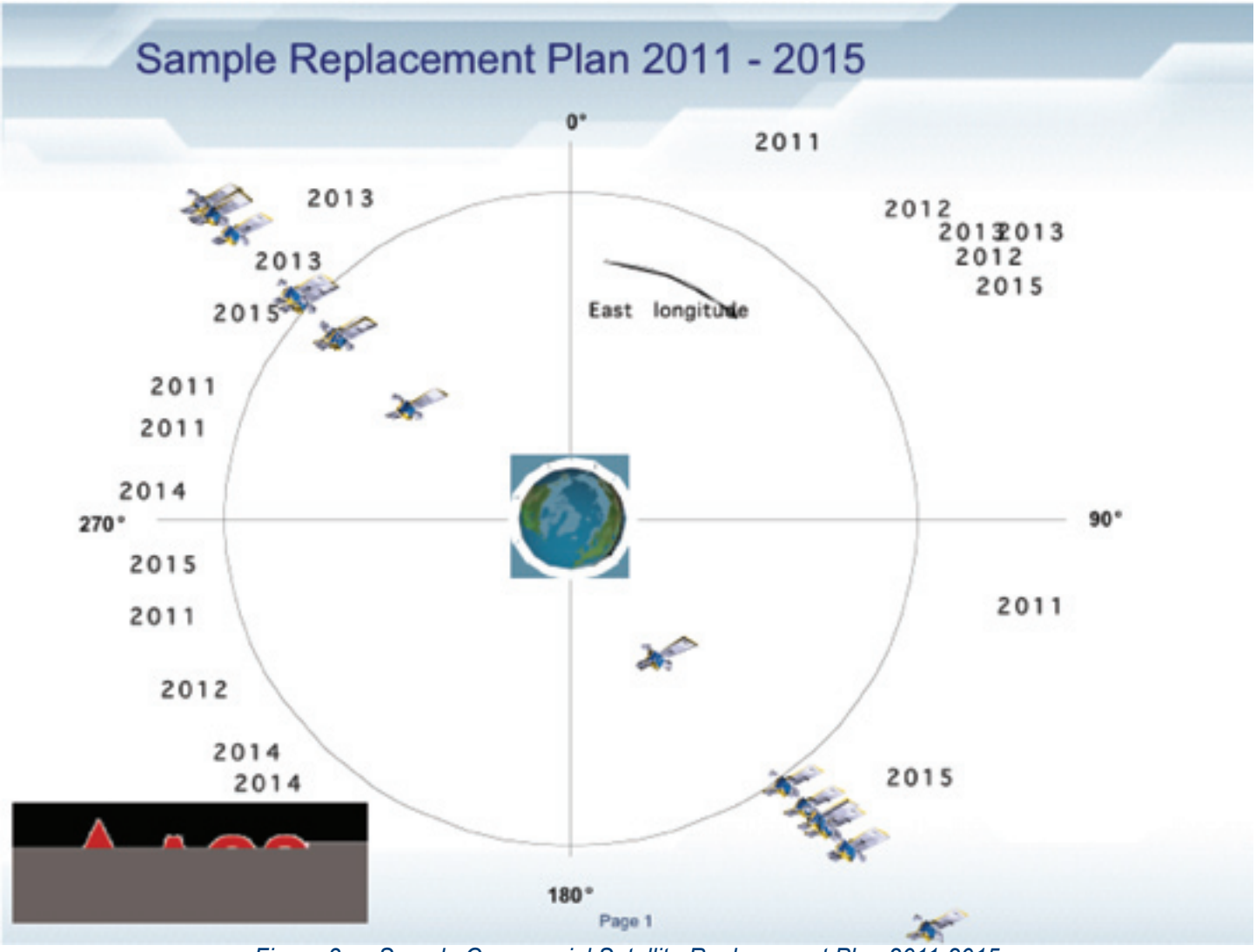


Figure 3 — Sample Commercial Satellite Replacement Plan 2011-2015

begin with satellites that will be launched in 2012 or later. One potential replenishment plan from 2011 to 2015 is presented in *Figure 3* above. This plan shows that you could select 8 – 10 spacecraft in a four year period which would come close to placing a hosted SSA sensor at or near the desired 36 degree spacing.

In order to continue our ability to safely operate in space, increasing our ability to track objects in space more accurately and timely is an absolute necessity.

This increased need is driven by the increased number of satellites operated in space, the increase in debris and technology advances that are producing smaller and smaller satellites. An SSA program aimed at dramatically increasing the detect and track capabilities at GEO could achieve full operational capability within six years by leveraging the hosted payload concept.

The key to accomplishing this task is to select and define an appropriate sensor in 2010 at the same time begin working with the commercial communication satellite providers to identify optimal hosting opportunities. Based on this approach, it is highly conceivable that a complete geosynchronous "neighborhood" watch program could be completed within 48 months of initiation.

REFERENCE:
[1] Dr. John Beusch, MIT Lincoln Laboratory, Onboard SSA Concept for Geosynchronous Object Detection and Tracking. Briefing given to the 2008 Space Control Conference, April 29, 2008.

Peter Shaper has been the CEO of CapRock Communications since its acquisition from McLeod in 2002. Mr. Shaper is also a founding partner of Houston-based private equity group Genesis Park. Previously, Mr. Shaper was the president of Donnelley Marketing, a division of First Data Corporation. He was directly responsible for the turnaround and eventual sale of the $100 million revenue database marketing company to a strategic buyer. In 1996, Mr. Shaper helped found the Information Management Group (IMG) as its Executive Vice President of Operations and CFO. IMG grew to more than $600 million in revenue during his tenure. Prior to joining IMG, Mr. Shaper was with a Dallas-based private equity firm where he was responsible for investments in numerous technology oriented companies, as well as assisting those companies with developing long-term strategies and financial structures. Mr. Shaper also has several years of experience with the international consulting firm McKinsey & Company.

Mr. *Shaper* holds a Master of Business Administration degree from **Harvard University** and a Bachelor of Science degree in Engineering from **Stanford University**. He currently serves on the board of directors of **CapRock Communications**, **Genesis Park**, **Alpheus Communications** and **US Fiduciary** as well as the ***Greater Houston Community Foundation*** and the **Texas Business Hall of Fame**.

Over the past two years, *Peter Shaper* has led CapRock Communications through a large-scale transformation through many challenges. In 2007, *Shaper* guided CapRock through a virtually seamless acquisition of government contractor, **Arrowhead Global Solutions**, which operates today under **CapRock Government Solutions**. By the end of 2008, *Shaper* and his executive team were able to leverage CapRock's core capabilities with those of their newly acquired government group, growing the company organically to produce significant double-digit growth. The company's focus on efficiency and cost control has delivered earnings that will help CapRock achieve close to 30 percent growth over last year's revenue. The acquisition and continued revenue growth led to CapRock's recognition on both the *Inc. 5000* list of the fastest growing private companies and *Space News*' list of the top 50 companies in the space industry. For this and all of CapRock's significant milestones, *Peter Shaper* was recently honored as a finalist for the annual *Satellite Executive of the Year Award*.

MilsatMagazine (MSM)

Mr. Shaper, can you briefly describe CapRock's business for us and how the company is faring in this recent economic climate?

Peter Shaper

CapRock is a leading provider of remote communications. Founded in 1981, CapRock focused on providing remote communications to oil and gas customers, primarily U.S. based companies. Since its inception, CapRock has grown and diversified into multiple vertical markets and today serves the energy, maritime, government, engineering & construction, mining and

disaster recovery markets. The company has also expanded geographically and is proud that that nearly 70 percent of its revenue is derived from client operations outside of the United States. While customers in these sectors have unique requirements, they all share the common need for reliable communications in some of the harshest and most isolated locations in the world.

