SatCom For Net-Centric Warfare November 2008

MilsatMagazine

Mission Critical — Secure Satellite Networking

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The security of the information being relayed between warfighters, command and control, satellites, fiber connections, antennas, uplinks, downlinks, is highly reliant upon secure and viable network delivery. Without protected and intrusion-proof communication, today's military, government, NGO and first responder operations are open to failure. When lives are at stake, such is unacceptable.

To help bring to all within the milsatcom and associated fields the ability to control their communication grids and to protect their assets, ***MilsatMagazine*** presents sage words of advice from subject matter experts within the security arenas as well as current information from companies within this critical market segment.

One company deeply invested in providing for warfighter network security is BBN Technologies. The Company has been hard at work on counters to improve the defensive capabilities of military networks. The company received a US$4.4 million contract from the Defense Advanced Research Projects Agency (DARPA) to develop scalable attack detection algorithms as well as a highly flexible architecture. Wherein the architecture is used to implement and deploy those algorithms and the ability to inspect traffic and then execute the appropriate algorithm upon intrusion detection. They also garnered a US$8.9 million for the third phase of their ***Disruption Tolerant Networking*** (DTN) program, after successfully completing Phase One and Phase Two that resulted in a working prototype system.

DARPA's ***Scalable Network Monitoring*** program requirements include:

- Malicious traffic detection probability greater than 99 percent per launched attack
- No more than one false alarm each day while monitoring traffic
- In Phase 1 of the contract, support capabilities must be delivered at conventional gateway line speeds of 1 Gbps — Phase 2 must demo scalability at gateway line speeds of 100 Gbps

Traditional signature based and anomaly detection-based defensive measures are proving inadequate in their speed and sensitivity. This comes as cyber attacks increase in number and avail themselves of enhanced technologies to intrude into networks via new attack routes. Algorithms to detect network invasions must operate extremely quickly and be highly efficient as well as effective, especially within content-rich environs. DARPA has indicated that traffic volume is increasing at a faster rate than the number of network hosts. This means the computing power necessary to provide gateway network monitoring and defense of autonomous systems will continually grow as a fraction of the monitored network's power. With increased intrusions, soon the network will have to apply the majority of its resources simply to defend itself.

With the DTN program, field and network services are to be developed that will deliver critical information reliably, even when no end-to-end network path exists. The traditional TCP/IP network relies upon stable, end-to-end connectivity. However, jamming, movement, terrain, and weather can interrupt the flow of message traffic. The uniqueness of the DTN system will be the ability to send and receive data, regardless of whether a stable end-to-end route exists. DTN will be integrated into fielded military networks that may combine various node types, including satellite, wireless, as well as vehicle-mounted.

At iDirect Government Technologies (iGT), *Karl Fuchs* is the Director of Engineering. Knowing how companies plan to address these crucial networking security needs is important for all to remain aware of, as the application of new technologies, new thinking, and new enterprise can assist others in their endeavors to help our warfighters and first responders protect the flow of data. I asked Karl how iGT is making networking security a leading priority.

"Security has been and continues to be an extremely important element of our business. Because satellite communications are broadcast through the air, it is necessary to provide very high levels of security, surpassing even the security requirements of terrestrial systems. Right now, there are very few government specifications in place to dictate standards for satellite technology providers. At the same time, government agencies are understandably very demanding in this regard. As a result, iDirect has taken it upon itself to continually raise the bar on security for these mission critical networks, being the first in the satellite industry to receive Federal Information Processing Standards (FIPS) compliance and the first to offer Transmission Security (TRANSEC) in a mobile environment. The iGT engineering team includes leading security experts who continue to work with our partners to improve the security of our systems in terms of encryption and in total network security."
Obviously, addressing a growing list of new security needs impacts the technology used by a company. As Karl indicated, "Many of our implementations have been migrating customers from a Single Channel Per Carrier (SCPC) environment to a Time Divisional Multiple Access (TDMA) environment. TDMA improves network efficiency by allocating bandwidth across a shared network, making connectivity more cost effective and getting more mileage out of bandwidth. This is especially important for government networks operating in areas of the world where capacity is limited, such as Southeast Asia and the Middle East. IGT has been able to win the trust of these customers due to our ability to provide TRANSEC in a TDMA environment, which is significantly more challenging than with an SCPC system."

For example, in a non-TRANSEC TDMA system, it is possible for an adversary to determine how much traffic is being communicated from each remote and to understand what type of traffic is being transmitted, whether video or data or VoIP. When combined with other intelligence, this information can jeopardize operations.
The risks of IP TDMA have been clearly identified by the National Security Agency (NSA). With TRANSEC, our system addresses each of these concerns and eliminates them. This has allowed us to work with major government agencies that require TRANSEC, such as the U.S. Navy and the Special Forces community."

Today, mobility is a huge factor in product planning — Karl addressed the role of security in a mobile network. "Providing TRANSEC in a mobile environment is crucial. Almost by definition, the information that is being communicated across a mobile network is extremely sensitive. At the same time, mobile networks present a distinct security challenge. Traditionally, satellite networks are constructed with remote terminals that are up and operational at all times. But in a COTM network, remotes are constantly entering and leaving the network. This is the case because remotes are often shut off when a vehicle is not in use.

The location of a remote may also cause it to leave the network, for instance, if it is temporarily under a bridge. With remotes entering and leaving the network, it becomes easier for a rogue remote to infiltrate the system. We pioneered TRANSEC for COTM to eliminate these concerns and we continue to improve these systems with the input of our partners.

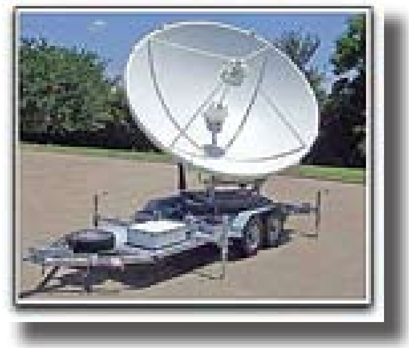
Moving forward, security will always be a major priority for government networks. iGT recently implemented TRANSEC on a MESH network to secure in theatre VoIP and data communications. Currently, in development, is a stronger encryption technology to better manage and transmit encryption keys across a secure network. The development of more stringent capabilities across the network is a main priority, ensuring our hubs, remotes and software exceed the security expectations of the users on the ground."

MSM's InfoNet

Taking a tour with the companies involved in the milsatcom arena, their products continue to espouse innovation and offer crafted solutions for this golbal business segment. Now presented is their new product and company information by business name, in alphabetical order, in ***MilsatMagazine's (MSM) InfoNet***. If viewing these items in the ".pdf" or web version of the magazine, select the link to automatically be taken to the appropriate URL. If reading the print version of ***MilsatMagazine***, simply copy and paste the article URL into your browser...

Agilent released their 2008 Aerospace/Defense Symposium papers on CD. The 15 technical papers contained on this CD provide Aerospace/Defense engineers with technically-rich content presented in two tracks: *Test System Development* and *Military Communications Test*. Also included is information on wideband vector analyzer calibration issues and time interval analysis measurements for radar. The CD is available now and is entitled "***Agilent's Aerospace & Defense Symposium 2008***". The CD can be ordered at the following link...
https://www.home.agilent.com/agilent/editorial.jspx?cc=US&lc=eng&ckey=1431860&nid=-35198.0.02&id=1431860&cmpid=20961

Aruba Networks, Inc. deployed their wireless networks by Babylon Telecommunications Inc. at Joint Base Balad in Iraq to provide Internet access to over 20,000 soldiers. Prior to this deployment there was no authorized Internet access at the base for the individual soldiers, making it difficult for troops to stay in touch with loved ones and affecting morale. Babylon Telecommunications was awarded a contract by the Army & Air Force Exchange Services (AAFES) to handle the integration services and provide Internet service at Joint Base Balad, the largest U.S. military base in the region.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1518463738



ASC Signal Corporation's (formerly Andrew Corporation Satellite Communications Group) 3.9 Meter F-1 Trifold Transportable antenna is now completely compatible with Ka-band and available to customers around the world. This antenna offers Ka-band capability and a patent pending, dual Azimuth drive high accuracy tracking capability.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1874128223

Crawford Communications, Inc. will provide content aggregation, media relations, Internet and satellite services for the U.S. military's Digital Video and Imagery Distribution System (DVIDS). Under the agreement of the long-term contract the mission is to provide a reliable connection between the global media and the military. DVIDS is a network of 106 portable Ku-band transmitters located with deployed military units and a central distribution hub located at Crawford's teleport. In addi-

tion to the core media and distribution services, the Company provides training classes; staffing; analysis; web support; and video and print editing services. Also, Crawford offers an asset management solution for the project's extensive content library.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1102090874

DataPath, Inc. has introduced DataPath MobiLink™, an easy-to-deploy communications on-the-move (COTM) solution that delivers cost-effective, mobile network-centric warfare and first responder capabilities. ***MobiLink*** incorporates standard communications electronics and delivers them in a newly designed, compact package that enables integrated UHF/VHF land mobile radio (LMR) and satellite COTM. MobiLink transforms almost any U.S. military vehicle into a command post on wheels. MobiLink features an innovative system that mounts on a standard **SINCGARS MT-6352** tray in military vehicles. A hub vehicle equipped with MobiLink supports high-bandwidth capability to send and receive video, data, and voice communications between many vehicles and users. MobiLink offers an ***everything-over-IP*** (**EoIP**) network link and establishes a robust local wireless network anywhere it is needed to go. MobiLink operates with the push-to-talk simplicity of LMR systems, combining ease of use with beyond-line-of-sight capability.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1123521611

DataPath, Inc. has also been awarded US$1.9 million to continue providing field services for DataPath Deployable Ku Band Earth Terminals (DKETs) at a key communications hub in Iraq. The **DKET** systems were built and installed by DataPath and are used by the U.S. military as critical satellite communications (SATCOM) hubs that deliver high-bandwidth capabilities on the battlefield. DataPath technical experts have been based on-site to ensure optimum performance of the systems since they were installed in March 2005.

LINK — http://www.satnews.com/cgi-bin/story.cgi?number=532513294

Additionally, DataPath, Inc. has received a $3.7 million order to provide on-site personnel to operate and maintain satellite communications (SATCOM) systems managed by the U.S. Army Network Enterprise Technology Command (NETCOM) in the U.S. Central Command (CENTCOM) area of operations. The agreement, which exercises options on an existing delivery order, will fund more than 30 DataPath technical personnel in Iraq, Kuwait, Qatar, and Afghanistan over the next 12 months to support U.S. military battlefield communications systems.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1309142705

Directed Perception, Inc., a manufacturer of products for the control and positioning of sensors, has now made availability their PTU-D48 family of computer controlled pan-tilt units. These units are designed for high speed, accurate positioning of cameras, thermal images, lasers, antennas, and other payloads up to 15 lbs. in weight. The rugged and compact design has flexible mounting options for single or multiple payloads and is suitable for fixed and mobile applications (air,

ground, sea) in industrial and military markets. The **PTU-D48** delivers this solution for applications such as: tower mounted surveillance cameras, UAV camera systems, police and military ground vehicles, antenna tracking systems, border and perimeter surveillance, military force protection systems, night-vision applications, and more.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1567913839

Echo Satellite Communications, Inc. has shipped its initial order to Naval Air Systems Command (NAVAIR) for a HeliSAT3 customized Iridium repeater system. ***HeliSAT3*** is a satellite communications repeater, specifically designed to create wireless satellite telephone "hotspots" aboard Naval aircraft. HeliSAT3 enables airborne Iridium users to quickly and easily make fully wireless, satellite voice, and data communications available from a helicopter passenger compartment. Historically limited by the requirement for satellite phones to have line-of-sight access to orbiting satellites, with HeliSAT3, passengers can now access dependable and uninterrupted in-flight wireless satellite communications.

LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1830833848

The General Dynamics C4 Systems Handheld, Manpack and Small Form Fit (HMS) radios have demonstrated their critical networked-communications capabilities in recent government-run Joint Tactical Radio System (JTRS) field tests. The tests have proven the radios' interoperability, range, video transmission and networking abilities.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=743808170

Harris Corporation has introduced the first tactical satellite terminals with the capability of transmission/reception of TOP SECRET global wideband data communications. These new terminals are designed to military standards for operations in harsh environments. The new ***Harris RF-7800B Broadband Global Area Network*** (BGAN) terminals offer a high-performance satellite solution for voice and data connectivity in beyond line-of-sight, SATCOM-on-the-move and SATCOM-at-the-quick-halt applications. When linked to ***Harris Falcon III*** manpack radios or ***SecNet 54*** encryption modules, the RF-7800B terminals provide end-to-end Type-1 HAIPE-certified security for data transmissions over long-range commercial networks. The first two products in the Harris Tactical BGAN line are the RF-7800B-DU024, a Class 2 Land Portable BGAN terminal for dismounted applications, and the RF-7800B-VU104, a Class 10 Land Mobile BGAN terminal for vehicles on the move.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=945276473

Pumping up data throughput on the network by as much as 500 percent for critical military and government needs without increasing recurring monthly bandwidth costs is big news. iDi**rect Government Technologies** (iGT) revealed that **3Di Technologies**, a provider of VSAT systems and Enterprise Internet Telephony services, has implemented more than 20 ***iDirect SkyCelerator Network Accelerators*** on a secure ***U.S. Government Type 1*** communications system in Southwest Asia.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1989317412

iDirect, Inc. has launched its Series 12200 Universal 4-Slot Industrialized Hub, which allows network operators to implement and manage a mobile satellite network in the field. The new 4-slot hub

will operate using iDirect's enhanced ***iDS 8.3*** software, engineered for use in mobile applications. The software also supports iDirect's new ***SkyMonitor Spectrum Analyzer***, a core network management tool that allows satellite operators to troubleshoot and monitor network performance. The new Universal 4-Slot Industrialized hub enables military and relief organizations to deploy complete satellite networks at a moments notice, meeting a critical need for unfailing mobile connectivity in the field. iDirect's new 4-slot hub is capable of delivering broadband connectivity, including videoconferencing and voice over IP, to thousands of remotes.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1883005461

Iridium Satellite LLC reports that its mobile satellite communications service has been providing peak levels of reliable, critical lifelines to first responders in the Gulf Coast Region. Outreach by **Iridium** and its partner base has resulted in a significant increase in usage in the Gulf Coast. In areas affected by the recent storms, hundreds of subscribers made calls on the Iridium network to test their equipment or to conduct mission-critical operations. The company shipped 5,000 phones to service providers for new subscribers over a period of two weeks, with the majority going to partners serving the Gulf Coast.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1929067049

KVH Industries, Inc. (NASDAQ: KVHI) has received a new contract from a southeast Asian customer for the purchase of KVH's TACNAV® military vehicle navigation systems and displays. The contract has a total value of approximately US$1.3 million, with shipments starting in late 2008 and extending into early 2009. KVH's ***TACNAV*** military vehicle navigation systems provide unjammable, precision navigation, heading, and pointing data for vehicle drivers, crews, and commanders.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=125941087

Loctronix™ Corporation successfully demonstrated tracking signals from all operational Global Navigation Satellite Systems (GNSS) last July. A single software defined radio (SDR) platform was used to receive and process the coarse and military precision ranging channels of GPS (U.S.) and GLONASS (Russia) for all satellites in view. Made possible with Loctronix' ***Spectral Compression Positioning*** (SCP) technology, this achievement marks a significant advancement in position sensing. The company demonstrated that a single, relatively simple sensor, composed primarily of software and hosted on a generic RF core, can readily track any positioning signal, be it *GPS*, *GLONASS*, localized beacons or, in the future, *Galileo* (Europe), *Compass* (China), and *QZSS* (Japan).
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=271133723