The government division, which was recently rebranded CapRock Government Solutions, provides communications to the U.S. defense, intelligence and government organizations. For decades, CapRock provided services to the government market through major U.S. government contractors and the acquisition now allows the company to directly serve the government segment.

As far as today's economic climate, I can tell you that CapRock is proud to serve some very strong institutional customers via its three core markets; the energy market, the maritime business which has expanded to serve other vessels beyond just energy transport, and most recently added, CapRock Government Solutions, which serves the government sector. With the economic times we find ourselves in, we are very happy to be serving customers with essential, mission-critical requirements.

The acquisition of Arrowhead further diversifies CapRock's customer base and better positions CapRock to grow, despite the cyclical nature of some of the markets it serves.

MSM

The company's government group that you've mentioned — CapRock Government Solutions — is actually the recently rebranded Arrowhead Global Solutions, correct?

Peter Shaper

Yes, CapRock acquired Arrowhead in 2007 to expand its overall market penetration as well as its strategic reach into the government sectors. During the two years since the acquisition, Arrowhead has evolved significantly — forming a new management team, implementing a visionary long-term strategic plan, and launching a comprehensive value-add product and service portfolio. Fully integrating Arrowhead as its own business unit of CapRock was the next logical step, which led to the rebrand and CapRock Government Solutions.

MSM

How has the government market responded to the acquisition and have customers been loyal through the transaction?

Peter Shaper

We've found that customers are responding very well to the acquisition and recognizing the sizeable benefits that it brings them. On top of CapRock's robust infrastructure, the company now has the additional benefit of a strong balance of commercial and government business. This means that CapRock is able to carry inventory and space segment that can be used to meet the needs of customers in each vertical.

The government team is now a fully managed service provider, supporting its customers with mission-critical communications services from the GIG to the foxhole. Before the acquisition, there was little more occurring than the acquisition of satellite bandwidth. Since that time, the government team has migrated from meeting single requirements to providing fully managed services. The growing mix of services has been hugely well received by customers. We are helping them to make more use out of less bandwidth and providing them with near on-demand communications when they need it most. Recognizing this need, the government team was able to partner with our customers to develop an online bandwidth portability system that has dramatically cut the provisioning cycle. Whereas the normal provisioning cycle for satellite capacity is typically 30-45 days, the portability tool that we developed allows us to provision bandwidth in as little as 12 hours. This provides greater flexibility for the U.S. Military, which may need to move troops to a new region or theatre quickly.

MSM

What is CapRock doing to stay abreast and ahead of its customers' needs?

Peter Shaper

Our customers' requirements and market conditions are constantly evolving and we've employed several processes to ensure that we are always capable of meeting and exceeding their needs.

One measure that we've recently put into practice is the implementation of the first CapRock Customer Advisory Board (CAB) in 2008. The CAB's purpose is to gain customers' input on CapRock's technology roadmap and earn their trust by executing on deliverables they prioritized. Through this process, CapRock has been able to develop true partnerships with multiple customers across our markets. Because of the strong relationships we have with our customers, we've been able to develop an intimate understanding of their requirements. This has allowed us to make significant investments in technology, people and infrastructure to put assets in place so CapRock can meet the critical needs of its clients at any given time.

We recently did just that when CapRock's government team made significant investments ahead of winning contracts in X-band teleport infrastructure and satellite capacity to provide a suite of communications solutions including fixed and rapid deployment packages and field services among other offerings. We knew that this new service would answer calls from our defense and intelligence customers for much-needed capacity. At the same time, we understood that our customers were spending significant portions of their budgets on capacity and that this solution would also offer them government specific frequencies at much more affordable commercial prices.

MSM

What additional services or capabilities were provided through the acquisition?

Peter Shaper

For both commercial and government customers the acquisition provided a combined set of broader suites of products, services and support including stronger engineering and systems integration capabilities, and an expanded team in more countries. Specifically for government customers, the acquisition provided

new resources through the CapRock infrastructure to better support their operations. This includes additional worldwide points of presence through CapRock's four self-owned and operated teleports, eleven regional support centers and four 24/7 Network Operation Centers located around the globe. In addition, the global network established to serve CapRock's customers is also one that can serve our customer base on the government side.

MSM

What was the importance of the name change from Arrowhead Global Solutions to CapRock Government Solutions?

Peter Shaper

From a very basic level it is important for us to always integrate as a singularly focused company with our customer's mission as our mission. It is good for our internal focus as well as that of our customers. From a deeper level, the complete integration of Arrowhead into CapRock allows us to leverage the power of the CapRock brand, utilize our global infrastructure, and support both our existing and potential customers with greater focus, resources, better service and expanded capabilities. Our customers continue to look to us for innovative, value-added solutions and creative deployment of our industry-leading technology. This integration has allowed us to expand significantly on this on-going mission.

MSM

Is CapRock looking at any more acquisition targets as a strategy to grow your business unit?

Peter Shaper

We are doing extremely well growing the business organically. CapRock is privately held, so we are not at liberty to release numbers, but I can say that our business is expanding with double-digit growth organically.

Overall, we are open to the possibility of appropriate acquisitions should any present themselves. The company is very opportunistic in that regard — we are open to selective opportunities that would help grow the business in complementary ways to what we are already doing. This is always something that is looked at by our executive team

The U.S. Department of Defense (DoD) has significantly increased the amount of commercial satellite bandwidth required to support in-theater communications for the military's intelligence gathering and tactical deployments. Satisfying the growing appetite for bandwidth has recently proven difficult, due to the shrinking supply of Ku- and C-band capacity. Forecasting future increases is also difficult. However, the DoD's fielding of increasing numbers of net centric systems, such as advanced Unmanned Arial and Surface Vehicles and the Army's Future Combat System, are a certainty. Future military operations will see increasing reliance on communications from the strategic to the tactical level of war.

Given the tight market for C- and Ku-band frequencies, X-band is the logical choice for military users with high bandwidth demand. The DoD is looking to use this newly available frequency due to available capacity and because it mitigates much of the interference that users are requently encountering on satellite fleets that are running at 95 percent capacity or higher. Newly deployed X-band services add much needed capacity for defense and intelligence communications, as well as offer the government specific frequency at more affordable commercial prices. X-band provides higher power and faster data rates while providing enhanced operational services in challenging environments that are common to military operations.

CapRock Government Solutions unveiled a suite of managed X-band network services and was awarded two multi-million dollar contracts to provide more than 200 Megahertz of X-band satellite services to two major U.S. Government agencies. The launch of CapRock's X-band services represents the first in a series of planned offerings tailor made to the unique requirements of government and military applications. This approach cuts the normal provisioning cycle of 30-45 days for typical satellite capacity to an online bandwidth portability system that can allow for bandwidth provisioning in as few as 12 hours, providing greater flexibility for the U.S. military, which may need to move troops to a new region or theatre quickly.

3 dB: What Is It Worth To Your Mission?

If you're unfamiliar with communications analysis, 3 dB (short for decibels) is probably meaningless. Those designing and relying upon communication systems, however, understand that 3 dB is a factor of two that, in terms of communications performance, can mean the difference between mission success and failure.

Net-centric warfare, information dominance, and spectrum management challenges have increased the complexity and importance of designing and operating communications systems. **Analytical Graphics, Inc.** (**AGI**), a producer of commercially available desktop software and development tools for space, defense, and intelligence professionals, supports these needs with two unique benefits: accurate representation of operational communications performance and illustration of how that performance affects the mission.

Predicting Operational Communications Performance

Accurately representing operational performance yields more confidence and productivity during conceptual design, requirements specification, field tests and real-time operations of communications systems. Achieving this accuracy depends on modeling salient attributes of the specific architectures and environments in which real communication systems operate. Local terrain, antenna obstructions, gimbal rate limits, platform kinematics, Doppler shifts, spatial distribution and directivity of interference sources and other factors can significantly influence actual performance. Spreadsheet link analyses and other communications-centric tools either ignore, abstract or worst-case these attributes, often misrepresenting actual performance.

In contrast, AGI's communications modeling uses physics and mathematical models to represent these attributes to provide better prediction of operational performance. For example, when planning a field test of an air-to-ground radio link, the outcome can be significantly impacted by seemingly simple decisions such as where to locate the antenna on the aircraft, how to fly the aircraft, where to conduct the test, and where within terrain to locate the ground antenna. AGI software can accurately considers these and other factors to better plan the test and ensure test objectives are met without wasting range time and other expensive resources in the field.

RT Logic, a wholly owned subsidiary of **Integral Systems, Inc**. and a leading provider of ground system components and test instruments, uses this accuracy to provide its clients improved communications link testing capability. "We've integrated AGI's communication systems modeling into our test instrumentation package so tests can be conducted in the laboratory, significantly reducing test cost and risk while dramatically improving test depth to include scenarios that would be impossible, dangerous and/or expensive to conduct in nature," says RT Logic Business Manager *Steve Williams*.

Using the communication link characteristics and behaviors computed by AGI software, RT Logic's ***T400CS Channel Simulator*** generates RF and IF signals that precisely match those encountered in nature. "At a recent missile test range event, our system allowed us to feed distant range telemetry monitoring sites simulated RF signals that will be indistinguishable by the Range Operations Center from an actual missile flight." says *Williams*. He continues, "This provides realistic range test without flying assets, assuring range customers and range control of safe, productive and cost-effective operations."

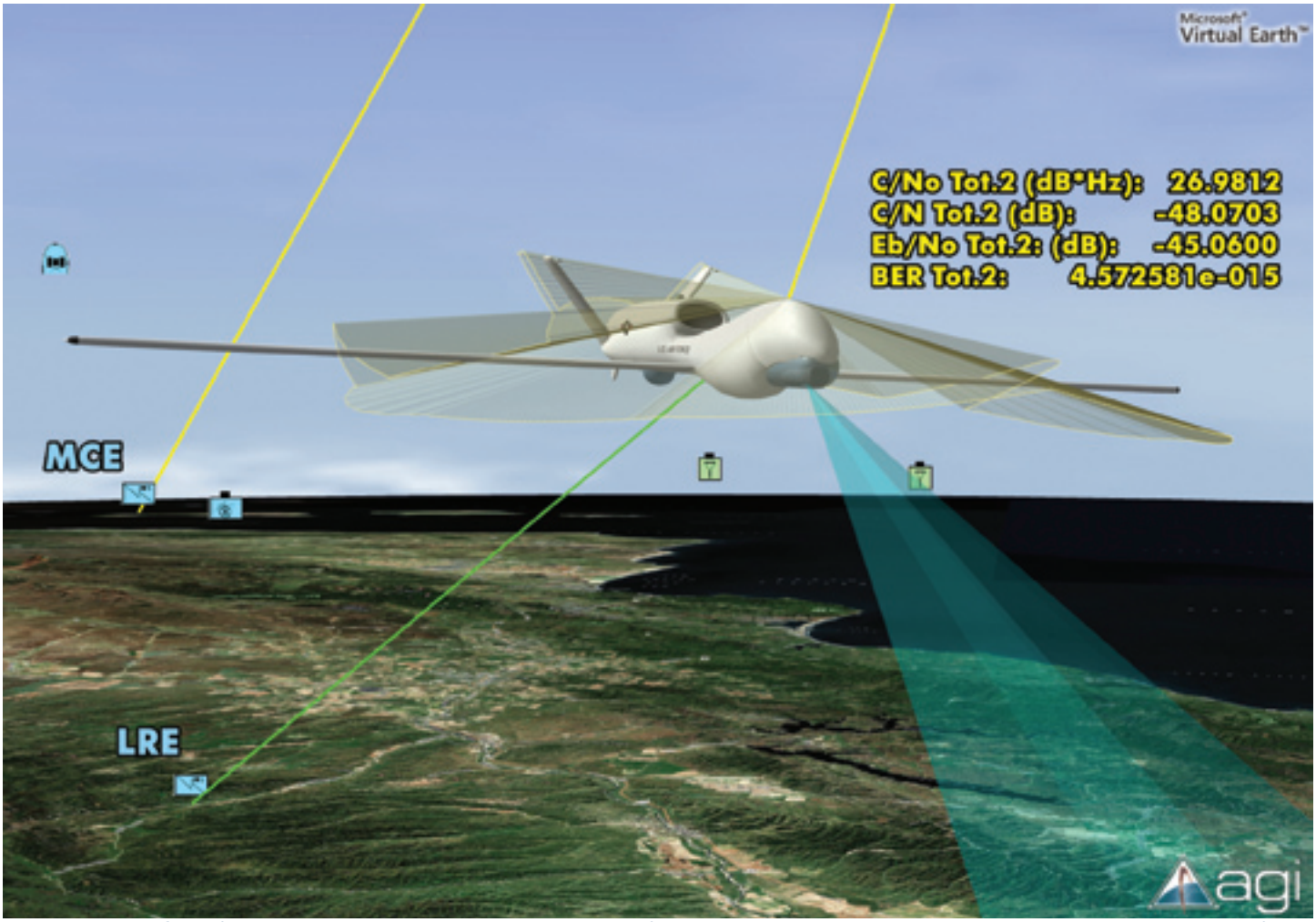


Image 1 — AGI software analyzes the communication performance over the entire link, such as a Bent-pipe relay from a ground control station to a UAV operating outside line-of-sight range.

This same AGI fidelity that is helping RT Logic transform test operations is also letting communication system designers and operators be more productive and confident in their work.

It's All About the Mission

The value of high-fidelity operational performance predictions cannot be overemphasized, but assessing communications performance in isolation can adversely influence system architecture design and overall mission satisfaction. For example, when designing the communications link for an *unmanned aircraft system* (**UAS**) that will return live video to field commanders, it would be a mistake to do so without an understanding of how the aircraft, optical sensor and communications combine to deliver surveillance coverage. Examining the communications link in isolation could lead to unnecessarily constraining the aircraft to higher altitudes, necessitating a heavier, higher-resolution camera that reduces mission duration and increases system cost. Similarly, decomposing the problem across individual disciplines can slow the systems engineering process and inhibit design innovation discovered through integrated analysis.

With AGI software, it is possible to avoid such suboptimal mission architectures and engineering inefficiencies by modeling the aircraft, optical sensor and communications link as a system and directly measuring resulting mission-level performance. This facilitates rapid trade studies that could indicate a lower operating altitude is possible and a small increase in power budget for the communications link could dramatically increases surveillance coverage.