Mobile Satellite Ventures (MSV) has joined with the State of Washington's Military Department Emergency Management Division to launch the NorthWest Satellite Mutual Aid Radio Talkgroup serving public safety interests throughout seven states in the northwestern United States. The states including Alaska, California, Idaho, Montana, Oregon, Washington, and Wyoming. ***NWSMART*** is the fifth in a planned network of nine, regionally-focused, locally managed talkgroups across the nation enabling critical and interoperable communications at all levels of public safety agencies and facilities. In coordination with MSV, the Washington State Emergency Management Division, including its state *Emergency Operations Center*, will manage, provide 24x7 monitoring, and approve participation in NWSMART by federal, tribal, state, and local public safety agencies — and appropriate private sector users with a public safety mission.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1867839073

Northrop Grumman Corporation (NYSE:NOC) has completed integrating all electronic units of the payload module for the third Advanced Extremely High Frequency (EHF) military communications satellite. The company is under contract to provide three communications payloads to ***Advanced EHF*** prime contractor **Lockheed Martin**. The Advanced EHF system will provide global, highly secure, protected, survivable communications for warfighters operating on ground, sea and air platforms.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=850907721

Northrop Grumman Corporation has also successfully fielded Guardrail Ground Baseline (GGB) 2.0 hardware and software to U.S. Army military intelligence battalions, standardizing Guardrail ground components across the service. ***GGB 2.0*** provides common hardware and software and eliminates obsolete equipment, thus improving operations, supportability, deployability and maintenance of the Army's ***RC-12 Guardrail Common Sensor*** aircraft ground component. GGB's network-based architecture supports forward garrison operators and rear operators via satellite link, as well as cooperative operations with other signals intelligence sensors.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1418546471

A critical link for rural military deployment as well as civilian use is that all-important line of communication to the rest of the world. Helping connect these areas is the STM Group with their break-through SuperPico GSM base stations. This patented technology is an integrated satellite-cellular system that provides low cost subscriber services using single hop connectivity and local routing. The product is targeted for rural deployments where all-solar installations are now preferred. Marine, military, suburban infilling, and emergency services are also expected to drive demand for this rugged GSM equipment.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=708943635

SWE-DISH Satellite Systems AB, a DataPath company, has added a 1.2-meter antenna module to the CommuniCase® Technology product line, creating the new SWE-DISH Suitcase® CCT120. SWE-DISH Suitcase terminals are light, compact, and easy to use, and have assisted the manner in

which journalists, military personnel, and emergency first responders communicate from remote locations.
[LINK — http://www.satnews.com/cgi-bin/story.cgi?number=445651911](http://www.satnews.com/cgi-bin/story.cgi?number=445651911)

Coming to NASA's Wallops Flight Facility, Wallops Island, Virginia is a first — the Tactical Satellite-3 (TacSat-3) spacecraft mission, which is scheduled to demonstrate rapid data collection and transmission to the combatant commander in the theater of interest. During this upcoming flight a new capability will be demonstrated and tested; that of employing a hyperspectral imager with a space-based, onboard processor to obtain and send images within minutes to the warfighter on the ground. Raytheon constructed the Advanced Responsive ***Tactically Effective Military Imaging Spectrometer***, or ARTEMIS, hyperspectral imager. Designated as the satellite's main demonstration, the ARTEMIS hyperspectral imager payload will provide target detection and identification information, as well as battlefield preparation and combat assessment data, within 10 minutes of its collection. A second payload representing the Office of Naval Research's satellite communications package, will employ sea-based buoys as data sites. The satellite's third payload – Air Force Research Laboratory's space avionics experiment will involve plug-and-play avionics, which features reprogrammable parts to link the payload and the satellite structure.
[LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1445836792](http://www.satnews.com/cgi-bin/story.cgi?number=1445836792)

The U.S. Air Force still plans to award Boeing or Lockheed Martin Corp a contract worth billions of dollars this fall to build a group of advanced military communications satellites, the general in charge of Air Force Space Command said recently.

Gen. *Robert Kehler* told reporters that the future of the ***Transformational Satellite*** program for which both companies are bidding was entwined with that of another program, the ***Advanced Extremely High Frequency*** satellite program, run by Lockheed. The Air Force told Congress earlier this month that the AEHF program had exceeded congressional caps on cost growth, which could lead to cancellation of the program unless it is certified as essential for national security reasons. The cost of the AEHF program was now projected to be US$9.2 billion, including US$2 billion for a fourth satellite added to the Pentagon's budget by Congress, accounting for about 80 percent of the overall cost increase.
[LINK — http://www.satnews.com/cgi-bin/story.cgi?number=467537210](http://www.satnews.com/cgi-bin/story.cgi?number=467537210)

Vandenberg Air Force Base (Vandenberg AFB) has celebrated its 50th anniversary. On October 4, 1958, Cooke AFB was renamed Vandenberg AFB in honor of the late General *Hoyt S. Vandenberg*, the Air Force's second Chief of Staff. Presently operated by Air Force Space Command's *30th Space Wing*, Vandenberg AFB supports a variety of aerospace missions and customers. It is the only military base in the United States from which unmanned government and commercial satellites are launched into polar orbit.
[LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1003038800](http://www.satnews.com/cgi-bin/story.cgi?number=1003038800)

ViaSat Inc. has been awarded contracts totaling US$25 million for LinkWayS2 satellite modems to support the U.S. Army, USMC, and other DoD customers. The ***LinkWayS2*** systems support various military communication programs such as WIN-T, SNAP, FHRN, SWAN, and C-MNF. LinkWayS2 modems provide single-hop, full mesh, high speed bandwidth-on-demand flexibility and efficiency that a hub-based satellite network system is unable to provide for the named applications. The modems delivered under these orders will also introduce DoD-approved *transmission security* (TRANSEC) to the LinkWay system as well as new LinkWayS2 system that improve throughput and efficiency.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=737933160

Military communications remain an essential part of security operations. The technology extends from equipping military personnel with devices so they can communicate on operations, to providing centralized systems for organizing battle and security operations on land, sea, and in the air. Today, all military forces rely heavily on sophisticated electronic communications systems, with technology transfer to and from civilian communications systems, both those in use and those in development. This reliance on advanced communications will increase year on year. You and your organization must be fully informed of these developments. For units out in the field, digital radio — such as the U.S. Military's ambitious *joint tactical radio system* (JTRS) — promises improved, programmable communications links. That system extends beyond voice-only communications to include the exchange of data and video messaging during battle and security operations. For linking all these systems in reliable, high-performing and secure networks, satellite and high-bandwidth terrestrial communications will exert an increasingly sophisticated and important role in military operations from 2008 onwards. This new visiongain report, ***Military Communications and COTS 2008***, describes both the technologies and the relevant markets in detail, along with cost-effectiveness, with relevant data and informed opinion. This information is valuable to defense procurement operations and to relevant technology providers.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1077521225

UAV Advisory

With the interest in unmaned aerial vehicles intensifying, ***SatNews*** covers this critical environment in our daily and weekly news. Adding such into ***MilsatMagazine*** makes a great deal of sense, as such units are responsible for data relay for everything from intelligence gathering and surveillance to actionable activities for warfighters, government organizations, and first responders.

AAI Corporation, an operating unit of Textron Systems, has entered into a teaming agreement with Aeronautics Defense Systems Ltd. of Israel to market the Orbiter Mini-UAV (unmanned air vehicle) system jointly to U.S. and select international customers. Under the terms of this teaming agreement, AAI will lead marketing activities for the ***Orbiter Mini-UAV*** (MUAV) system in the U.S., including foreign military sales to Israel, and in other countries to be mutually agreed in the future. AAI also will manufacture the Orbiter system at its Hunt Val-

ley, Maryland, HQ for select programs. The Orbiter MUAV is less than 40 inches in length and designed for intelligence, surveillance, and reconnaissance missions. With an operational endurance of up to three hours, the Orbiter MUAV can fly as high as 18,000 feet. With light composite construction and battery-powered operation, the Orbiter offers easy portability to ensure a team of two fielded warfighters can quickly deploy, launch, and operate the aircraft.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1255747252

TACMET II has been fielded on more than 50 UAV ground control systems for the U.S. military. **Climatronics Corporation** now offers an improved, tactical weather station, the EMI-hardened ***TACMET II*** (P/N 102304), to provide real-time surface weather input for UAV ground control stations. This rapidly deployable, compact, self-contained weather station typically mounts on a mast on the ground control shelter and includes an internal flux gate compass to automatically align the wind direction data to North. The system requires extremely low power and can be operated from a wide variety of AC or DC power sources.

LINK — http://www.satnews.com/cgi-bin/story.cgi?number=890164646

General Atomics Aeronautical Systems, Inc. (GA ASI) and the Company's "Team Sky Warrior" partners AAI Corporation and L-3 Communication Systems-West have successfully first-attempted automatic takeoffs and landings of a Sky Warrior UAS controlled from the AAI-developed Extended Range/Multi-Purpose (ER/MP) One System Ground Control Station (OSGCS). Three automatic landings were successfully executed at GA-ASI's El Mirage Flight Operations Center in Adelanto, California, on August 29th, followed by three successful automatic takeoffs on September 26th. GA-ASI's ***Sky Warrior*** aircraft was under full line-of-sight command and control through the ***L-3 Communication Systems-West Tactical Common Data Link*** (TCDL).
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1643700543

Lockheed Martin's (NYSE: LMT) Unmanned Aerial Vehicle Airspace Management System (UAMS) solved one of the more difficult challenges facing military services and their industry partners — the Company has successfully demonstrated the ability to deconflict groups of in-flight UAVs during a test near Pittsburgh, Pennyslvania. Sponsored by the U.S. Army's ***Aviation Applied Technology Directorate***, a team lead by Lockheed Martin Advanced Technology Laboratories (ATL) developed UAMS as a battalion echelon system that deconflicts flight paths of multiple, small UAVs with limited on-board sensors, communications, and processing resources. UAMS also uses its own on-board sensors to "see-and-avoid" obstacles and other aircraft.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=714864460

Parvus Corporation has received a sub-contracting agreement with Aurora Flight Sciences to supply common Mission Computers for Aurora's Unmanned Aerial Vehicles (UAV) under several prime contracts. No financial terms were disclosed.
Parvus has delivered Aurora Common Mission Computer (ACMC) units for use with the ***GoldenEye 80 Unmanned Aircraft System*** (UAS), an advanced *Vertical Take-Off and Landing* (VTOL) aircraft designed to carry advanced sensor payloads for homeland security and battlefield operations. The ACMC computer is a small-form factor rugged computing system based on Parvus' COTS DuraCOR 820 subsystem, designed to accommodate the environmental and physical requirements of Aurora's airborne vehicles.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=725534090

Zephyr's reputation as the world's leading solar powered high-altitude long-endurance (HALE) Unmanned Aerial Vehicle (UAV) has been reinforced with a world-record of a three and a half day flight at the U.S. Army's Yuma Proving Ground in Arizona. The solar powered plane built by **QinetiQ** flew for 82 hours 37 minutes, exceeding the current official world record for unmanned flight, which stands at 30 hours 24 minutes set by ***Global Hawk*** in 2001 and Zephyr's previous longest flight of 54 hours achieved last year. The **U.K. Ministry of Defence** (**MoD**) has funded the development of ***Zephyr*** to date and has partnered with the U.S. Department of Defense (DoD) under their ***Joint Capability Technology Demonstration*** (JCTD) Program, which is designed to move urgently needed technologies rapidly into the hands of U.S. forces in the field.
LINK — http://www.satnews.com/cgi-bin/story.cgi?number=1584440622

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Hartley Lesser, Editorial Director
SatNews Publishers

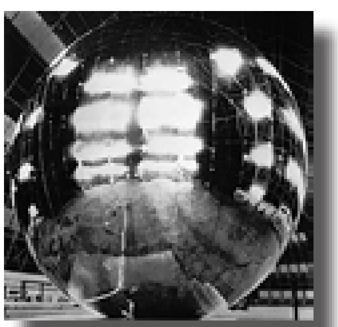
by Jos Heyman, Tiros Space Information

The military services of the United States and its NATO allies have been and remain extensive users of satellite technology to support their military communications requirements. The purpose of this article is to provide a historical overview of the military communications satellites and its NATO allies.

Early Research and Development

Much of the early research with communications satellite undertaken by the USA was conducted by the military services or NASA. As a result, a number of such satellites deserve consideration in this overview.

The ***Signal Corps Orbiting Relay Experiment*** (**Score**) was the first satellite used for investigating communications between Earth orbit and the surface. Launched on December 18, 1958, the satellite was placed in an orbit of 185 x 1484 km at an inclination of **32.3°**, remaining attached to the final stage of the launch vehicle. It carried a tape recorder and transmitted a recorded message spoken by President *Eisenhower* at 132 MHz. The batteries became exhausted after 13 days, during which period the feasibility of such communications had been proven.



The **Echo** program investigated the use of a reflective surface in radio communications. After suborbital tests with the balloon from Wallops Island on October 28, 1959, February 27, 1959, and May 31, 1960, and a launch failure on May 13, 1960, ***Echo-1***, launched on 12 August 1960. It successfully provided the first space communications link between two ground stations. It was a 30-meter diameter balloon with an aluminized surface that reflected radio signals back to Earth. It was in a near-circular orbit of 1524 x 1684 km at an inclination of **47.2°** and remained in orbit for almost eight years. After initial taped messages from **Goldstone** (California) to **Holmdel** (New Jersey), the first two way communication took place on August 13, 1960, between **Cedar Rapids** (Iowa) and **Richardson** (Texas). Also, the first pictures were transmitted between the same stations on August 19, 1960.

Echo-2, launched on January 25, 1964, and was larger than Echo-1, measuring 46 meters in diameter. It was placed in a polar orbit of 1029 x 1316 km and an inclination of **81.5°**, enabling the first joint experimental program to be carried out by the United States and the U.S.S.R. Although the two Echo satellites provided valuable experience in space communications, they proved to be unsuitable for long-term use. The lack of signal amplification was a severe handicap. Their large size was also a factor as the pressure of solar radiation caused the balloons to drift erratically.

Reference must be made to the **Westford** project. This was a military program that envisaged the placing of 400 million copper needles in orbit, which would then be used as a passive reflector for communications. The needles were launched on board the ***Midas-4*** early warning satellite on October 21, 1961, but failed to disperse properly. The experiment was repeated on May 9, 1963, with the launch of the ***Midas-7*** early warning satellite — 400 million metal fibers needles were released. Only a few of the needles were catalogued and, although in 1966 it had been suggested that most of the needles had re-entered with a few clusters expected to re-enter by 1968, in reality most of the needles remain in orbit.

Courier-1B, launched on October 4, 1960, (after a failure on August 18, 1960) was the first '***repeater***' satellite, amplifying the signals and then re-transmitting them to Earth. It was placed in a 938 x 1237 km orbit with an inclination of **28.3°**. The satellite was built by **Philco** and carried four transmitters operating in the 1700/2300 MHz band, as well as a repeater system that consisted of five tape recorders with a five minutes capacity each. Its batteries lasted for 17 days during which time much information was acquired about the operation of repeaters in space, propagation conditions and ground-station operations.

Syncom-1 (February 14, 1963) was the first attempt to place a satellite into geostationary orbit but, due to communications problems, this orbit was not achieved. ***Syncom-2*** was intended to be placed in a geostationary orbit at **55° W** on July 26, 1963 but only achieved a near-synchronous orbit of 35,584 x 35,693 km with a period of 24 hours and 14 minutes but with an inclination of **30.3°**.

In spite of this incorrect orbit, the satellite, which was used for military communications over the Indian Ocean until April 1969, provided valuable experience. The satellite was built by **Hughes** and was spin-stabilized and carried two transponders operating in the 7.3/1.8 GHz band.

Syncom-3 was identical to Syncom-2 and was the first satellite to achieve a near-geostationary orbit on August 19, 1964 — the orbit was 38 minutes short of being geostationary. The satellite was used for communications over the Pacific Ocean, including the relay of television

Name	Int.Des.	Launch	Notes
IDSCS-1/7	1966 053B/H	16-Jun-1966	Also known as Ops-9311/9317
IDSCS	---	26-Aug-1966	Eight satellites failed to orbit
IDSCS-8/15	1967 003A/H	18-Jan-1967	Also known as Ops-9321/9328
IDSCS-16/18	1967 066A/C	1-Jul-1967	Also known as Ops-9331/9333
IDSCS-19	1968 050A/H	13-Jun-1968	Also known as Ops-9341/9348

Table 1: IDSCS launch dates

Name	Int.Des.	Launch	Notes
DSCS II-1/2	1971 095A/B	3-Nov-1971	Also known as Ops-9431/9432
DSCS II-3/4	1973 100A/B	13-Dec-1973	Also known as Ops-9433/9434
DSCS II-5/6	1975 040A/B	20-May-1975	Also known as Ops-9435/9436; failed to achieve correct orbit
DSCS II-7/8	1977 034A/B	12-May-1977	Also known as Ops-9437/9438
DSCS II-9/10	---	25-Mar-1978	Also known as Ops-9439/9440;failed to orbit
DSCS II-11/12	1978 113A/B	14-Dec-1978	Also known as Ops-9441/9442
DSCS II-13/14	1979 098A	21-Nov-1979	Also known as Ops-9443/9444
DSCS II-15	1982 106A	30-Oct-1982	
DSCS II-16	1989 069A	4-Sep-1989	Also known as USA-43

Table 2: DSCS II launch dates

Name	Int.Des.	Launch	Notes
DSCS III-1	1982 106B	30-Oct-1982	
DSCS III-2/3	1985 092B/C	3-Oct-1985	Also known as USA-11/12
DSCS III-4	1989 069B	4-Sep-1989	Also known as USA-44
DSCS III-5	1992 006A	11-Feb-1992	Also known as USA-78
DSCS III-6	1992 037A	2-Jul-1992	Also known as USA-82
DSCS III-7	1993 046A	19-Jul-1993	Also known as USA-93
DSCS III-8	1993 074A	28-Nov-1993	Also known as USA-97
DSCS III-9	1995 038A	31-Jul-1995	Also known as USA-113
DSCS III-10	1997 065A	25-Oct-1997	Also known as USA-135
DSCS III-11	2000 001A	21-Jan-2000	Also known as USA-148
DSCS III-12	2000 065A	20-Oct-2000	Also known as USA-153
DSCS III-13	2003 008A	11-Mar-2003	Also known as USA-167
DSCS III-14	2003 040A	29-Aug-2003	Also known as USA-170

Table 3: DSCS III launch dates

broadcasts of the *1964 Olympic Games* from Tokyo to the United States. Syncom-3 was taken out of service in April 1969.

The U.S. Air Force conducted another experiment involving passive communications systems with ***Orbiting Vehicle (OV) 1-8***. The OV consisted of a wire mesh sphere with a diameter of 914 cm that contained a balloon inside, which was launched on July 14, 1966.

on February 9, 1969. The satellite, which was built by **Hughes**, was positioned over the Galapagos Islands in the Pacific Ocean and was the most powerful communications satellite in orbit at that time. It provided a link between ground-based mobile receivers with 30 cm antennas and aircraft and operated in the 225/400 MHz and 7/8 MHz bands.

In 1965, the U.S. Air Force commissioned the **Lincoln Laboratories** of the **Massachusetts Institute of Technology** to develop and build a series of experimental satellites to test and evaluate advanced space communications devices and systems.

Experiments included satellite-to-satellite transmissions over long distances and communications with a variety of small ground terminals. The satellites, designated as ***Lincoln Experimental Satellites*** (**LES**), were placed in synchronous orbits of various inclinations. The last two in the series were powered by *radioisotope thermoelectric generators* (**RTG**) and were three-axis stabilized. Eight LES satellites were launched between February 11, 1965, and March 15, 1976.

A follow-on to the LES series was known as ***Tactical Communications Satellite*** (**Tacsat**) and was launched

DSCS

The first operational U.S. military communications satellite system was the ***Initial Defense Satellite Communications System*** (**IDSCS**), which commenced as a research and development project but was converted into a global operational network for high volume communications in 1968 (***see Table 1, Table 2 and Table 3 on page 18***). It was originally known as the ***Initial Defense Communications Satellite Program*** (**IDCSP**). The satellites were placed in an equatorial, near-geostationary orbit at altitudes of approximately 33,800 km in which they drifted app. 30° each day. They were built by **Philco** and carried a single transponder operating in the 8/7 GHz band.

The second generation of satellites was named ***Defense Satellite Communications System*** (**DSCS**) ***II***, and featured increased capacity with two transponders operating in 8/7 GHz. The operational system consisted of four satellites located over the Atlantic Ocean at **12° W**, the Indian Ocean at **60° E**, the West Pacific Ocean at **135° W** and the East Pacific Ocean at **175° E** with an additional two satellites as in-orbit spares. The DSCS II satellites were built by **TRW** and were spin-stabilized.

The third generation was ***DSCS III*** and the 14 satellites launched between October 30, 1982, and August 29, 2003, were built by **General Electric** (and their successors). They were equipped with seven transponders which operated in the 7/8 GHz band and were also fitted with anti-jamming devices.

Milstar

Milstar satellite

The next generation of military communications satellites, designated as ***Military Strategic Tactical and Relay*** (**Milstar**), consisted of three satellites in geostationary orbit. Built by **Lockheed Martin**, the satellites were equipped with up to 32 transponders operating in the 45/21 GHz, to service mobile military terminals, 225/400 MHz and 60 GHz bands, the latter for satellite-to-satellite communications.

Initially it was planned to augment the system with three satellites in highly elliptical polar orbits as well as a number of satellites in much higher orbits as spares, but the constellation remained restricted to geostationary satellites of which five were launched. Milstar is the current primary system for the U.S. military.

WGS

Designed by **Boeing** and based on the ***Boeing 702*** satellite bus, the geostationary orbiting ***Wideband Global Satcom*** system (also referred to as ***Wideband Gapfiller System***) augmented the Defense Satellite Communication System (DSCS) III, which it will eventually replace. ***See Table 5 on Page 22.***

The 5987 kg satellites will be fitted with transponders operating in the 5-10 GHz band and the 45/21 GHz band to provide a wide range of communications capabilities to the military services by the ability of connecting users between any and all of the 18 proposed coverage areas

Name	Int.Des.	Launch	Notes
Milstar 1-1	1994 009A	7-Feb-1994	Also known as USA-99
Milstar 1-2	1995 060A	6-Nov-1995	Also known as USA-115
Milstar 2-1	1999 023A	30-Apr-1999	Also known as USA-143; failed to achieve correct orbit
Milstar 2-2	2001 009A	27-Feb-2001	Also known as USA-157
Milstar 2-3	2002 001A	16-Jan-2002	Also known as USA-164
Milstar 2-4	2003 012A	8-Apr-2003	Also known as USA-169

Table 4: Milstar launch dates

even when users are operating on different frequency bands. The capacity of the satellites will be 10 times that of the DSCS III series of satellites. The first three satellites will be ***Block I*** satellites, to be followed by three ***Block II*** satellites —the last one will be funded by Australia in exchange for access to the entire system. The Block II version will include a radio frequency bypass capability designed to support airborne intelligence, surveillance, and reconnaissance platforms with data rates of up to 311 megabits per second.

FLTSATCOM

The ***Fleet Satellite Communications System*** (**FLTSATCOM**) network provided global communications for the U.S. defense forces, but primarily for the U.S. Navy. ***See Table 6 on Page 22.***

Each satellite was equipped with a single transponder operating in the 8/7 GHz and 23 transponders in the 240/400 MHz band. Other channels included 25 KHz and 125 KHz. Ten channels were for the exclusive use of the U.S. Navy and provided mainly ship-to-ship and ship-to-shore communications. The satellites, which were three-axis stabilized, have been built by TRW. Four satellites provided a worldwide coverage except for the Polar Regions.

UHF

The ***UHF Follow-on*** series of satellites replaced the FLTSATCOM satellites. They were built by **Hughes** and the operational system consisted of nine satellites in a geostationary orbit. Each satellite carried 11 transponders operating in the UHF band. Commencing with ***UHF-4***, an EHF transponder operating at 44/20 GHz was added, offering a further 11 com-

Name	Int. Des.	Launch	Notes
WGS-1	2007 046A	11-Oct-2007	Also known as USA-195
WGS-2		2008	
WGS-3		2009	
WGS-4		2011	
WGS-5		2012	
WGS-6		2013	

Table 5: WGS launch dates

Name	Int.Des.	Launch	Notes
Fltsatcom-1	1978 016A	9-Feb-1978	Also known as Ops-6291
Fltsatcom-2	1979 038A	4-May-1979	Also known as Ops-6292
Fltsatcom-3	1980 004A	18-Jan-1980	Also known as Ops-6293
Fltsatcom-4	1980 087A	31-Oct-1980	Also known as Ops-6294
Fltsatcom-5	1981 073A	6-Aug-1981	
Fltsatcom-6	---	26-Mar-1987	Failed to orbit
Fltsatcom-7	1986 096A	5-Dec-1986	Also known as USA-20
Fltsatcom-8	1989 077A	25-Sep-1989	Also known as USA-46

Table 6: Fltsatcom launch dates

Name	Int.Des.	Launch	Notes
UHF-1	1993 015A	25-Mar-1993	Failed to achieve correct orbit
UHF-2	1993 056A	3-Sep-1993	Also known as USA-95
UHF-3	1994 035A	25-Jun-1994	Also known as USA-104
UHF-4	1995 003A	29-Jan-1995	Also known as USA-108
UHF-5	1995 027A	31-May-1995	Also known as USA-111
UHF-6	1995 057A	22-Oct-1995	Also known as USA-114
UHF-7	1996 042A	25-Jul-1996	Also known as USA-127
UHF-8	1998 016A	16-Mar-1998	Also known as USA-138
UHF-9	1998 058A	20-Oct-1998	Also known as USA-140
UHF-10	1999 063A	23-Nov-1999	Also known as USA-146
UHF-11	2003 057A	18-Dec-2003	Also known as USA-174

munications channels, while ***UHF-7*** carried two additional EHF transponders operating at 44/20 GHz offering a further 20 communications channels. ***See Table 7 above.***

AEHF

The ***Advanced Extremely High Frequency*** (**AEHF**) military communications satellite system will be a cross-linked constellation in geosynchronous orbit that will provide secure, survivable, and protected communications systems for the U.S. military.

To be built by **Lockheed Martin**, using the ***A2100*** spacecraft bus, the system will replace the ***Milstar 2*** communications system. The satellites will deliver a 10 times total capacity and channel data rates six times higher than that of Milstar 2. The design includes a sophisticated payload and phased array antennas as well as an electric propulsion system. The first launch is scheduled for 2009. Initially it was planned to have six satellites but that was reduced to three in 2004. The option to launch a further two satellites remains open.

Syncom IV

For some time, the U.S. Navy leased a series of communications satellites from **Hughes**. Designated ***Leasat***, or ***Syncom IV***, the satellites were equipped with eight transponders that operated in the 240/400 MHz band and one transponder in the 7/8 GHz band. ***See Table 8 on Page 23.***

Name	Int.Des.	Launch	Notes
Syncom IV-1	1984 113C	10-Nov-1984	
Syncom IV-2	1984 093C	31-Aug-1984	
Syncom IV-3	1985 028C	13-Apr-1985	
Syncom IV-4	1985 076D	29-Aug-1985	Failed to achieve correct orbit
Syncom IV-5	1990 002B	9-Jan-1990	

Table 8: Syncom IV launch dates

Name	Int.Des.	Launch	Notes
SDS-1	1976 050A	2-Jun-1976	Also known as Ops-7837
SDS-2	1976 080A	6-Aug-1976	Also known as Ops-7940
SDS-3	1978 075A	5-Aug-1978	Also known as Ops-7310
SDS-4	1981 038A	24-Apr-1981	Also known as Ops-7225
SDS-5	1983 078A	31-Jul-1983	Also known as Ops-7304
SDS-6	1985 014A	8-Feb-1985	Also known as USA-9
SDS-7	1987 015A	12-Feb-1987	Also known as USA-21
SDS 2-1	1996 038A	3-Jul-1996	Also known as USA-125
SDS 2-2	2000 080A	6-Dec-2000	Also known as USA-155 and Great Bear
SDS 2-3	2001 046A	11-Oct-2001	Also known as USA-162 and Aquila
SDS 3-1	1998 005A	29-Jan-1998	Also known as USA-137 and Capricorn
SDS 3-2	2004 034A	31-Aug-2004	Also known as USA-179, NROL-1 and Nemesis
SDS 3-3	2007 060A	10-Dec-2007	Also known as NROL-24, Scorpius and USA-198

Name	Int.Des.	Launch	Notes
NATO-1	1970 021A	20-Mar-1970	
NATO-2	1971 009A	3-Feb-1971	
NATO-3A	1976 035A	22-Apr-1976	
NATO-3B	1977 005A	28-Jan-1977	
NATO-3C	1978 106A	19-Nov-1978	
NATO-3D	1984 115A	14-Nov-1984	
NATO-4A	1991 001A	8-Jan-1991	
NATO-4B	1993 076A	8-Dec-1993	Also known as USA-98

Table 10: NATO launch dates

SDS

The ***Satellite Data Systems*** series of satellites, which evolved from the ***Code 313*** and then the ***Data Relay Satellite System,*** were initially built by **Hughes** and were used for communications by the strategic forces in the UHF frequencies. In particular they were used to transmit images from surveillance satellites.

They were placed in highly elliptical orbits with an inclination of 63° to cover the polar regions which cannot be adequately covered by geostationary satellites. Three separate generations of SDS satellites have been identified.

Name	Int.Des.	Launch	Notes
Skynet-1	1969 101A	22-Nov-1969	
Skynet-2	1970 062A	19-Aug-1970	Failed to achieve correct orbit
Skynet-2A	1974 002A	19-Jan-1974	Failed to achieve correct orbit
Skynet-2B	1974 094A	23-Nov-1974	
Skynet-3	---	---	Cancelled
Skynet-4A	1990 001A	1-Jan-1990	
Skynet-4B	1988 109A	11-Dec-1988	
Skynet-4C	1990 079A	30-Aug-1990	
Skynet-4D	1998 002A	10-Jan-1998	
Skynet-4E	1999 009B	26-Feb-1999	
Skynet-4F	2001 005B	7-Feb-2001	
Skynet-5A	2007 007A	11-Mar-2007	
Skynet-5B	2007 056B	14-Nov-2007	
Skynet-5C	2008 030B	12-Jun-2008	

Table 11: Skynet launch dates

United Kingdom: Skynet

The United Kingdom, through its military commitments overseas, undertook early development of a military communications satellite system under the designation of ***Skynet***. By means of a satellite stationed over the Indian Ocean, reliable communications were possible between the United Kingdom and military establishments in Western Europe, the Middle East and the Far East, as well as ship-based terminals. ***Skynet-1*** and ***-2***, which were built by **Philco-Ford** were spin-stabilized, and equipped with one transponder operating in the 8/7 GHz bands.