The ***U.S. Marine Corps Combat Development Command*** (**MCCDC**) realized such benefits when it employed AGI products for its ***Tier II/ Small Tactical Unmanned Aircraft Systems*** (**STUAS**) ***Analysis of Alternatives***. This **AoA** involved finding

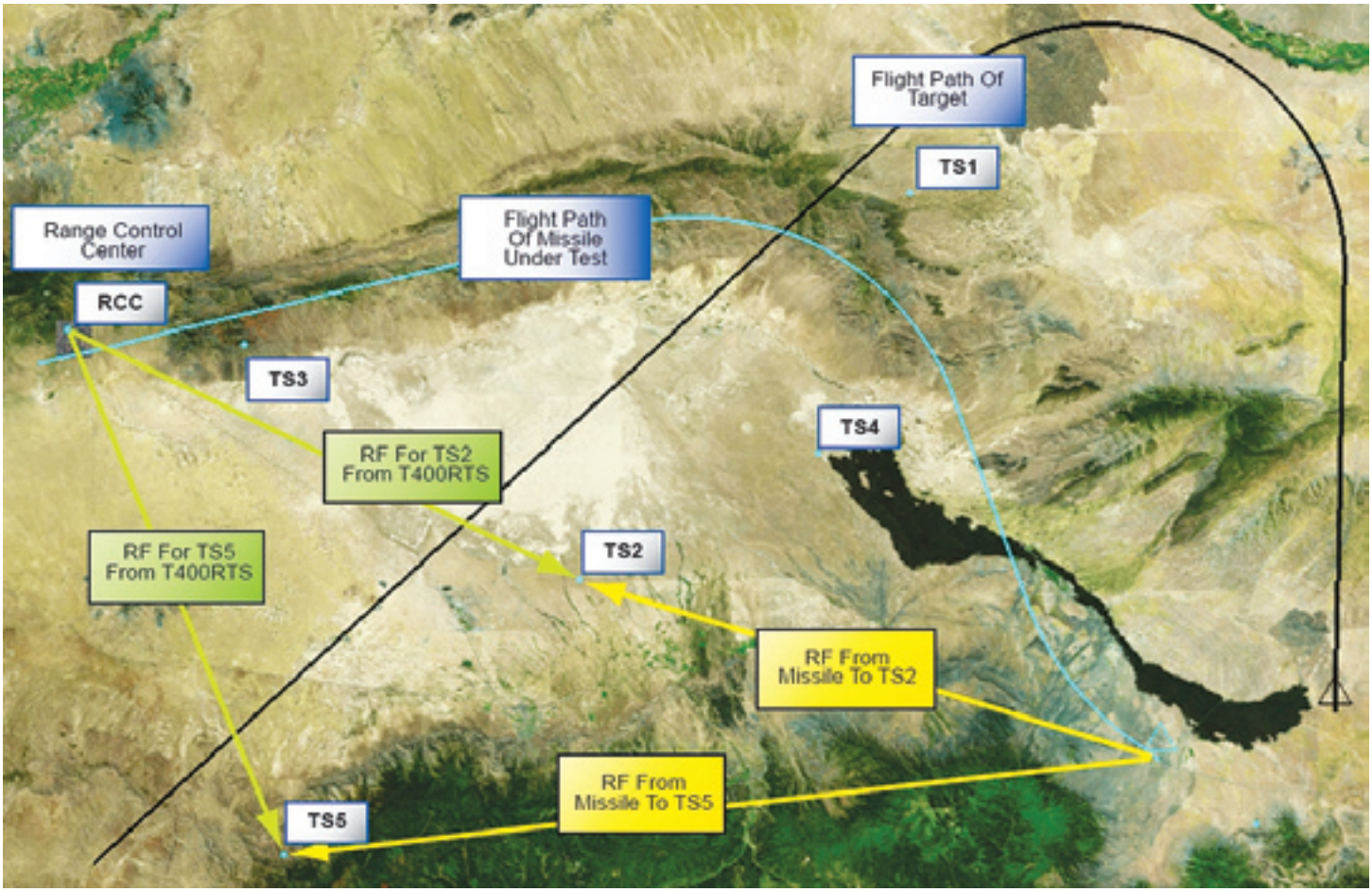


Image 2 — Using the communication link characteristics and behaviors computed by AGI software, RT Logic's T400CS Channel Simulator generates RF and IF signals that precisely match those encountered in nature.

the most cost-effective mix of UAS capabilities to meet operational Marine Air-Ground Task Force requirements. As MCCDC's primary qualitative tool, AGI products assessed UAS and candidate sensors and their ability to communicate with ground control stations and ground-based assets in realistic terrain; performed detailed comparative analyses on EO/IR sensors; and tested operational effectiveness of ISR UASs.

"It would have been futile for me to produce analyses that only included the sensors in an operational context without factoring in the communications sub-systems. There is a huge correlation between the two, and STK gives us this specific capability," says Lt. Colonel *Brian Zacherl*, MCCDC.

Using AGI technology, MCCDC tested what impact environments such as mountainous terrain have on situational awareness and line-of-sight communications. AGI software provided integrated sensor and platform analysis and modeling capabilities for the trials including the incorporation of high-fidelity terrain; sensor coverage; communications and line-of-sight analysis; and high-level sensor modeling. "AGI software shows us the tradeoffs and that is why we keep working with it," *Zacherl* says.

Tier II/STUAS was approved by the Joint Staff in September 2008, with AGI products serving as the primary software used to develop and analyze this new UAS concept. In addition to guiding this important acquisition, the AGI-based ISR mission analysis tool is now in use to support combat operations in Afghanistan.

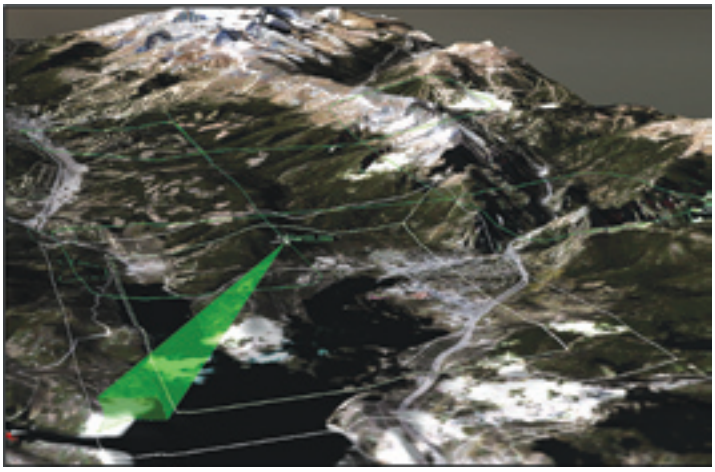


Image 3 — The U.S. Marine Corps Combat Development Command (MCCDC) used AGI software to test what impact environments such as mountainous terrain have on situational awareness and line-of-sight communications for its Tier II/ Small Tactical Unmanned Aircraft Systems (STUAS) Analysis of Alternatives

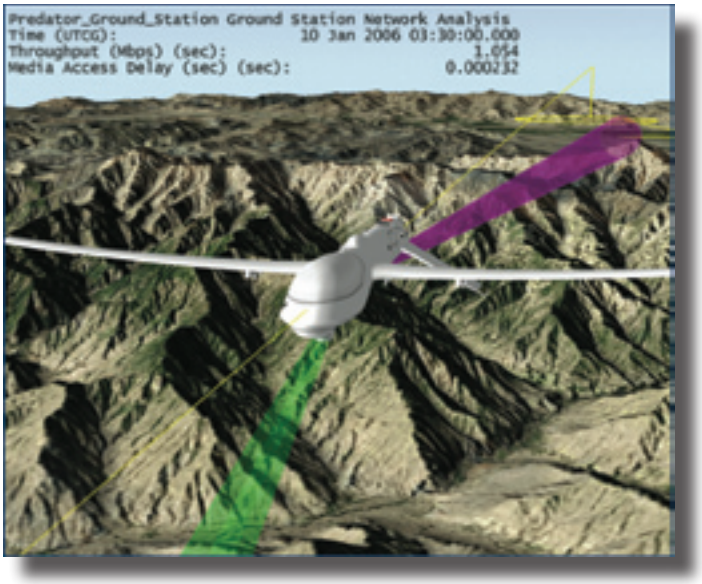
Right Answers. Right Now.