Skynet-2A and ***-2B*** were built by **Marconi**, were also spin-stabilized, and had one transponder operating in the 8/7 GHz band. The ***Skynet-3*** series was a mid-seventies proposal that was cancelled due to the reduction of the overseas military activities of the United Kingdom. The fourth generation of Skynet satellites operated within a NATO framework and consisted of six separate satellites. The satellites, built by **British Aerospace,** carried three transponders in the 8/7 GHz band and two transponders in the 310/255 MHz band.

The ***Skynet-5*** series were a 4725 kg military communications satellite fitted with 9 UHF and 15 SHF transponders as well as anti-jamming capabilities. They were built by **EADS Astrium** using the ***Eurostar 3000*** platform. The satellites are owned and operated by **Paradigm Secure Communications** on a lease to the military.

North Atlantic Treaty Organization (NATO)

To provide a communications network between **NATO** headquarters in Belgium and the various capitals of the member nations, as well as the NATO command centers on land and at sea, a satellite system was brought into operation in 1970.

The satellites of the first generation, ***NATO-1*** and ***-2***, each carried two transponders operating in the 375/400 MHz bands. They were built by **Philco-Ford**, and were spin-stabilized. They provided voice, wide-band, telegraph and facsimile services and were designed to be compatible with the United States' ***IDCSP*** and the British ***Skynet*** satellite systems, except that the antennas had been optimized for operation in the Northern Hemisphere only. Separate channels were provided for communications with fixed ground stations with large antennas or ship-borne receivers with small antennas. The second generation of satellites (***NATO-3*** series) were more powerful versions, and the three transponders operated in the 8/7 GHz band. The ***NATO-4*** generation was based on the Skynet-4 satellite and carried three transponders that operated in the 8/7 GHz band and two transponders in the 1470/1530 MHz band.

Experimental Satellites

In addition to the operational systems described above, the U.S. military services have been responsible for several experimental communications satellites designed to test new technologies.

The ***Global Low Orbiting Message Relay Satellite*** (**Glomar**) was launched on October 30, 1985, to demonstrate the feasibility of a small satellite to send on/off commands to small sensors on the ground, record the data transmitted from these sensors and dump such data, on command, to a ground station.

The Glomar satellite, launched on April 5, 1990, was an experimental communications satellite for the U.S. Navy—two ***Multiple Access Communications*** (**Macsat**) satellites, launched on May 9, 1990, were experimental satellites for the Defense Research Agency, **DARPA**. The seven ***Microsat*** satellites, which were launched on July 17, 1991, were also for experimental military communications of a store-dump nature.

Cancelled Proposals

The designation ***AFSATCOM*** was originally used for a proposed series of satellites optimized for use by the U.S. Air Force. The satellites never materialized as the requirements were met by other transponders carried on DSCS, FLTSATCOM and SDS satellites. Other systems that did not materialize included; the ***Strategic Polar Communications Satellite System***, to consist of four satellite in polar orbit; the ***Advanced Polar Communications Satellite*** (carrying codename ***Tackle***); and the ***Decree*** system, a code name for the ***Global Communications Satellite for Instantaneous Message Relay***. MSM

About the author

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

by Lieutenant General Kevin T. Campbell
Commanding General
SMDC/ARSTRAT

Army Aviation can trace its roots back to September 1908 when Orville Wright conducted a test flight of the Wright Flyer at Fort Myers, Virginia. The Wright Flyer reportedly flew about 100 feet in the air and stayed aloft for less than two minutes. A year later, the Army purchased its first airplane and Army Aviation was born.

The Army looked at the Wright Flyer 99 years ago and envisioned capabilities and possibilities. In similar fashion, the **U.S. Army Space and Missile Defense Command/Army Forces Strategic Command** looks at space and sees capabilities and possibilities to support warfighters, and we look at missile defense and see an integrated global system.

Today, **SMDC/ARSTRAT** is experimenting with our own version of "flyers" that can reach altitudes greater than 60,000 feet and stay aloft for several days, providing warfighters with enhanced capabilities. High altitude flyers are but one of many space and missile defense capabilities that SMDC/ARSTRAT is working on to support the warfighter.

SMDC/ARSTRAT is the Army proponent for space, high altitude, and ground-based midcourse defense (GMD), that develops, transitions technology, and provides acquisition support to assigned fields. We are uniquely organized to develop the technologies necessary in each of those areas and to deliver those capabilities to the Army and to the nation.

One example of space-based capability that I believe will have significant impact is the ***Wideband Global SATCOM*** (**WGS**) satellite. WGS increases communications capability by tenfold over existing satellites. The system helps close one of the largest capability

gaps identified: limited high-throughput, protected military satellite communications. WGS is a collaborative effort between the Army, Air Force, and industry.

The first WGS satellite was launched October 2007 and became operational earlier this year. The satellite is "piloted" by the Air Force and SMDC/ARSTRAT Soldiers control its onboard communications capabilities.

Another area with great potential is small satellites. We have an initiative underway to determine if low-cost small satellites will satisfy warfighter needs for Beyond-Line-of-Sight communications as well as other capabilities. One of the objectives of the SMDC/ARSTRAT initiative is to demonstrate and validate that a level of persistence over a specific region for a specific purpose is feasible using small-satellite formations.

A key aspect of space-based capabilities is the professionals working in the arena. ***Army Space Operations*** professionals are the space experts who integrate space-based capabilities at the tactical and operational levels of command. They also ensure Army space requirements are understood and addressed in decision and developmental locations within and outside the Army at locations such as the **National Security Space Office**, the **Air Force Space and Missile Center**, the **National Reconnaissance Office** as well as working to expand our presence inside **Air Force Space Command**.

As critical as our space role is, of equal importance is our continuing development and fielding of global integrated missile defense capabilities. To see first, decide first, and act first when responding to a missile threat requires a global focus — regional missile defenses operating alone are no longer adequate.

The evolution of an integrated ***command and control, battle management communications*** (**C2BMC**) architecture for integrated missile defense and its ability to contribute to situational awareness will be of critical importance to the warfighter.

Enhanced real-time command and control through net-centric interoperability of sensor, C2BMC, and "shooter" systems will increase the effectiveness of air, space, and missile defense systems. These enhancements will promote mobile, modular, mission tailored forces, integrated fire control; and joint systems interoperability — all distinct attributes of our transforming Army.

Our missile defense SMDC/ARSTRAT Soldiers are deployed around the world supporting the missile defense mission and stand ready to protect our nation and our allies from a missile attack. I continue to be very proud of our soldiers and civilians who deploy into harms way. SMDC/ARSTRAT Soldiers have deployed in support of ***Operations Enduring Freedom*** and ***Iraqi Freedom*** since the beginning of combat operations. I am also proud of the soldiers, civilians and contractors who work tirelessly behind the scenes researching, developing, and acquiring the space and missile defense systems needed to maintain our dominance in space and our dominance on the ground. MSM

About the author

Lieutenant General Kevin T. Campbell graduated from Worcester State College in 1973 with a bachelor's of science degree. He received his commission into the Air Defense Artillery branch that same year. In 1982, he earned a master's degree in personnel management from the University of New Hampshire. His military education includes the Air Defense Artillery Officer Basic and Advanced Courses, the Nike-Hercules Officer Course, Ranger and Airborne Schools, the Army Command and General Staff College, and the Naval War College.

General Campbell's previous assignments include: Chief of Staff, United States Strategic Command, Offutt Air Force Base, Neb.; Director of Plans, United States Space Command; Deputy Commanding General, United States Army Air Defense Artillery Center and Fort Bliss, Texas; Commanding General, 32nd Army Air and Missile Defense Command (AAMDC), Fort Bliss, Texas; Assistant Deputy Chief of Staff for Combat Developments, United States Army Training and Doctrine Command, Fort Monroe, Va.; Commander, 94th Air Defense Artillery Brigade, Darmstadt, Germany; Political-Military Planner (Eastern Europe/ Bosnia), J5, the Joint Staff, Washington, D.C.; G3, 32nd AADCOM, Darmstadt, Germany; Commander, 2nd Battalion (PATRIOT), 43rd Air Defense Artillery, Hanau, Germany; Executive Officer, 3rd Battalion (PATRIOT), 43rd Air Defense Artillery, Fort Bliss, Texas; Chief, Unit Training Division, Directorate of Training and Doctrine, Fort Bliss, Texas; ROTC Instructor, University of New Hampshire; Adjutant, 1st Battalion (HAWK), 2nd Air Defense Artillery, Korea; Assistant Operations Officer, 38th Air Defense Artillery Brigade, Korea; Commander, Nike Hercules Battery, Homestead, Fla., and Fort Bliss, Texas; and Artillery Team Commander, Datteln, Germany.

General Campbell's decorations and awards include the Defense Superior Service Medal (with Oak Leaf Cluster), Legion of Merit (with Oak Leaf Cluster), Bronze Star, Defense Meritorious Service Medal, Meritorious Service Medal (with two Oak Leaf Clusters), Army Commendation Medal (with two Oak Leaf Clusters), Army Achievement Medal (with two Oak Leaf Clusters), Southwest Asia Service Medal (with three Bronze Stars), Kuwait Liberation Medal, Ranger Tab, and Parachutist Badge.

About SMDC/ARSTRAT

"Securing the high ground starts at SMDC/ARSTRAT." The command's objective is to provide dominant space and missile defense capabilities for the Army and to plan for and integrate those capabilities in support of U.S. Strategic Command (USSTRATCOM) and Geographic Combatant Commanders (GCC) missions.

***Mission*: SMDC/ARSTRAT conducts space and missile defense operations and provides planning, integration, control and coordination of Army forces and capabilities in support of US Strategic Command missions; serves as the Army specified proponent for space, high altitude, and ground-based midcourse defense; serves as the Army operational integrator for global missile defense; and conducts mission-related research and development in support of Army Title 10 responsibilities and serves as the focal point for desired characteristics and capabilities in support of USSTRATCOM missions.**

Since 1957, when the Army created the first program office for ballistic missile defense, the command has dedicated itself to missile defense research, development and deployment. In December 1962, the command made history with the first successful intercept of an ICBM reentry vehicle with the Nike-Zeus. History was repeated in the 1980s with a new non-nuclear technology. The kinetic energy concept of "hitting a bullet with a bullet" was first proven in June 1984 with the intercept of an ICBM warhead in the Homing Overlay Experiment.

In 1987, the Flexible Lightweight Agile Guided Experiment confirmed the concept against shorter-range tactical missiles. Nearly a decade later, the command demonstrated the missile defense applications of directed energy systems. In February 1996, the Mid Infrared Advanced Chemical Laser destroyed a short-range rocket in flight.

MilSatCom Offers Attendees Solutions

by Pattie Lesser

Cheery London is the setting for the upcoming Global MilSatCom Conference and Expositiion. Global MilSatCom 2008 certainly occurs at a perfect time, considering the current global situations. This will be a gathering of the best, for the best, from November 3rd through 5th at the *Millennium Conference Centre*, London, United Kingdom.

This is the tenth anniversary of the event wherein those involved with the European hub for Military Satellite Communications gather and discuss national developments, international cooperation, and current operational challenges.

Attendees will learn how to enhance current communication capabilities and what is required to maintain battle dominance. By experiencing key presentations, you will acquire the solutions information to match your organization's needs. Also addressed will be ***Understanding Ku and Ka Band SATCOM-on-the-Move Antenna Systems***.

- Analyze the latest national programs from Europe, the U.S., Australia, and the United Arab Emirates
- Directly engage with decision makers and industry leaders from 20 countries worldwide
- Hear about the latest technological advances from industry leaders and benchmark them against military operational experiences
- Understand future technologies and how they are going to impact upon current operations
- Gain insight into policy frameworks and procurements strategies
- Learn about Satcom on the Move and Satcom on the Halt

Key speakers at this global conference include:

- Rear Admiral *Victor C. See*, Jr., USN Commander, Space and Naval Warfare Systems Command, Space Field Activity (SPAWAR) and Director, Communications Systems Acquisition and Operations Directorate (COMM), **National Reconnaissance Officer** (NRO) and Program Executive Officer (PEO) Space System, **Department Of The Navy**
- Lieutenant General *Pietro Finocchio*, General Director, General Directorate for Telecommunications, IT and Advanced Technologies, **Ministry of Defence, Italy**
- *Malcolm Green*, Chief, CAT 9 Communication Infrastructure Services, **NATO C3 Agency**
- Brigadier General *Ian Fordred*, Director, Information Communication Technology(DICT) in the Command and Management Information Systems Division (CMIS), **South African National Defence Force** (SANDF)
- Commodore *Eric Fraser* RN, Assistant Chief of Staff J6, **U.K. Permanent Joint Headquarters**
- Colonel *Patrick H. Rayermann*, Chief, Communications Functional Integration Office, **National Security Space Office**, Pentagon

- Colonel *Robert Champagne*, Head of CIS Branch, Canada Operational Support Command (CANOSCOM), **Department of Defence**, **Canada**
- *Peter Kerr*, Head, Satellite Communications Discipline, C3I Division, **Defence Science and Technology Organisation (DSTO)**, **Australia**
- Lieutenant Colonel *Flemming Agerskov*, Head, CIS Branch, **Army Operational Command, Denmark**
- *Michael Pascaud*, Syracuse III Program Manager, DGA, **Ministry of Defence**, **France**
- Commander *Alexandre Baillot*, Military & Civil SatCom Leader, Space & Joint SystemsDivision, **French Joint Staff**
- Major Dr. Eng. *Mohamed N. Mubarek Alahbabi*, Information Communication Technology (ICT) Advisor, **General Headquarters, United Arab Emirates**
- Armed Forces Commander *Chris Cheesman* RN, Capability Team Leader, DEC CCII, **Ministry of Defence**, U.K.
- Dr. *Oystein Olsen*, Principal Scientist, Communication Information Technology Systems, **Norwegian Defence Research Establishment**

As is the case with most conferences and expositions, there are a number of sponsorship and exhibition opportunities. **SMi Conferences,** who organizes ***MilSatCom***, offers a wide range of opportunities to promote a company's products and services at nearly 200 events every year. Here are some of the most popular options, all flexible and able to be tailored to meet any firm's show objectives.

Exhibition Stand

- Stand Space for two days at the conference
- Presence on SMi's website: company logo, profile and a live link to your website
- Promotional presence: your company's name, profile and logo to feature in the conference brochure and/or mentioned in other marketing material across a number of mediums

Drinks Reception

- One and a half hour Drinks Reception
- Full waitress service
- Wine, soft drinks and canapés
- Two additional personnel allowing increased networking opportunities
- Stand space
- Presence on SMi's website: company logo, profile and a live link to your website
- Promotional presence: your company's name, profile and logo to feature in the conference brochure and/or mentioned in other marketing material across a number of mediums.