Accurately representing operational performance and putting that performance in the context of the overall mission is what sets AGI communications modeling apart from alternatives. These capabilities are available as desktop applications, an application engine and as low-level software components suitable for service oriented architectures — all with flexible pricing and licensing options.

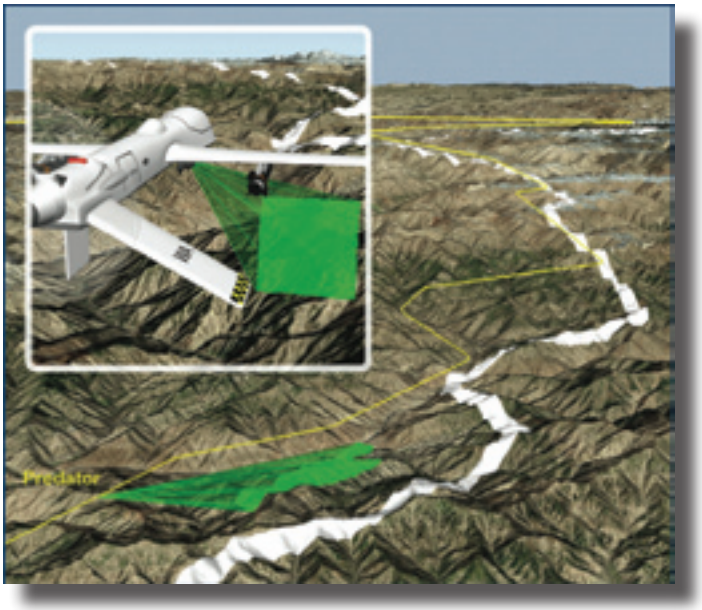
About AGI

AGI provides commercial off-the-shelf software to national security and space professionals for integrated analysis of land, sea, air, and space assets. The technology can be applied to a variety of solution areas.

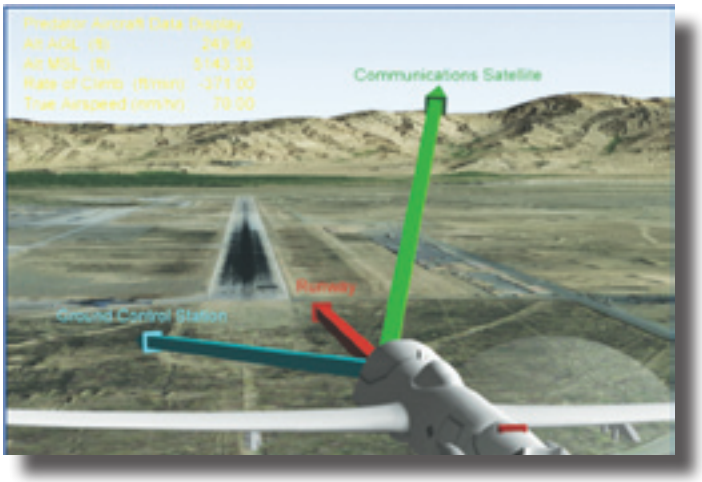
AGI emphasizes product excellence, customer success, fun, and exceptional stakeholder value. Founded in 1989 and enjoying strong growth in its history, AGI has been named to numerous prestigious lists. It ranked first in the Great Place to Work Institute and Society for Human Resource Management's "Best Small Company to Work For in America" contest in 2004 and 2005, third in 2007, and first in the medium-sized company category in 2006.



Ground Station Network Analysis for Predator UAV



STK/Analyzer manipulates UAV's route



Upon mission completion, a post mission analysis is conducted regarding the key events.

The Transition To IP — How + Why To Up The Pace

by Jim Sprungle, Vice President, Government Programs, TeleCommunication Systems (TCS)

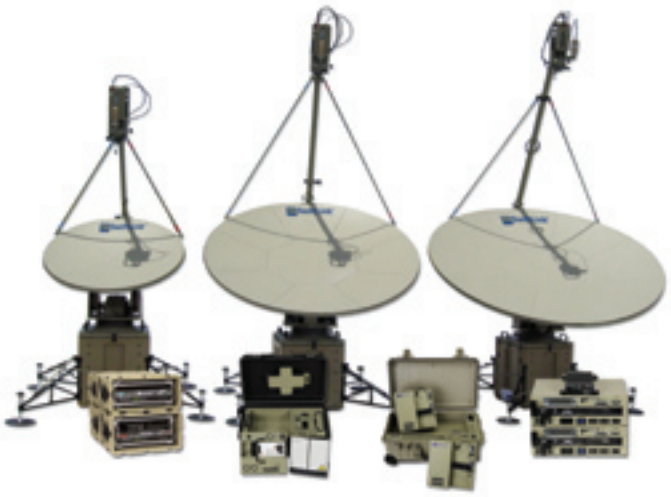
Grand plans such as the Department of Defense move to a more unified and effective Global Information Grid (GIG) of military networks often run headlong into reality. The DOD played a key role in the creation of the Internet Protocol, so it certainly makes sense that the U.S. military should maximize the advantages of today's commercially available and increasingly sophisticated IP technologies. In an "everything over IP" (EOIP) environment, the communications needs of a mission can be met with a fraction of the equipment and support personnel required to deploy separate data, phone, and video conferencing networks. EOIP communications systems result in higher mission effectiveness with lower implementation costs.

On the other hand, unique military requirements make it impractical to simply adopt off-the-shelf products and run the GIG as if keeping the world safe for democracy were no steeper a challenge than keeping the shelves stocked at Wal-Mart. Fulfilling the complete GIG vision includes solving computer sciences challenges such as implementing a cyphertext "black core" to the global network capable of protecting and separating traffic according to varied classification and ownership rules. The GIG must reach over satellite links and function in austere environments with limited bandwidth.

Figuring out the best way of achieving these goals is a puzzle that won't be solved overnight. The good news is that it doesn't need to be. As with many problems that seem overwhelming when considered in their entirety, the transition to unified communications over IP is far less intimidating when considered on a mission-by-mission basis. And by solving the problem in phases, we can build the expertise needed to solve it on a grander scale.

Traditionally, the military has relied on a wide variety of radio, satellite, and wired network technologies designed to meet different communications and security requirements. The ***Defense Information Systems Agency*** (*DISA*) acts as a wholesale provider of wide-area network services to the armed forces, but that includes separate networks for data, phone service (over the **TDM**, or *Time Division Multiplexing*, protocol) and video conferencing. In addition, each service and many agencies operate their own data, voice, and video networks or purchase these services from commercial providers. The divisions between all these networks tend to be relatively fixed, so that every effort to combine them for joint operations spawns at least a minor systems integration project.

IP has the potential to be a great unifier. The reason the TCP/IP protocol suite was invented in the first place was to provide common ground between multiple operating systems and local area networking technologies. Eventually, it became so successful that many of the protocol gateways faded away, and IP protocols came to be used on both local and wide-area connections.