Conference Luncheon

An efficient way to target key players is to host an SMi conference luncheon. This provides sponsors with an opportunity to relax and discuss business in an elegant yet formal environment.

- Presence on SMi's website: company logo, profile and live link to your website
- Promotional presence: your company's name, profile and logo to feature in the conference brochure and/or mentioned in other marketing material across a number of mediums, including promotional banners and a printed menu with company logo and profile.

Branding Package

- Literature distribution at the conference
- Presence on SMi's website: company logo, profile and link to website
- Promotional presence: your company's name, profile and logo featured in the conference brochure and/or mentioned in other marketing material across a number of mediums, including prominent position in the Delegate/ Speaker Pack and accompanying CD-ROM

CD-ROM Sponsorship

The package includes the following:

- Flash design opening sequence, tailored specifically to your company
- 150 word Company Synopsis including your logo on both the inlay card and included within the contents of the CD Rom
- Hyperlink to your company's website
- Logo on front cover of CD Rom packaging
- Logo on CD Rom label
- Watermark logo on conference menu screen
- Option to include a letter to be dispatched with all CDs to all Conference attendees

For additional details regarding registration, accomodations, travel and more, select the Global MilSatCom advertisement below... join those who will be "in the know" at this outstanding, global event.

MSM

An Ideal Middle Ground Between Commercial Outsourcing and Internal Asset Deployment

by Jose del Rosario
Senior Analyst and Regional Director
Asia-Pacific, NSR

The military business, specifically the U.S. Military, has been a stable and growing vertical market over at least the past seven years. Satellite operators have spun-off government entities to serve military and government customers more efficiently, and these divisions account for a growing revenue stream with little sign of slowing down.

Increased military bandwidth requirements over the long term lead to a question of deploying more satellite capacity in order to support a relatively stable business, yet satellite operators have not taken risks even when the Pentagon has indicated that it cannot be self-reliant until at least the year 2020. The move is understandable given that longer term military contracts are hard to come by, unlike the video markets where transponder capacity is signed over the long term.

On the military side, a seemingly growing bandwidth crunch has led to plans to increase deployment of proprietary satellite assets, which cost in the $billions. Programs such as Wideband Global Satcom (WGS), Advanced Extremely High Frequency (AEHF) and the Transformational Satellite Communications System (TSAT) have been slated as budget line items to specifically address the growing bandwidth needs of the U.S. Military. However, budget processes are oftentimes arduous and protracted in justifying procurement of such assets, particularly during times when governments are faced with other seemingly more pressing issues such as financial bailouts in order to restore the health of one's economy, if not the entire global financial system.

Consequences of budget processes inherent in government procurement lead to delays of programs, reduction of the original capability of programs, or the outright cancellation of such programs. However, as requirements for war fighting that inherently incorporate next-generation systems like ***communications-on-the-move*** (**COTM**) capabilities need to become more integrated in a defense network umbrella, delays, cutbacks or cancellations impede or even handicap a nation's ability to project power.

An idea that has been regularly discussed in light of budget considerations is to host a government or military payload on a commercial satellite. Dual-use programs for use by both commercial and government clients have actually been in existence and have worked quite well for other governments like Australia and South Korea. Will hosted payloads or dual-use satellite systems work just as well for the U.S. Military, the largest government entity that uses commercial satellite bandwidth?

The Case for Commercial Outsourcing

Reliance on commercial satellite assets is now a foregone conclusion and will remain a key component of U.S. and international government/military strategies for the foreseeable future. Commercial satellite operators, specifically **Intelsat** and **SES Global**, have accounted for some 80 percent of U.S. Military leases and their government arms, **Intelsat General** (IGen) and **SES AMERICOM Government Services** (AGS), respectively, see continued growth in both transponder uptake and revenue streams for managed services over the near term.

But, as mentioned above, even with admission from the Pentagon that a bandwidth gap exists and is likely growing, Intelsat and SES have not disclosed plans to launch capacity covering some of the globe's hotspots such as Iraq and Afghanistan. Once again, government procurement as seen historically is unlike video customers that sign leases over the long term.

Interviews by **NSR** with both operators point to the fact that the U.S. Government seems to be more open to a closer partnership. Whether these discussions lead to long term leases or perhaps even to joint efforts to launch satellites with hosted payloads will depend on contract vehicles over the next few years.

In other developments, **XTAR**, a private entity and a program that carries X-band transponders, is being used by governments exclusively. The fixed and steerable beams on two payloads support military, diplomatic and security communications requirements. X-band capacity on XTAR has been available since 2005, and it was awarded a contract by the **U.S. Department of State**'s ***Diplomatic Telecommunications Service Program Office*** (**DTS-PO**) to provide X-band communications services to embassies and consulates in Africa and Asia. However, the U.S. Military has not taken up capacity as quickly as many expected. But in October 2007, XTAR received a contract from the **U.S. General Services Administration**, where an unlimited spending ceiling may be used by any federal, state or local agency to acquire XTAR's X-band bandwidth and services.

Militaries and civil government agencies have outsourced bandwidth requirements on traditional commercial C- and Ku-band transponders, as well as X-band, that fall under the exclusive use of non-commercial customers. In the future, commercial Ka-band transponders are expected to be used more extensively by government customers as well.

The growth of commercially outsourced bandwidth has been steady since 2003 for both U.S. and non-U.S. government users. As applications and communications requirements grow over time, commercially outsourced bandwidth should continue on a positive growth track as well. But by far, the largest user of commercial bandwidth has been the U.S. Military and although commercial assets have been available for their use, control of these assets as well as security requirements may not be at the level that the U.S. Military may be used to.

And therein lies one of the challenges on being too reliant on commercial capacity. Coupled with the costs and budget considerations in deploying proprietary assets, the case for dual-use or hosted payload solutions become more compelling as an option for the U.S. Military.

Hosted Payloads and Dual-Use Systems

In 2003, the **Optus** and **Defense C1** satellite was launched, carrying a mixed payload that now serves the needs of **Singtel Optus Pty. Limited** and the **Australian Department of Defense**. The satellite operates in four frequency bands:

- Commercial services in Ku-band for Singtel Optus
- Military communications at UHF, X-band and Ka-band for the Australian Department of Defense.

Optus uses C1's Ku-band payload to distribute video, DTH, telephony and Internet connections to remote areas. For the Australian Department of Defense, the satellite's Ka-band payload provides high-data rate broadcast coverage for video, voice and data communications. The satellite's X-band provides medium-to-high data rate voice and data for land and maritime applications. And finally, the UHF payload provides secure low-rate voice and data communications to mobile platforms.

In South Korea, the nation launched its first civil-military dual-use communication satellite in August 2006, a move that introduced cutting-edge warfare systems in its overall capability. The dual-use satellite carries 12 military relay terminals and 24 commercial terminals, whereby the 12 military relays are capable of covering troop communications from the Malacca Strait to the Central Pacific sea areas. Prior to the satellite's launch, the South Korean military relied on ground-based communication systems; however, the system using underground military cables or microwave relay towers was vulnerable to enemy attack. The dual-use satellite system has been successful thus far such that South Korea plans to deploy a total of 20 satellites, including eight multipurpose satellites, by 2015.

One of the key benefits of dual use systems include reduced costs compared to internal asset build-up. A case in point is the recent budget challenges faced by the U.S. Military's ***TSAT*** program, which took a serious hit in FY2009. This will have a dramatic impact on U.S. Military capabilities as the bandwidth the U.S. had planned on owning internally will be drastically reduced within the time frame set forth in the original schedule of the program. Dual-use systems or hosted payloads that also draw on commercial customers cost a fraction of proprietary assets. Even with payload and bus enhancements, where the costs of which are shared with the commercial operator or partner, the total price tag is far below deploying and owning a proprietary military system.

The other benefit of dual use or hosted payloads is the speed by which assets are deployed. Even if TSAT were to be deployed based on the original scope of five satellites, the delays that are now expected to take place, where first launch has been moved from 2013 to 2016 at the earliest, means that bandwidth planning and systems capability will have to likewise be delayed. Barring other available alternatives, commercial outsourcing will once again have to take up the slack.

These considerations appear to be in full view of the U.S. Military's system planners. In July 2008, **AGS** announced that it was awarded a contract by the U.S. Air Force to host an experimental sensor on board a commercial spacecraft. The three-year $65 million firm fixed price contract will host the experimental sensor on board an SES AMERICOM spacecraft scheduled to be launched in 2010 and will operate over the United States. The program, known as the C***ommercially Hosted Infrared Payload*** (**CHIRP**) ***Flight Demonstration Program,*** will have the primary purpose of testing a new type of infrared sensor from geo-synchronous altitude. The passive infrared sensor will be integrated onto a commercial satellite so that it can be launched into orbit, and the data can then be transmitted to the ground for analysis.

Although the CHIRP program is for experimental purposes only and also not designed to address the communications mission and bandwidth shortfall faced by the U.S. Military, one cannot help but ponder whether the next line of contracts coming from the U.S. Government will be for dual use satellites similar to the Australia and South Korean models or for hosted payloads.

The impetus is there, having granted a contract to SES and discussions are more prevalent from both the military side as well as the commercial operator side. For the military, cost and speed provide compelling arguments to deploy a dual-use or hosted payload satellite system. For commercial satellite operators, cost-sharing, long-term contracting and an anchored tenant provide invaluable benefits in a business that is inherently risky given the 15-year life of the asset.

Conclusion

In 2008, Pentagon leaders disclosed that non-traditional conflicts such as the insurgents and terrorists facing coalition forces in Iraq and Afghanistan will be the main military battlefields for years to come. The classified Pentagon assessment likewise concluded that the U.S. Military in many respects including its bandwidth resources is prevented from improving its ability to respond to any new crisis such as potential outbreaks in North Korea, Iran, Lebanon, or China.

Hosted payloads provide a vehicle by which cost savings and speed of deployment are met. Faced with the current economic environment and the limited ability of the U.S. Government to allocate funds for next-generation space programs, hosted payloads may be the answer in addressing urgent requirements in order to maintain and even improve its war fighting capability in terms of fully developing "Netcentricity."

NSR understands that militaries around the globe in general and the U.S. Military in particular prefer to own and control its own communications assets for security and reliability. However, given the budget challenges and scheduling requirements, commercial outsourcing coupled with hosted payloads or dual use satellite programs may be the bitter pill the military has to take in order fulfill its missions and enhance its capabilities in the next decade. MSM

About the author

Mr. del Rosario covers the Asia Pacific region and is a senior member of the consulting team where he focuses

his research on quantitative modeling, data verification, and market forecasting for the wireless industry and satellite communications sector. He conducts ongoing research with specialization in policy analysis, regional economic indicators, regulatory initiatives and end user demand trends.

In addition to authoring numerous syndicated reports in his areas of focus, Mr. del Rosario has been involved in a wide range of strategic consulting projects. He has advised clients on market trends, implications, and strategies on such diverse topics as WiMAX, mobile communications, mobile video, 3G offerings, terrestrial microwave services, IPTV, IP telephony, multi-mission satellite programs, launch vehicles, broadband equipment and services, Internet trunking, and Enhanced IP Services.

Prior to joining NSR, Mr. del Rosario worked with Frost & Sullivan as Program Leader of the Mobile Communications Group, as Senior Analyst & Program Leader of the Satellite Communications Group, and most recently as Country Manager for the Philippines. Prior to that, he was the Public Affairs Officer of the European Commission's Delegation in the Philippines, co-managing the Commission's programs on economic cooperation and development assistance. He also performed economic and political risk assessment of the Philippines and ASEAN, for use by Delegation officials in the Philippines and in the Commission's headquarters in Brussels. Jose also worked as a congressional aide for the Malaysian Embassy and as a telecommunications legal researcher for Irwin & Lesse in Washington, D.C.

Mr. del Rosario holds a Master of Arts degree in Applied Economics from The American University, and a Bachelor of Science degree in Political Science/International Relations from the University of Santa Clara.

Can the U.S. Government Leverage the Benefits?

by Chris Hoeber, Senior Vice President
Program Management and System Engineering
Space Systems/Loral

As the U.S. Government (USG) comes under increasing pressure to contain costs for all types of space programs, the question of whether or not commercial providers can meet the needs of government programs has taken on new relevance. This is particularly true in the case of satellite communications, where the demand for capacity has continually outstripped the supply. By the time a new program launches its capacity is often already insufficient. This, along with typical schedule delays, necessitates gapfiller programs and reliance on commercial infrastructure for much of the communications demand. Gapfillers, decade-long programs, and multi-billion dollar cost growth for major system developments dramatically drive up the cost of USG communications while never fully meeting the demand. In contrast, commercial satellite operators develop, test and launch multiple satellites per year with ever increasing capabilities.

The status quo and high costs are sometimes rationalized based on the critical quality and reliability requirements of USG space programs. However, commercial communications satellite programs routinely produce and field systems with equally high quality and reliability in two to three years and at 20-30 percent of the cost. These programs are executed on a fixed price basis and are incentivized for on-time delivery and on-orbit performance and reliability. The design, manufacturing, testing and quality practices of these programs are equivalent to those of their government program counterparts and the government already relies, successfully, on such commercial satellites to cover its communications capacity shortfall.

While there is a core capacity that requires levels of survivability, radiation hardness and interference protection not routinely provided by commercial systems, a large percentage of the demand for USG spacecraft could be filled by taking advantage of commercially available capabilities. It is encouraging that more and more government organizations are beginning to take a closer look and are discovering that fixed-price, commercial-like procurements may well be a viable option.

Characterizing Commercial Programs

Commercial satellite programs have provided some of the world's largest, highest-power, and longest-life spacecraft. These spacecraft are an indispensable part of the world's communications infrastructure, and actually serve approximately 80 percent of the USG's communications needs today. Most commercial communications satellites perform functions that are critical to the success of their operators' business plans and are designed with very high reliability and for long on-orbit life. Typical commercial satellites provide greater than 0.9999 availability, ensuring continuity of service to the operators' customers. For a direct broadcast operator, losing the signal during the Super Bowl could be disastrous to its business.

Commercial satellites are no longer limited to a few frequency bands and simple C- and Ku-band "bent-pipe" payloads. Today, manufacturers such as **Space Systems/Loral** (**SS/L**) are providing very complex satellites with 20-kW power capability, steerable spot beams, 18-meter unfurlable antenna reflectors, Ka-, X-, S-, L- and UHF-band payloads, nearly 100 Gbps communications throughput, and ground-based beam forming.

Product Focus vs. Process Focus

Typical commercial satellite manufacturers are able to complete three to eight spacecraft or more per year with a product-line approach that uses heritage building blocks that can be configured to meet the satellite operators' needs. Every satellite follows a disciplined process which is the same for each program. The details of this process vary from manufacturer to manufacturer, but the key to reliability is repetition, which allows the manufacturer to learn from missteps and make continuous process improvements.

Technology advances are developed in advance of the programs and incrementally inserted into the time-tested subsystems. This evolutionary process enables commercial operators to keep pace with innovation over time with far less risk than programs where multiple systems require simultaneous development.

When payload requirements demand developments, these are implemented with technologies that permit qualification within the commercial program time-frame. By focusing on a satellite's performance requirements and on the shortest path to a product solution, commercial operators can leverage the efficiency of existing capabilities and processes to meet a broad range of customer needs.