TCS' VSAT Trio

Technologies and techniques for integrating voice and video and ensuring the quality of their transmission came much later, but really just represent an extension to the goal of inter-networking around common standards.

In the corporate world, multimedia convergence mostly is happening around VoIP routing of phone calls and, for some organizations, IP video conferencing. Broadcasting and cable networks have also begun to make selected programming available to the masses over the Internet. In a military setting, IP networks can extend to video feeds from unmanned aircraft and ground vehicles, as well as other sensor and surveillance data feeds. Convergence around IP standards also makes it more practical to support multi-mode communications, such as using presence detection based on logins to computers or wireless devices to help soldiers figure out the most efficient way to communicate with each other by phone, mobile phone, instant message, or a rich collaboration session combining voice or video and applications such as desktop sharing and white boarding.

If implemented intelligently, these technologies can be more than gimmicks. They can be tools for creating a more agile fighting force, where the commander faced with an immediate crisis can more quickly connect with superiors and subordinates, intelligence sources and other experts, and communicate with them more effectively. We can do a better job of making sure to get the right information to the right people at the right time for the right mission. One early proof point is the ***Joint Network Node***, a unified system for data and voice communications that was designed for rapid deployment to a war zone or disaster response situation. With **JNN**, a unit can go into the field with a single satellite communications system and a single operator to address all its communications needs. JNN is based on a fixed (albeit portable) satellite node, but other efforts such as the Army's ***Warfighter Information Network-Tactical*** (**WIN-T**) and the ***Joint Tactical Radio System*** (**JTRS**) initiative are extending IP to mobile network nodes mounted on a truck or carried by a soldier.

At **TeleCommunication Systems Inc**. (**TCS**), headquartered in Annapolis, Maryland, we have particularly focused on integrating the various components of an EOIP network to provide secure access to voice, video, and data applications using a field-upgradable multi-band, multi-aperture flexible VSAT system to agile, forward-deployed units in the field. These IP-enablers deliver the operational flexibility to accommodate both on-the-ground conditions and hybrid network constraints dynamically. Engineered to ensure maximum flexibility, each VSAT terminal is field-upgradeable in less than two minutes with a simple swap of the pre-configured feed-boom assembly. Warfighters may not only operate in their choice of frequency bands (Ku, Ka and X) but also easily migrate between bands as the situation requires. TCS aims to design its products so minimal training and ease of field use is paramount.

Even before the arrival of all the proposed WIN-T increments in-theater, the warfighter has already been provided plug-and-play options through an expansive choice in terminal apertures sizes, L-band modems and baseband packages. In fact, baseband **SIPR**/**NIPR** (classified/non-classified) network platforms are built on COTS architecture to deliver scale and performance as required. Each baseband package consists of an integrated system of best-in-class IP routers, WAN accelerators and crypto units with EoIP support for converged voice, video, and data applications. TCS is playing an active role in the military's transition from JNN to WIN-T and the attendant EOIP implications that this transition implies.

Does this mean you can believe every claim about the glories of unified IP communications? Of course not. But if you approach the challenges with eyes wide open and do the necessary planning for success, you too can take advantage of the benefits that are already available today. ***What are you waiting for?***

About the author

Jim Sprungle is the Vice President of Government Programs at TeleCommunication Systems, Inc. (TCS). Prior to joining TCS, Mr. Sprungle worked for Verizon Communications designing network infrastructures. Mr. Sprungle attended the U.S. Naval Academy and served as a Communications Officer in the Surface Navy for six years.

Satellite Communication Services + FISMA: Are You Ready?

by Ronda Henning and Brad Kizzort, Harris Corporation

With the publication of the President's Cyberspace Policy Review: Assuring a Trusted and Resilient Information and Communications Infrastructure on May 29, 2009, the interdependency of public and private information infrastructures and the fragile security state of these infrastructures were highlighted. Satellite Communications are a key element of several National Critical Infrastructures. The Federal Information Security Management Act of 2002 (FISMA), consists of Title III of the E-Government Act of 2002 (U.S. Public Law 107-347) which was enacted into law at the close of 2002. FISMA provides an assessment framework for the protection of government information assets against various threats. By assessing the criticality of the information transmitted, and determining the protection capability of the provider's infrastructure, an educated risk acceptance decision can be made.

Critical infrastructures are the mainstay of modern life. Without electricity, telecommunications, water, and manufacturing supply chains, our world would be very different. In the 1950s, information technology was a novelty. By the late 1980s, it was a necessity, and the microprocessor changed control systems as we know them. What was once considered an optional status system became our primary monitoring infrastructure, and we became in information technology dependent country. Within that information infrastructure, satellite communications are used to transmit status information from remote sensors to centralized control infrastructures. In the Cyberspace Policy Review, the fragile nature of our critical infrastructures is presented. One of the recommendations in the Policy Review is the application of U.S. Government information security practices to the private sector. This article explores the implications of that recommendation to satellite communication services.

Mission Critical Infrastructure

Satellite communications systems are frequently used by organizations that demand rapid access to status information from remote, isolated locations. For example, pipeline operations in rugged terrain that travel over long distances, transmit status data to control systems at central operations facilities. In such cases, satellite communications play a key role in maintaining an organization's cash flow and operational continuity — without knowing the status of a pipeline, it becomes difficult to project an organization's ability to supply product to consuming subscribers.

Mission Critical Infrastructures should be part of the continuity of operations and disaster recovery programs of every major enterprise. In the most fundamental case, the determination of criticality is simple: will the organization's profit or operations be adversely impacted for a sizeable period of time? If so, an asset may be considered mission critical. Because of the role satellite communications plays in organizational communications, it would be difficult not to consider a satellite system mission critical.

How does an organization protect a mission critical infrastructure? The U.S. Government requires each Federal agency to conduct an annual review of its information security program (**U.S. Public Law 107-347**, including the security posture of mission critical systems). **NIST Special Publication 800-37** provides a risk-based assessment technique that can be used to determine the security compliance of an organization's information technology systems. While a

commercial entity is not a Government Infrastructure, the critical nature of communications in any enterprise requires some degree of protection.

Categorizing Countermeasures

When thinking about security countermeasures, we often think of firewalls, intrusion protection systems, and encryption techniques as the only types of countermeasures that matter in a network centric environment. In reality, there are three general categories of countermeasures that can protect critical information:

- ***Technical — controls provided through the use of technology.***
- ***Managerial — control provided through the use of project management or governance***
- ***Operational —controls provided in the course of daily process and procedures.***

Not every information system needs the same controls, deployed in the same manner. For example, a ground station may use a single firewall, or multiple firewalls to segregate data channels and control channels amongst multiple subscribers. What matters is that the controls have been considered, implemented, and enforced in the normal course of system operations.

Systems management makes the determination of how to balance the use of technical controls against operational policies, processes, and procedures. For example: there is a very expensive software solution to a particular security issue. It is also possible to address the issue with a low cost paper policy that involves manually examining some set of system parameters on a regular basis. The question becomes one of resource allocation: is it less expensive to have a system administrator examine the data, or is it more cost effective to automate the process? *Figure 1* illustrates the responsible balancing of management, technical, and operational controls in an information system.

As a subscriber to net-centric systems, it is the consumer's responsibility to perform security due diligence with its service providers. Assurances that "our systems are secure" should be reinforced with technical evidence upon request. If an operator cannot produce a policy describing what to do in the event of a security intrusion on the network, there is a high probability that the procedures required for responding to an intrusion do not exist.