Think of buying an extremely powerful and reliable luxury car. You wouldn't go to Rolls Royce or Mercedes Benz and say, this is how I want you to build my car. You would trust that the company has its own rigorous processes to deliver the automobile that meets your requirements. You would trust that an automobile manufacturer knows more about how to design and assemble your Lexus than you do

In the same way, commercial satellite manufacturers have established robust processes, testing, and mission assurance requirements that are repeated for every satellite program independent of the customer's identity. Because these known processes are repeated on multiple programs with many years of on-orbit operational experience, they have been refined for maximum efficiency and designed to uncover issues early. Many lessons learned are applied to every procurement, and problems, when they occur, do not continue to show up on later programs. As operators insure their satellites, the insurance rates depend on the proven and consistent reliability of each manufacturer's satellites. Operators are not reluctant to switch satellite providers and manufacturers are driven by the attitude that "You're only as good as your latest spacecraft."

This is in direct contrast to the unique Mission Assurance Requirements (MAR) for each government agency. These requirements can even differ from program to program within the same agency thereby eliminating of repeated processes. Historically, when

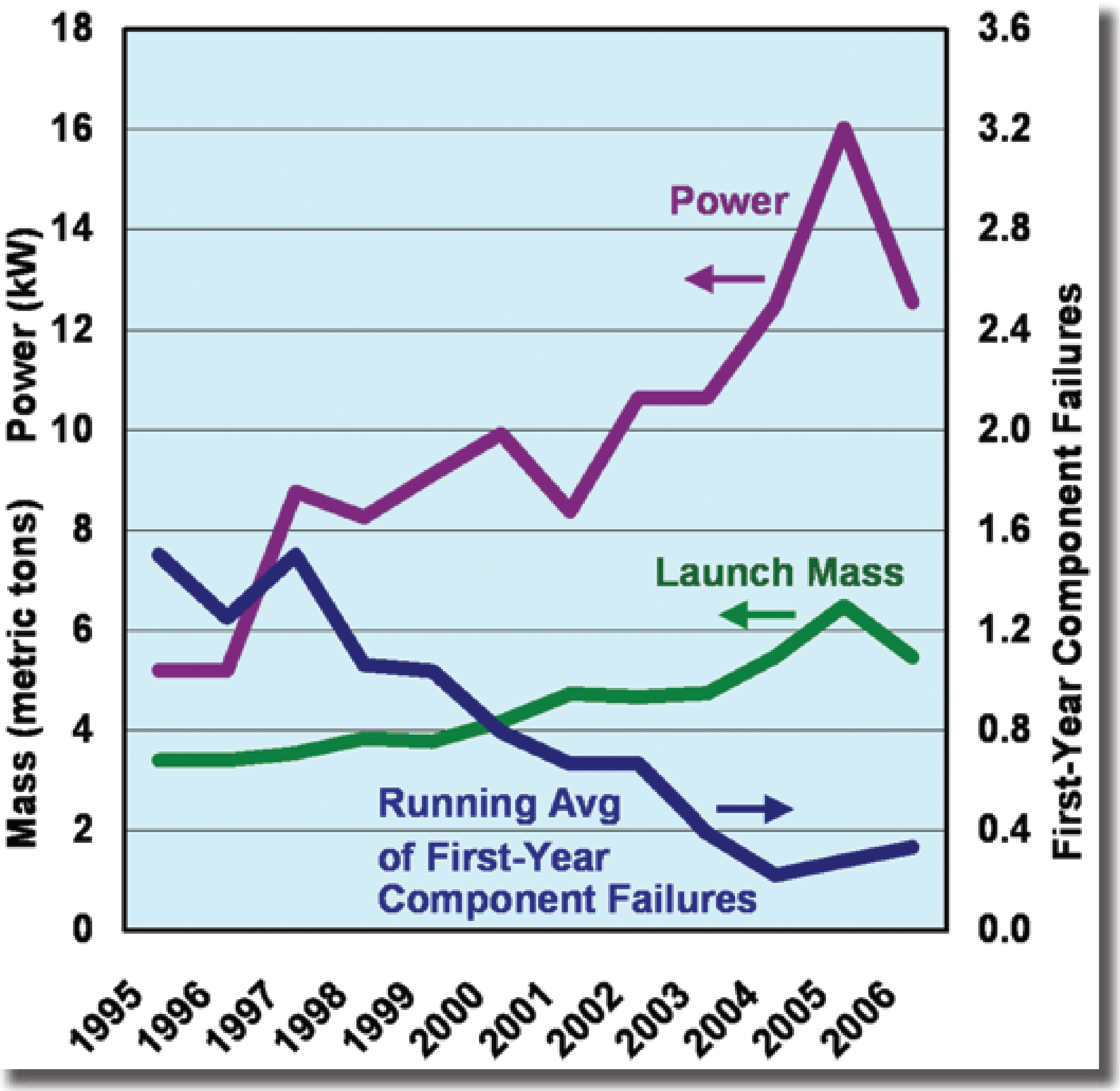


Figure A

Space Systems/Loral Satellites Have Had Decreasing First Year Component Failures as Size and Complexity have Increased. Note that component failures seldom directly impact satellite operation due to redundancies.

the USG contracts with a satellite manufacturer, it is purchasing a development process as much as it is buying a product. But the customized MARs might not add significant value. Analyses of SS/L's mission assurance and design standards, derived and evolved from the old MIL standards, shows that they are as stringent as new MARs being developed by government organizations, and in some aspects more so. However because they are uniformly and routinely applied, they do not impact cost or schedule.

As a satellite program is executed, sometimes the ultimate goal for the satellite and the way it will be used seems to become secondary in importance to the very specific processes, procedures and tools demanded by USG programs The unique requirements of each USG procurement mean that the manufacturer is in many cases "reinventing the wheel" and not benefiting from previous experience. Because manufacturers are reimbursed for hours billed, there is little motivation on the manufacturers' side to improve the efficiency of this process and there is less opportunity to incorporate lessons learned or to benefit from previously designed systems.

Recently, this practice is being reexamined. In an effort known as ***Operationally Responsive Space*** (**ORS**), the U.S. Air Force is studying ways that it can streamline the process for ordering both LEO and GEO satellites as well as meeting urgent short term needs using microsatellites, existing on-orbit satellites, hosted payloads and a variety of alternative approaches. The U.S. Department of Defense commitment to improving the nation's ability to more affordably and quickly acquire and employ space capabilities makes it certain that commercial processes will be examined.

Security

For most government satellite procurements, security is extremely important and when satellite features are mission-revealing, protection measures can impact the speed and cost of program execution. But most commercial manufacturers already have the capability to provide these protections while preserving the consistency and robustness of the processes that underlie their cost-effective and timely program execution. Unique aspects of payloads and spacecraft can be designed, built and tested in a compartmentalized fashion and integrated under appropriate conditions to support security needs while still realizing the major benefits of the commercial approach.

Mission Assurance

Reliability is of ultimate importance to the military and most government agencies. However, reliability and availability have been shown to be equally if not more important to commercial satellite operators, whose business success hinges on reliable service. In highly competitive commercial procurements, reliability is scrutinized as a key criterion for selection. Commercial manufacturers are further incentivized for Mission Assurance through orbital incentive payments that typically cover all of the profit and even some of the program cost and are only received as long as a satellite delivers the contracted on-orbit performance. If a failure does occur, insurance may replace the operator's satellite, but it does not cover the lost revenue while the new satellite is being built, and it does not compensate the manufacturer for its program losses.

At Space Systems/Loral, statistics show that even as the company has delivered increasingly larger and more complex satellites, reliability has also increased. In general, the first year on-orbit is a good indicator of the robustness of design processes, the effectiveness of test programs, and the integrity of quality systems. Robust design processes are a prerequisite because no amount of testing or quality control can make up for a flawed design. Commercial manufacturers' confidence in their processes is reflected in their success in working under firm fixed price contracts.

Figure A on Page 38 shows **Space Systems/Loral** data from the past 12 years, which tracks a steady decrease in first year component failures despite the growth in satellite size, power and complexity. Note that component failures seldom directly impact satellite operation due to system redundancies.

For 2007, Space Systems/Loral reported 99.997 percent availability for its 50+ on orbit GEO spacecraft, 12 of which were operating past their mission life requirements. Insurance records show that Space Systems/Loral delivers on average approximately 20 percent more transponder years than contracted.

Firm Fixed Price Practices

One of the most significant differentiators between typical USG procurements and commercial contracts is the establishment of a fixed cost to the customer in advance. A firm fixed price (FFP) changes the nature of a procurement and the processes that support it in fundamental ways.

Before an FFP contract is signed, there is significant communication between the customer and the supplier to develop a design concept that meets the operator's needs and is compatible with cost and schedule objectives. Schedule is often vital to support a commercial operator's business case. Once the requirements are agreed upon, the satellite is configured based on the existing product line architecture. With knowledge of the heritage building blocks that have been proven over time, the manufacturer can guide the customer toward a plan that maximizes the operator's objectives. If any technology developments are required, they are agreed upon in advance and the schedule is adjusted accordingly.

At contract signing the scope of the project is well defined with a complete set of documents including contract terms and conditions, statement of work, system specifications, mission assurance plan, and test plan. At this point the design is frozen and, whenever possible, no further changes are made.

Typically, commercial customers co-locate program staff with the manufacturer and through their continuous involvement there is real-time coordination that mitigates schedule delays and ensures that there are no surprises. Because the customer has continual insight into the status of the satellite program, it does not have to be burdened by excessive formal reporting and delays due to document approval cycles. Compliance to the contracted scope is demonstrated with approvals at specified events, and payments are made when these milestones are met. Because the profit for the commercial manufacturer is not actually achieved until the satellite performs on orbit over time, the manufacturer has significant motivation to perform flawlessly.

Currently, according to ***Federal Procurement Regulations***, FFP contracting for USG systems is allowed in cases when mission requirements are known or when a follow-on design is significantly unchanged from the previous build. On other USG satellite contracts, payment is made on a cost reimbursement basis. The focus is typically on program specific development processes and procedures, often minimizing the big picture view of how these processes impact the goal that needs to be achieved. Oftentimes the required formal reporting and delays caused by lengthy document approvals actually impede program success.

The implicit importance of schedule to commercial FFP contracts discourages the requirements creep that can plague USG procurements. All commercial contracts include provisions for contract changes, however significant redirection is rare. Since the manufacturing cycle is typically only three years, and since large satellite operators have multiple procurements in process at any given time, new requirements can always be addressed in later programs.

Hosted Payloads

Hosted payloads are an effective way for government objectives to be met on a very timely and cost effective basis. Also known as piggyback payloads, or rideshare payloads, they are garnering increased attention as a result of the same cost and schedule pressures discussed previously. USG agencies including NASA, NOAA, FAA and DoD have all recently solicited commercial operators for proposals for carrying hosted missions and payloads into space.

The ***Space Systems/Loral 1300 satellite bus*** has been shown to be a good choice for hosted payloads because of its size, high power and heat dissipation capability, as well as its standard interfaces and environments. Hosted payloads are not a new concept. Examples of hosted payloads on the 1300 platform include ***MTSAT-1R***, which was built for both the ***Japanese Civil Aviation Bureau*** (**JCAB**) and ***Japanese Meteorological Agency*** (**JMA**) and launched in 2004, and ***Optus C1*** a commercial satellite which was built for **SingTel Optus**, with an **Australian Department of Defence** hosted payload, and launched in 2003.

MTSAT-1R combined aeronautical services with a meteorological payload. JCAB uses the satellite's L-band mobile links to provide communications and navigational services for aircraft, increasing the efficiency of aircraft flight routes, providing flexible flight profile planning, enhancing air travel safety and improving the quality of aeronautical communications.

For the JMA, MTSAT-1R gathers critical weather information for users throughout the Asia-Pacific region, broadcasting cloud imagery and continuous weather data, including cloud and water vapor distributions, cloud-motion wind vector, sea surface temperature, and information on typhoons and other severe weather conditions. The **U.S. Air Force** and the **Navy Joint Typhoon Warning Center** also both use MTSAT-1R imagery to track weather patterns in the Western Pacific to Indian Ocean regions.

Built on the Space Systems/Loral 1300 satellite bus, MTSAT-1R has two payloads, one that provides aeronautical services and one for weather monitoring.

Optus-C1 satellite

Optus, a leading Australian telecommunications service provider, uses ***Optus C1***'s Ku-band payload to distribute video, direct-to-home TV, and telephony and Internet connections to remote areas. For the Australian Department of Defence, the satellite's Ka-band payload provides high-data-rate broadcast coverage for video, voice and data communications. The satellite's X-band payload provides medium- to high-data-rate, voice and data communications for land and maritime applications and its UHF payload provides secure low-rate voice and data communications to mobile platforms.

More recently the U.S. Air Force contracted with **AMERICOM Government Services** (**AGS**) to host an experimental sensor on board a commercial spacecraft that is being built by **Orbital Sciences** and is scheduled for launch in 2010. The program, known as the ***Commercially Hosted Infrared Payload*** (**CHIRP**) ***Flight Demonstration Program***, will test a new type of infrared sensor from geosynchronous altitude. This is an example of how the commercial satellite industry can provide value to USG customers looking for affordable access to space. It represents an endorsement of commercial practices.

New Product Development

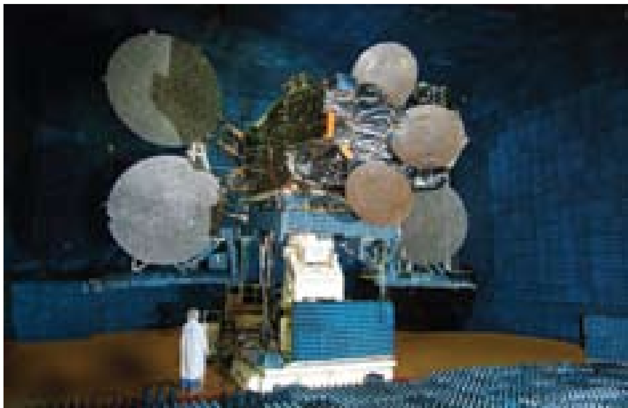
Fixed priced contracting and design closure does not mean commercial satellite systems are built with old technologies. The competitive nature of the commercial market requires state-of-the art technologies. For example, over the last decade commercial satellites have more than doubled in power capability. Other developments, such as the introduction of *Hall Effect*, or *Stationary Plasma Thrusters* (**SPTs**) for electric propulsion and the use of ***Lithium Ion*** (**Li-Ion**) batteries have become commonplace. However, in the commercial world these introductions are incremental, based on meticulous processes designed to insure success.

With insurance companies monitoring risk, it is significant to note that over the past ten years a broad range of new capabilities have been implemented on the Space Systems/Loral 1300 satellite bus with such comprehensive and thorough testing that insurers did not find it necessary to impose "first use" penalties in their premiums. SPTs are a good example. These electric thrusters replace the traditional bipropellant thrusters used for station keeping and momentum management and save several hundred kilograms of launch weight, which can be used for additional payload instead.

SS/L successfully introduced the electric propulsion technology commercially on ***MBSAT***, which was built for **MBCO** (**Mobile Broadcasting Corporation**) of Japan. Previously these thrusters were used on multiple Russian satellite missions and adapted for SS/L use after extensive ground tests for life, power electronics interfaces, and analysis of the plume impingement effects.

MBSAT-1 satellite

SPTs were also used by SS/L on ***Thaicom-4*** and ***Galaxy 28*** (**Intelsat Americas 8**), which were both launched in 2005 and by **EADS Astrium** on ***Intelsat***



Thaicom 4 is a highly complex broadband commercial satellite built by Space Systems/Loral.

1002 and the three ***Inmarsat 4*** spacecraft. To date, with nearly daily firings for stationkeeping on these seven large GEO satellites, there have been no unit failures. SPTs for station keeping and momentum management are now a standard option on the 1300 satellite bus and are regularly implemented in new satellite programs as required.

Li-Ion batteries are another mass-efficient advanced technology that has been inserted as a space-proven building block for use with the 1300 satellite bus. The same detailed process of careful qualification and extensive end-to-end ground testing was implemented before this technology was offered for use on SS/L spacecraft. The first use of Li-Ion batteries and associated power control electronics was on Thaicom-4, which provides broadband service Asia and Australia.

Because ***Li-Ion*** batteries are much smaller and lighter than traditional ***Nickel-Hydrogen*** (**NiH2**) batteries, their use on Thaicom allowed for more payload mass for the satellite. This satellite provides more than 45 gigabits per second (Gbps) data throughput capacity, which is more than 50 times the data throughput of a typical satellite built just 5 to 10 years ago. Li-Ion batteries are now being built into all of the satellites under construction at SS/L. To date, SS/L spacecraft have demonstrated 2.4 million hours of on orbit operation of Li-Ion batteries with no unit failures.

Currently all western commercial satellite manufacturers - **EADS Astrium**, **Boeing**, **Lockheed Martin**, **Orbital Sciences**, **Thales Alenia Space**, as well as **SS/L**, offer Li-ion batteries. While this technology is performing flawlessly on a number of on orbit GEO satellites, it has not yet been introduced on a USG GEO satellite.

Product Development Rigor

At most commercial satellite manufacturers, product development planning is market driven and long term. Manufacturers communicate regularly with satellite operators in order to understand their future needs and challenges and when a new product is essential to an operator's business plan, it is added by way of a carefully planned product development roadmap.

As an example, in 1999 SS/L adopted a formal ***Product Development and Qualification*** (**PDQ**) program that institutionalized a well-planned development process, thorough qualification, strict documentation requirements and pass/fail criteria. PDQ requires a consistent development approach and careful incorporation of lessons learned. It is applied to small product improvements as well as multi-year development programs for major new capabilities such as the Lithium Ion battery system.

PDQ establishes minimum standards for processes and provides planning requirements and tools for concurrent product development as well as mechanisms for tailoring the scope of the plans to the unique characteristics of each project. Integrated product teams are required so that all manufacturing, test, system integration, reliability, parts, materials and processes considerations are addressed thoroughly in the engineering and development of the product.

In many new product developments, *highly accelerated life testing* (**HALT**) is used to assess robustness. HALT stresses units thermally and mechanically well beyond qualification levels to establish the upper and lower operating limits beyond which the product ceases to meet performance requirements, and then the levels at which the product fails. HALT helps identify any latent design weaknesses so that they can be resolved during development, allowing significant robustness increases to be accomplished for a modest investment that can be amortized across a range of programs over several years.

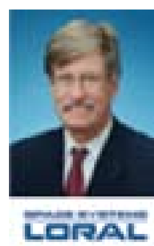
These commercial product development practices are voluntarily self-imposed by spacecraft manufacturers in order to ensure low-risk insertion of new technologies into their product lines for the benefit of their customers and the future of their businesses. These practices typically meet or exceed the product development process expectations of USG customers.

Space Systems/Loral, like all U.S. commercial satellite manufacturers, is a Government contractor certified for classified U.S. Government programs. Space Systems/Loral received the NASA Goddard Contractor Excellence Award for its work on five Geostationary Operational Environmental Satellites (GOES). Launched between 1994 and 2001 the satellites have collectively outperformed their life expectancy by more than 55 percent, with two of the satellites still providing critical meteorological monitoring functions.

Conclusion

USG agencies are coming to see that it is imperative to incorporate some of the efficiencies of the commercial satellite industry into their space assets procurement process in order to maintain national security and worldwide peacekeeping within today's ever tightening cost constraints. The timely deployment of new, reliable space assets can be ensured through the use of satellite manufacturers that have a long term culture of high quality and high reliability satellites delivered on short schedules with fixed budgets. In the future, unique, mission-driven capabilities that require multi-year developments can be segregated from the more routine capabilities. With a "best of both worlds" approach, there is the potential of finding a very attractive cost optimum for USG space system procurements.

About the author



Christopher F. Hoeber has been with Space Systems/Loral for 28 of his 33 years in the commercial satellite business. His current responsibilities as senior vice president, program management & systems engineering include customer satisfaction; program profit; schedule and performance objectives; and planning and managing SS/L's R&D and product development activities. Most recently, Mr. Hoeber was vice president of business development for SS/L, which included marketing and sales. Prior to that, he held the position of chief engineer. Throughout his career, Mr. Hoeber has served in systems test and engineering and program and functional management positions.

The U.S. Army's Trojan Spirit Program

by Nicholas Yuran, Global Protocols

Delivering combat intelligence to the battlespace quickly and reliably is an essential element of modern warfare. As with so many other categories of mission-critical communication, our military depends on satellites to get that information to the deployed warfighter, regardless of the geography, environment, or operating conditions. Modern warfare, like those operations currently being conducted in Afghanistan and Iraq, relies on satcom to deliver tactical intelligence to combatant commanders to help formulate their tactical decisions. Enemy movements and strength level data, weather and terrain products, imagery and other forms of military intelligence (MI) can be transmitted to the battlespace via broadband satellite, and consumed by the tactical commander at near real-time speeds.

The U.S. Army's premier tactical system for distributing combat intelligence is the ***Trojan Special Purpose Intelligence Remote Integrated Terminal*** (**Trojan Spirit**). Tracing its roots back to the 1991 Gulf War, Trojan Spirit has evolved the original concept of pushing MI to the battlespace via satellite to match the vastly enhanced capabilities of 21st century technologies.

"During Desert Storm, the ability to push MI to the battlefield just wasn't there", says *Mark Jurik*, TROJAN System Engineer at Ft. Huachuca, Arizona. "The limited capability that did exist was restricted to 64-128

Trojan terminal overlooking Pristina, Kosovo at sunrise.

kbps links". At those rates, only limited amounts of finished intelligence could be delivered to theater, and data sets were restricted primarily to ASCII data over a patchwork network. Very little in the way of collaboration over the return channel was even possible.

Today's Trojan Spirit system is a stark contrast to its predecessors, carrying a broad variety of data types that include voice, data, imagery and video, at near T1 rates. Users can collaborate and distribute finished intelligence products over this highly managed network at security levels up to ***Top Secret/Special Compartmented Intelligence*** (**TS/SCI**). The network also offers connectivity and reachback that extends ***Joint Worldwide Intelligence Communication System*** (**JWICS**) networks and ***Secure Internet Protocol Router*** (**SIPR**) networks to reach key MI collaboration assets. Employing the latest satcom technologies, Trojan is providing the warfighter with an essential tool in modern information warfare.

Architecture

Trojan terminals are deployed both as a vehicular solution, and as a transit case-based system. The primary Trojan terminal type, deployed in as many as 22 separate transit cases, bears the unlikely name "**Lite V1**" (***Lightweight Integrated Telecommunications Equipment***) and is intended primarily for Army MI brigades and battalions. The system comprises everything from the baseband equipment and workstations, to the RF spares and UPS units. While these terminals are pallet-transportable, some cases require up to a 4-man lift and are not particularly well suited for a rapid mobility requirement. The **V2** and **V3** vehicular equivalents, however, can be sheltered in a **HMMWV** or ***Enhanced Combat Vehicle*** (**ECV**), providing a true mobile platform for the Trojan terminal.

On the baseband side of the terminal, the Trojan system is currently undergoing a technology refresh. The core equipment is the ***Evolution*** series of satellite routers by **iDirect**, **IGT**, and **Comtech EF Data**'s ***turboIP-G2***, accelerated by **Global Protocols**' ***SkipWare***®. The products represent the latest in bandwidth-on-demand satcom and satellite acceleration, ensuring that Trojan users remain on the cutting edge of contemporary satellite technology. Fieldings of this new equipment began in mid-2008 and will continue through 2009, as new and expanded capabilities are added both on the baseband and RF side of the system.

The Trojan program maintains its own hubs, with satellite bandwidth services provided by **Americom Government Services** (**AGS**) and backup services through DISA's ***Standardized Tactical Entry Point*** (**STEP**) program. Deployed Trojan users have the ability to collaborate over this network with any Intelligence Center or other MI support assets, with reachback into JWICS and other classified networks. TACLANEs and KIV-9s provide the requisite COMSEC capabilities, giving Trojan users access to NSA, JWICS or virtually any other level of the national intelligence community.

Trojan terminal deployed in support of operations in Iraq.

Trojan Spirit in Iraq

While the requirements for combat intelligence via satellite have existed since the advent of military satcom, it took the beginning of combat operations in Iraq in 1991 to spur the deployment of the Trojan concept. From inception to field deployment, Trojan engineers needed only 39 days to deliver the first terminals to theater.

This rapid response to combat requirements is testimony not only to the essential nature of combat intelligence, but also to the remarkable efficiency of those program engineers. The success of that original fielding prompted ongoing deployments throughout the 1990s, with an ever-expanding set of roles and mission requirements, culminating in the role Trojan plays in Iraq and Afghanistan today.

There are currently approximately 85 Trojan terminals deployed in Iraq, 13 in Afghanistan, and another 77 terminals deployed in support of other global military operations. Near term plans for Trojan Spirit include the fielding of an additional 220 terminals worldwide in support of the Army's ***PROPHET*** program.

As Trojan terminals proliferate throughout the U.S. military, they are increasingly becoming a military-wide standard in field intelligence delivery, collection and dissemination. Not only does Trojan serve the U.S. Army's MI units, but an increasing number of tactical intel units throughout the U.S. military have

Trojan Spirit terminal supporting USAF Predator UAV operations.

Network Components of the Trojan V2/V3 vehicle variant.

adopted Trojan as their method of delivery for combat intelligence. In Iraq, the USMC used Trojan terminals to disseminate MI back to the Marine Corps' ***Satellite Wide Area Network*** (**SWAN**). In the early stages of the Iraq War, the U.S. Air Force employed Trojan Spirit terminals in support of UAV reconnaissance and intelligence gathering operations, using the system as a data dissemination point for forwarding UAV video and other reconnaissance data. Given the versatility and historical success of this terminal, it is likely to remain at the forefront of the US military's MI mission for years to come.

The program is managed by **CECOM**'s ***I2WD*** at Ft. Monmouth, New Jersey, with engineering support provided by the **Army Information Systems Engineering Command** at Ft. Huachuca. Together, the program's technology staffs are working to expand the capabilities of the Trojan systems even further,

with the goal of revolutionizing the way tactical intelligence is collected and disseminated.

Beyond simply consuming MI, Trojan engineers are already working on upgrades to the RF component that will vastly increase the network's bandwidth and allow for a greater intelligence collection mission in the field. Aiming for speeds up to 50 Mbps, the network will eventually support the transmission of more SIGINT product and imagery to the field as well as allow MI units to collect larger volumes of field intelligence and forward it to **CONUS**/**OCONUS** intelligence centers for processing and analysis.

The ***Trojan Spirit*** program is another example of the critical role that satcom plays in the modern battlefield. Whether simply in support of morale services or delivering vital combat intelligence to the deployed warfighter, satcom continues to be the backbone of tactical military communications. The delivery of combat intelligence to the battlespace presents its own unique challenges, from bandwidth demands to security requirements. But the combination of modern satcom technologies and the ingenuity of the Trojan program engineers have made the dissemination of tactical intelligence a practical and effective component of our military's information warfare mission. MSM

About the author

Nick Yuran is the Vice President of Business Development at Global Protocols, Inc. As a founding member of the company, Nick has worked to promote standards and interoperability among the military communications community, with a focus on tactical satellite.

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 leading implementation of SCPS in the US DoD, SkipWare has the largest install base of any SCPS vendor, and has been specified for many of the US DoD's largest tactical and strategic satellite networks. Standards and Certifications. Since the initial release of SkipWare v. 1.0, Global Protocols has focused on providing high-performance and ease of use, while remaining true to the original open-source SCPS standard. Users of SkipWare-powered devices can be assured of standard-compliance and interoperability. There are no proprietary technologies hidden in SkipWare that will lock the user into Global Protocols as the soul vendor of their network acceleration. SkipWare is fully compliant with Mil-Std-2045-44000, and has been JITC-certfied to operate in US DoD networks.

SkipWare has been successfully tested by the DoD for interoperability with many of the military's most common modem technologies, including iDirect INFINITI, ViaSat Linkway and Comtech EF Data Vipersat-based architectures. SkipWare is the specified acceleration for the US Army's Joint Network Node (JNN) program, as well as DISA's STEP and Teleport programs. It is currently in operational use on nearly 3,000 platforms worldwide supporting thousands of warfighters.

Operating Systems

Linux

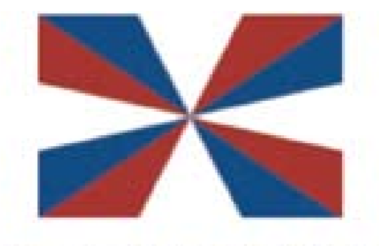
Feature Set

- *Dynamic Bandwidth Acceleration (D-TDMA, S-TDMA/DAMA, SAMA, DVB/RCS)*
- *Packet and Header Compression*
- *Bandwidth Shaping Controls*
- *Selective Negative Acknowledgments (SNACK)*
- *Asymmetric Routing Tolerance*
- *Rate Paced Acceleration*
- *Path MTU Discovery*
- *DoD-mandated Security Features*

Simultaneous Sessions

Unlimited—3200 Max Accelerated Sessions

When the Royal Netherlands Navy needed 24/7 connectivity for a fast combat support ship, it turned to specialized Leasing Services from Stratos. Later, when the Navy required a new maritime messaging system, it adopted AmosConnect from Stratos. These solutions have substantially reduced costs and improved crew welfare. Today the Royal Netherlands Navy is pursuing Enhanced Leasing options for more of its vessels.



Naval Jack of The Netherlands.
Image credit: Wikipedia

In 2005, the **Koninklijke Marine** (Royal Netherlands Navy) began planning a six-month military operation to take place near the Arabian Peninsula that required vessels to have 24/7 access to a coalition forces network. The Navy planned to send a frigate and a fast combat support vessel. As ships do not always sail in close proximity to one another, each ship requires its own communications. The warship—like, all large Navy vessels came equipped with state-of-the-art military SATCOM, but the smaller supply ship had only a slow dial-up Inmarsat connection to access the coalition network.

"In modern military operations there is a need to be online all the time," explains Lieutenant-Commander *Alex de Nijs*, Senior Communication Information Systems Planner for the Royal Netherlands Navy headquarters in Den Helder. "But the cost of a 24/7 dial-up connection charged by the minute would have been an enormous amount of money. We needed a less expensive solution."

About that time, Lt. Cdr. de Nijs came in contact with coalition personnel from Canada and Australia who told him they were using Leased Lines from **Stratos**. Stratos was the first Land Earth Station operator in the world to deploy specialized leasing services over the Inmarsat constellation. With a dedicated leased line, a satellite channel with a fixed bandwidth of 128 Kbps can be reserved 24 hours a day, 7 days a week at a greatly reduced cost.