Another Perspective

The National Institute of Standards and Technology, (**NIST**) describes compliance with the ***Federal Information System Management Act*** (**FISMA**) as a risk management based approach to information security controls. *Figure 2* above summarizes the FISMA compliance process as applied to an information system.

Again, the question comes down to categorizing the information processed by or transmitted through the system. If the information impacts the revenue or continuity of business operations, the risk of having the information fall into the wrong hands or not being accessible to the decision makers needs to be a consideration in designing the infrastructure that carries it. An informed decision that the risk level is acceptable should be documented and incorporated into the system design.

Risk Is A Continuous Function

The risk associated with operating an information system is much like the risk associated with every day events. For example, a person may determine that the risk of being run over crossing the street is minimal once, but looking both ways is necessary every time a person crosses the street. Such is also the case with information systems. Examining documentation once is not enough: any organization can generate a set of policy documents that say it is sufficiently secure. Annual audits, and/or continuity of operation drills validate the policy in an operational setting. These techniques ensure that policy is incorporated into the people, processes, and tools that comprise the communications services offering.

Figure 1. - System management makes the determination of how to balance the use of technical controls against operational policies, processes and procedures.

Figure 3 on page 80 demonstrates the effects of the IA audits and drills. For example: a communications system with 10 "highly critical" vulnerabilities may not actually

Figure 2 — FISMA as a risk assessment process.

be a high risk communications system. Vulnerable protocols may be disabled for general use, and only accessible under emergency circumstances. If the protocols are not enabled; the protocols do not impact the security posture of the system. Another example would be stating that the organization has an access control policy. The statement alone is not sufficient. The organization is required to produce the policy, as well as device configuration parameters that demonstrate its enforcement and audit log entries that show exceptions to policy enforcement generate alerts.

Implications For Satellite Communications

To successfully address security controls with minimal effort, it is imperative that the supporting infrastructure be in place. To some extent, this infrastructure is common sense, and may already exist, but it needs to be expanded to address the pervasive nature of information networks in today's economy. Organizations are frequently reluctant to pay for security services until a system compromise occurs.

FISMA guidance provides an enterprise a baseline set of direct and indirect capital costs that can be applied to allocate security investment. This investment can be allocated based upon system size, percentage of processing capacity, number of users, or any other cost basis. The significance is that security cost can be segregated, as illustrated in *Table 1* (**NIST, 2003B**) located on *Page 81*.

When costs can be allocated, it is easier to attribute the security expenditures to a given information system, or a given requirement that a system must fulfill. For example, if it is imperative that a given trading partner have connectivity to a corporate network, then the cost of all architecture components that provide isolation of that connectivity can be allocated. This would include the cost of firewalls, virtual private networks, intrusion detection sensors, spam filters, and any other architectural components deemed necessary to protect the corporate infrastructure.

The following sections along with *Figure 4* on P*age 82* describe the security implications for traditional

Figure 3 — Annual audits and/or continuity of operation drills ensure IA policy is incorporated into the people, processes, and tools that comprise the communications services offering.

data management disciplines in terms of the impact on existing tools, processes, and people.

Tools

There are a series of supporting subsystems that facilitate satellite communications security:

- ***Asset management — a single data repository must be in place that can track all hardware, software, and firmware assets of the program. The state of all devices within the network must be maintained in a known, secure state. The customer can request a site inventory for any site, at any time, and expect the service provider to produce an accurate inventory and connectivity diagram including device configurations, cabling, manufacturer, and model.***
- ***Vulnerability remediation — vendors discover vulnerabilities in specific products on a regular basis, and may release corrections to the product code base. Large, distributed networks require automated techniques for vulnerability scanning and patch management. This involves the use of a vulnerability scanner and a patch deployment tool. When used with an asset management system, it is possible to determine which devices and which sites may be vulnerable to a particular problem, and to establish an orderly plan for correction.***
- ***Integrity monitoring — knowing who has modified a device, when it was modified, and what has been changed is a necessary part of defining the secure state of a system. Integrity monitoring software is available as a COTS product that can deliver an alert if the state of a device is modified by an unauthorized user***
- ***Audit correlation and analysis — all devices in a network capable of supporting an audit capability generate data. This data needs to be analyzed and correlated in real time to provide intrusion detection capabilities and allow for incident response.***
- ***Standardization in configurations — a provider should define a standard device configuration. A standard device configuration enforces the concept of least privilege, removes unnecessary***

protocols, closes unneeded ports, and tightens the security posture of a device. It also facilitates troubleshooting, because each device has a clearly defined standard for normal operations.

Processes

To address configuration management, incident response, vulnerability remediation, physical security, environmental security, media protection, and maintenance procedures, there should be defined, enforced processes for the provider's environment. Configuration management is not the traditional data management function: it is the living, organic, operational configuration management of the devices. The network must be maintained in a known, secure state, with an accurate inventory of all devices, hardware, firmware, and software versions deployed at any given site and throughout the network. Procedures must be coordinated between field maintenance and operations to ensure that replacement of failed equipment is coordinated and accounted for in the asset database.

Beyond this function, the physical and environmental security controls associated with each site must be maintained to the specifications. When network gear is placed at a customer site, it is a reasonable assumption that the existing site's security procedures are sufficient. This includes maintenance laptops, USB Drives, and all floppy disks, tapes, and hard drives associated with equipment. Prior to disposal of hardware, all volatile and non-volatile memory must be erased to ensure that no sensitive information is contained. This involves researching the devices with the vendors, defining the decommissioning procedures, and ensuring the procedures are followed.

Maintenance procedures and protocols must be defined and documented. These procedures ensure that the security of network and security management traffic is not compromised, and that new devices are appropriately and securely configured prior to deployment in the network.

This may include disabling ports, removing unnecessary services, or applying key management protocols as part of the device provisioning process. Documentation and enforcement are key elements of maintaining the system in a known, secure state.

Direct Costs	Indirect Costs
• Risk assessment • Security planning and policy • Certification and accreditation • Specific management, operational, and technical security controls • Authentication or cryptographic applications • Education, awareness, and training • System reviews/evaluations (including system security test and evaluation [ST&E]) • Oversight or compliance inspections • Development or maintenance of agency reports to OMB and corrective action plans which pertain to the specific investment • Contingency planning and testing • Physical and environmental controls for hardware and software • Auditing and monitoring • Computer security investigations and forensics • Reviews, inspections, audits, and other evaluations performed on contractor facilities and operations	Configuration or change management control • Personnel security • Physical security • Operations security • Privacy training • Program/system evaluations whose primary purpose is other than security • System administrator functions • System upgrades with new features that obviate the need for other standalone security controls

Table 1

Figure 4. - To successfully address security controls with minimal effort, it is imperative that the supporting infrastructure be in place. Given the pervasive nature of information network in today's economy, the security implications impact on existing tools, processes, and people.

Incident response processes prepare the operational management staff for the possibility that the security of the infrastructure may be compromised.

Distributed denial of service, viruses, Trojan horses, worms, and other malware could contaminate the network, corrupt data, and compromise the network infrastructure. Incident response procedures include maintenance of network forensic evidence that is required for successful prosecution. These procedures also involve notification of the Security Incident Response Capability (SIRC) and coordination of a plan of attack in the event compromise does occur.

Vulnerability remediation is the countermeasure deployed to address potentially exploitable flaws in information systems. The vulnerability remediation process includes deployment of virus and intrusion detection signatures in the infrastructure as preventative measures as well as patch management processes. The vulnerability remediation processes define the least intrusive correction plan and ensure that the network infrastructure is minimally impacted by the correction. This includes regression testing to ensure that a patch has no adverse performance or latency impacts.

Contingency planning and management must be accommodated. The network will support a primary and backup control center. An annually exercised plan to activate and transition to the backup operational control facility is mandatory. Similar planning exercises must be documented to address the potential loss of sites.

People

Beyond processes and tools, personnel policies must also be addressed. Program specific security information must be communicated to all team members and maintained through a security awareness program. Program personnel must be made aware of the security responsibilities and obligations to maintain the infrastructure in a known, secure state at all times.

Personnel also play a significant role in the contingency management process. If key personnel must travel between primary and backup facilities, arrangements must be made prior to natural disaster situations so the team is pre-positioned. Identification of key personnel for the "stay and away" teams and the team's respective responsibilities must be addressed well before the contingency management plan is activated.

Conclusion

A security compliance methodology is not flawless. Unless one has benchmarked a system's initial security posture, it is difficult to determine if that security posture is improved or degraded by changes to the technical or operational controls. A subscriber needs to assess the criticality of the information transmitted, and determine the protection capability of the provider's infrastructure. When these tasks are accomplished, the subscriber can make an educated risk acceptance decision as an informed consumer. Ignorance of network security is no excuse for data compromise in the paper world, and it should not be a convenient defense in a network centric environment either.

About the authors

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CASE WORK
Need For Tactical Voice And Data Comms

A major challenge for the U.S. military is providing reliable voice and data links to small units of warfighters operating in remote, hostile corners of the globe. In Afghanistan, land-based wireless infrastructure is lacking, and mountains and harsh weather conditions often disrupt radio and satellite transmissions to troops at the edge of existing military networks.

The Pentagon is moving to fill those needs and hopes to close a looming capability gap as work continues on the ***Mobile User Objective System*** (**MUOS**), a military satellite constellation under development to replace the aging ***Ultra High Frequency Follow On*** satellites. Given the growing demand for bandwidth, it's likely the **U.S. Department of Defense** will continue to rely on a mix of government and commercial satellite assets.

One promising commercial solution already in the hands of some U.S. troops is the satellite-based ***Distributed Tactical Communications System*** (**DTCS**). This "push-to-talk, one-to-many" radio communications system is being produced by **Iridium**, a mobile satellite service provider based in Bethesda, Maryland, and industry partners **Boeing Company** and **ITT Corporation**.

In June, the **U.S. Naval Surface Warfare Center** in Dahlgren, Virginia, awarded a five-year, $21.6 million indefinite-delivery, indefinite-quantity contract to Iridium's *Government Programs* subsidiary to expand its capabilities. Designed around Iridium's constellation of 66 low-earth-orbiting (LEO) satellites, DTCS is an extension of what the company calls "*Netted Iridium*." The netted aspect enables a warfighter equipped with a modified, commercial off-the-shelf radio handset to talk or send narrowband data files over one channel to many listeners within designated user "nets." This multicast architecture enables tactical communications by advancing beyond the typical person-to-person satellite phone connections.

Iridium's constellation of cross-linked satellites provide near real-time voice and data links in places where the military's geostationary satellites or line-of-sight communications systems often cannot. Troops operating in a deep mountain valley, for instance, often can't pick up a geostationary satellite's signals unless they move to higher ground. DTCS is shifting paradigms in the way disadvantaged, dismounted warfighters acquire and use voice and data for *beyond-line-of-sight* (**BLOS**), *over-the-horizon* (**OTH**) and *on-the-move* (**OTM**) communications, according to *Igor Marchosky*, DTCS program manager for the Naval Surface Warfare Center.

"With DTCS, the LEO satellite assets will find you, and not the other way around," *Marchosky* said. "If you can see the sky, eventually you will have comms, and that is particularly useful in mountainous terrain."

Since the DoD began testing Iridium's netted technologies in 2006, DTCS has evolved rapidly. Within two months in 2008, for instance, the Naval

Surface Warfare Center's *Harsh Environment Lab* (**HEL**) at Dam Neck, Virginia, produced a handset prototype that featured miniaturized and ruggedized electronic circuitry. To guard against the cold, the devices were equipped with sensors that activate internal heaters to warm the liquid crystal display when temperatures drop, said Rob Anderson, HEL's program manager for DTCS.

Around 100 of the handheld radios currently are in use by U.S. troops in Afghanistan, including two *Provincial Reconstruction Teams*, whose primary role is to win support of local villagers. By the end of 2009, around 1,000 of the devices are expected to be deployed in the Middle East, said *Scott Scheimreif*, Iridium's vice president of government programs. The radios weigh about a pound and have GPS embedded into the electronics, providing a position location indicator similar to **Blue Force** tracking. It's relatively easy to use, with one knob for volume, one knob to select channels and a push-to-talk button.

"One of the primary things Iridium has focused on is reducing combat load," *Scheimreif* said. "The original customer was the guy on the ground who has to carry all the tools and solutions he needs to survive in the field. This device can replace two or three pieces of hardware, especially in the case of BLOS and Blue Force tracking capabilities."

Work under the five-year contract will focus on upgrades to the handheld device, and expanding the range and number of user networks. ITT is leading efforts to improve the tactical radio, including development of an advanced radio, called the ***C2***, that will feature a built-in PDA and give users web-based computer capability.

To hold down development and life cycle costs, DTCS uses commercial-off-the-shelf components. The radios, for instance, are powered by ***CR123*** lithium batteries that troops also use for flashlights and other equipment. They also are compatible with the ***H250*** tactical headset, one of the most ubiquitous in the field. The devices can be easily installed in up-armored vehicles and quickly removed, and are being tested in medevac and troop transport helicopters.

Boeing, which operates and maintains Iridium's constellation, is overseeing software upgrades to the satellites to expand the capacity and range of user nets. The system currently supports around 250 unique nets — each with its own encryption and security keys — and offers reliable coverage of 100 miles for users within a net. The improvements aim to expand the user nets to 2,000 and increase the range to 250 miles.

DTCS operates much like a trunked-based radio, in which a pool of users share a range of frequencies. The individual nets can be divided up, such as nets for command and control, medevac and fire support. Users in each net are assigned a channel number, and the radio will scan for traffic on other nets where a user has access.

Users don't have to worry about dialing in a specific frequency, or requesting a channel or time slot. All they do is select a channel. When a user pushes the talk button, the satellite network automatically assigns a frequency based on availability and alerts other users in the net. Ongoing research and development will focus on providing more secure protection of data while preserving the ability to share information across military communities, including coalition forces in theater.

As DTCS develops, voice communications will remain the top priority, Scheimreif said. The most significant data capability is transmission of troop position locator information, but DTCS radios also enable text messaging, chat and exchange of small data files in single-digit kilobytes.

User feedback has been encouraging. DTCS offers the best potential to date for fulfilling command and control on-the-move, says Brig. Gen. *Mark Bowman*, director of Central Command's J6 Command, Control, Communications, and Computer Systems directorate. "In my opinion," he said, "Netted Iridium will be the most significant tactical communications improvement developed and fielded during the Global War on Terror."

DTCS' spiral development has focused on rapidly deploying and improving prototypes based on user input from the field, a process that has cut development time and produced a product tailored to customer needs.

"What we're hearing is that they are getting the ability to communicate in places they've never been able to before," *Marchosky* said. "The majority of feedback is not 'I can't communicate,' but 'I would like a radio with this shape, or this form, or this kind of pouch or button.' "It's not a matter of capability, and that in itself is a major success. So, the billions of dollar problem has been solved. Now we're looking at a thousands of dollars problem."

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