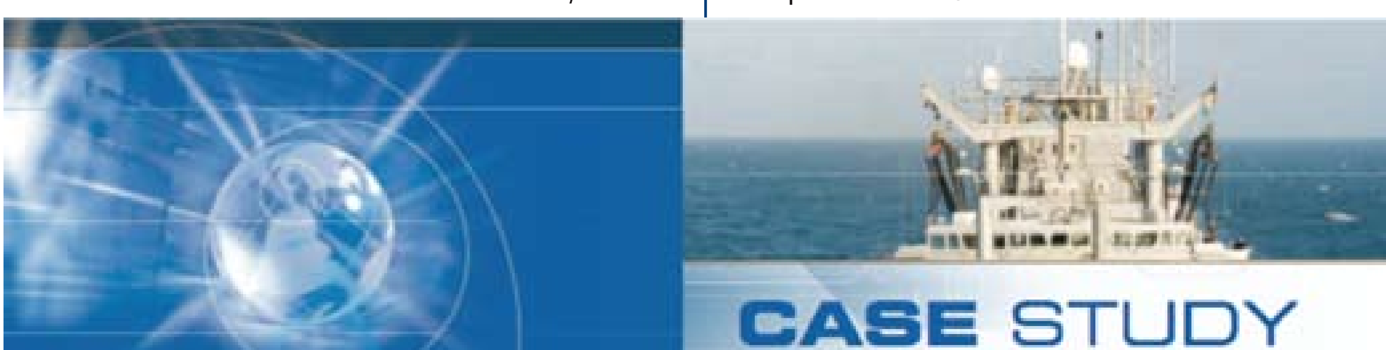
"We did an extensive investigation and found no other provider coming near the quality and prices Stratos offered," recalls de Nijs. "The cost of one month of 24/7 connectivity using a leased line equaled about one and a half days of dialing in."

The Navy signed a six-month lease with Stratos for the operation, which occurred in 2006. At that time, the leased line on the combat support ship was used primarily for military business, rather than crew communications.

Upgrading Crew Welfare

Near the end of 2006, the ***Auxiliary Oil Replenishment Ship HNLMS Zuiderkruis*** was preparing to depart for a long tour of duty in the West Indies. The Commanding Officer had been CO of the supply ship deployed in the Arabian operation.

"He had felt so good having the 24/7 leased line, he requested it again and obtained permission from our admiral," says Lt. Cdr. *de Nijs*. "He also received some new equipment—very clever multiplexers that Stratos recommended—which made



it possible to have four permanent telephone lines onboard the ship, as well as access to two networks: the Internet and the Navy's intranet."

Previously, with dial-up connections paid by the minute, the Navy had not allowed crew welfare calls at sea except in emergency situations. Not only was it costly, but also with only one phone onboard, it was impossible for official military calls to get through when crewmembers were making personal calls. Hence they could call only while in port—a frustrating limitation.

"When you're away from home for six months, making a phone call every now and then can relieve some of the stress and discomfort," says the Lietenant-Commander. "With the leased line and multiplexing, it was no longer a problem to use some of those extra lines for crew welfare. That was a big plus for them.

"These young people simply must be allowed to chat with the home front," said Lieutenant-Commander *Oscar van Lent*, Commanding Officer of the HNLMS Zuiderkruis at the time. "With this technology from Stratos, welfare support for the crew has been upgraded to 21st century status."

With greater access to the Internet, crew can also check web mail more often, send and receive pictures, and shop online. Even on vessels without leased lines or military SATCOM systems, the Royal Netherlands Navy has improved crew welfare and saved money by adopting ***AmosConnect from Stratos***, an integrated maritime messaging system.

"Our internal ICT organization planned to stop delivering email service by January 2007, so we went to Stratos," explains Lt. Cdr. *de Nijs*. "We had already used AmosConnect on a few vessels, but now we have rolled it out for the whole fleet. The quality of AmosConnect is a lot better because emails are compressed, so it takes less time for crew to download or send their emails. Every ship has an Inmarsat budget. The less time it takes, the lower the cost, and the less it costs, the more money they have to do other things. So it adds to crew welfare."

HNLMS Zuiderkruis, a fast combat support ship, pilot tested a 24/7 Leased Line with multiplexing on a tour of the West Indies in 2007.
Photo credit: Koninklijke Marine

Bridge of the HNLMS Zuiderkruis.
Photo credit: Koninklijke Marine

According to Lt. Cdr. *de Nijs*, approximately 30 Navy vessels and ten mobile units of the **Royal Netherlands Marine Corps** deployed worldwide are now equipped with AmosConnect from Stratos.

"We did an extensive investigation and found no other provider coming near the prices Stratos offered. The cost of one month of 24/7 connectivity using a leased line equaled about one and a half days of dialing in."

Bandwidth Sharing Among Ships

Based on the success experienced by ships using dedicated, point-to-point leased lines, the Navy has also proposed to make funds available for ***Enhanced Leasing Services*** (ELS) from **Stratos**. ELS would enable bandwidth sharing among multiple vessels—oilers, mine hunters, other auxiliary ships—currently lacking military SATCOM.

"This is a very efficient means of getting better connectivity on those units for a very good price," Lt. Cdr. de Nijs observes. "For the investment required to put enhanced leased line services on, say, a dozen ships, I couldn't buy half a military SATCOM installation we have on one big ship."

Cost, however, is only one part of the equation. "It's not all about money. It's also about quality and availability of service," he concludes. "In a military operation, we need the confidence that service will be there 24/7—without problems. There may be no alternative. We're getting that quality of service from Stratos. We consider them an important partner in getting our job done."

FleetBroadband — The Future

In December of 2007, Stratos began a field trial with the Royal Netherlands Navy for FleetBroadband. The field trial established the Navy as the first organization to activate the FleetBroadband service. The three-month field trial is being conducted onboard the HNLMS Van Kinsbergen in Western European waters, including the Western Baltic.

"We believe the field trial of FleetBroadband from Stratos will provide the Navy with an excellent opportunity to evaluate the benefits of this new high-performance service in a wide variety of deep-water conditions," said Lieutenant *S.H. Veenstra*, commanding officer of the Van Kinsbergen.

The main mission of the Royal Netherlands Navy (www.marine.nl) is the defense of Dutch territory and that of its allies, including the territory and waters of the Netherlands Antilles and Aruba. Hence, it has a permanent naval presence in the Caribbean/West Indies. The Royal Netherlands Navy also supports and assists civilian authorities in maintaining law and order, providing disaster relief and humanitarian aid both on a national as well as international scale. Den Helder in North Holland is home to the Navy's principal naval base. MSM

The United States currently possesses the largest and most active space economy in the world. It is also the most technologically advanced, although other nations have excelled in certain aspects of space technology.

This leadership position is being challenged as other spacefaring nations seek to develop their capabilities in cooperation or in competition with the United States. The U.S. space industry is concerned that its competitiveness is being undermined by the export control regime that regulates trade between the U.S. and the rest of the world.[1] It is difficult to quantify the total effect of export controls on the space industry, as much of the evidence presented in the past has been anecdotal in nature.

The Space Foundation conducted a survey in 2007 to provide data on the effect of the International Traffic in Arms Regulations (ITAR), which govern the export of space technology. The intention was to see if ITAR had affected the business practices and the cost structures of the space industry in a significant way. The survey contained both quantitative and qualitative questions and the results showed that most responding U.S. companies are aware of the need for protecting certain technologies but they do not believe that ITAR is working the way it should. The results also indicated that smaller respondent companies are more likely to feel adverse effects from ITAR than large companies.

This is a matter of some concern, as lower-tier contractors are a significant source of the new technology and innovation that enables the United States to remain a world leader in space. By continuing to operate an export control regime designed during the Cold War, the United States reduces the competitiveness of its space industry in the global market and potentially harms the domestic innovation processes that enable U.S. space leadership.

It is not only the space industry that has concerns about the process, but also military and civilian government personnel. Deputy Secretary of Defense Gordon England has expressed the view that technology exports should be encouraged because "in this world of coalition warfare and building partnership capacity, it's essential for us and our friends and allies to have greater interoperability ... even with vastly different levels of investment."[2] At every level of military activity, from discussions of interoperable hardware designs to battlefield support, the unintended consequences of ITAR can affect the ability of troops and their support personnel to carry out vital tasks.

The Space Foundation does not suggest that ITAR be abolished, as there are certain space technologies that the United States must protect. However, both the regulations and the processes of implementation need to be modernized to reflect the current global market, the state of space technology, and the increasing pace of innovation. With this goal in mind, we submit the following issues and recommendations for consideration by government and industry.

Issue

The export licensing process is lengthy, unpredictable, and inefficient. The expertise required to understand the technical details often lies outside the State Department and consultation is time-consuming.

- The State Department should hire several employees with space expertise when fulfilling the staffing requirements under consideration by Congress.
- The Senate should ratify the defense trade treaties with the United Kingdom and Australia, enhancing collaboration with two strong U.S. allies and decreasing the volume of licensing requests substantially.
- The enforcement of ITAR should shift its focus from a system that regulates individual transactions to a system that reviews the scope of the entire project.

Issue

ITAR restricts the ability of U.S. firms to compete because foreign companies do not operate un-

[1] U.S. Department of Defense and Department of Commerce, Defense Industrial Base Assessment: U.S. Space Industry. Final Report (Dayton, OH, 2007), 14.

[2] "Deputy Secretary of Defense Urges Easing U.S. Export Controls," Satellite Today, May 19, 2008, http://www.satellitetoday.com/smd/23097.html (accessed May 20, 2008)

der equal restrictions. Technology remains on the United States Munitions List (USML), even when it is commercially available in other countries, because lists of critical U.S. military technologies are seldom updated.

- When reviewing the USML and ITAR, the State Department should take into account the availability of space technology »»in the global market. U.S. companies should be allowed to compete freely to sell goods and services that are not materially different from those offered by international competitors. In addition, exports should only be governed by ITAR if they represent a technological advantage that is militarily significant.
- A validated end-user program should be created for ITAR-controlled exports, enabling transactions that require exporters »»to notify the State Department instead of applying for a license. This would enable U.S. firms to offer competitive bids in a timely manner to companies that had been approved by the U.S. government previously.

Issue

Small firms do not have sufficient resources to comply with ITAR so the cost of compliance is a barrier to entry; this is a concern since lower-tier companies are a major source of innovation. Regulations also deter or delay collaboration with foreign partners, increasing the financial burden on a sole firm.

- Any plans to use export licensing fees to sustain additional duties by the State Department should avoid placing undue »»financial burden on lower-tier suppliers.
- Transfers of technology between U.S. and overseas divisions of the same company should not require a license, provided all »»sites are ITAR-compliant.
- A database of recipients should be made available to exporters, enabling them to see which customers have been granted »»access to certain categories of ITAR-controlled exports and which customers require greater scrutiny for certain transactions. This database would also provide incentives for foreign entities to maintain ITAR compliance, since a negative listing would decrease their chances of doing business with U.S. companies.
- The licensing process should be as transparent as possible, without harming national security or the competitiveness of the »»companies involved. This will enable the industry to engage in regular dialogue with the State Department to reach a better consensus regarding what needs to be controlled and how to make the process more efficient.

Introduction

In the United States, exports of space products and services fall under the jurisdiction of the Department of State regardless of their purpose, whether it is military, civil, commercial, or academic. The International Traffic in Arms Regulations (ITAR) which govern these transactions are considered by some members of the space industry to be a government-imposed hindrance that prevents the United States from reaching its full potential as a leader in global space activity.[3]

Many feel that the export of technical data, defense services, technology, and commodities is overly restricted under the current export control regime, in which individual licenses are required for each transaction and minimal exceptions are made. They believe that the export control process should be routine and transparent with timely and consistent license application procedures, upholding vital national security safeguards and enabling continued U.S. technological and economic competitiveness.

[3] For the sake of simplicity, "space industry" includes the government and academic sectors in addition to the commercial interests that the term implies. For instance, NASA must comply with ITAR when engaged in projects with international partners. In some cases, as with the International Space Station, the process is expedited due to the safety concerns involved in human spaceflight, although these exceptions are often difficult to negotiate.

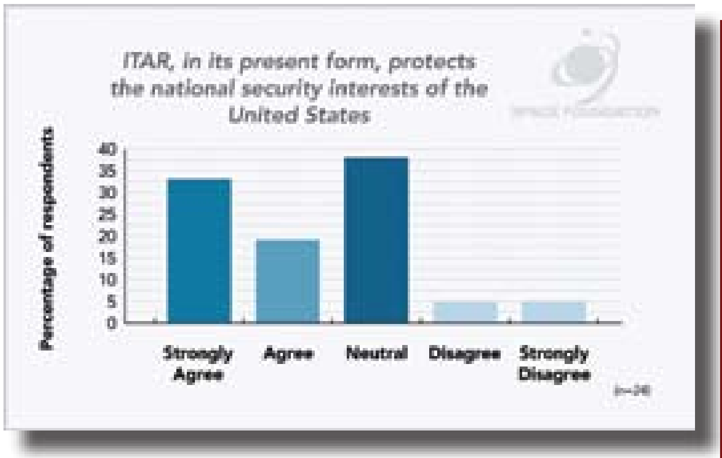
Recent initiatives by the Administration and Congress have addressed some of these concerns, as well as laying the foundation for future reforms. This is a positive sign, but it remains to be seen whether the implementation of these measures will truly make a difference in the way that the export process works.

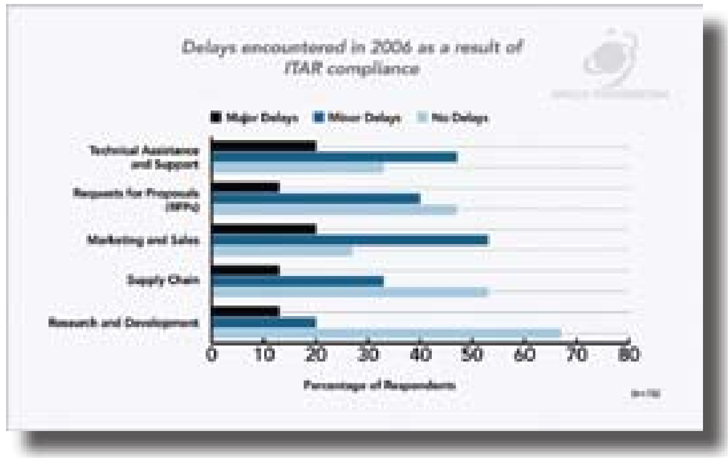
The “problem” of ITAR for the space industry is not an insurmountable one, but it may be extremely difficult to address unless the parties with a stake in the matter have a common understanding of the issues. Without this shared perspective, efforts to modernize the export process are likely to add to the complexity of an issue that is already complicated. The results of the Space Foundation’s ITAR survey, presented below, are intended to help inform the debate about how to shape the relevant policies and guidelines for maximum efficiency and effectiveness.

Findings and Recommendations

The concerns of the U.S. space industry with regard to ITAR encompass issues of competitiveness, access to the global market, technological development, and leadership in the space domain. The industry recognizes that there are valid national security concerns with regard to space technology that ITAR is trying to protect. Of the respondents to the Space Foundation’s ITAR survey, more than half believed that ITAR, in its present form, protects the national security interests of the United States. This corresponds closely with a 2006 survey of executives in the broader aerospace and defense community, which revealed that two out of three believed that the export control system effectively protected U.S. national security interests.[4] However, the export control process is not

[4] Marty Bollinger and Joshua M. Boehm, Moving Toward a Faster and More Predictable Process of Licensing Defense Articles and Services for Export: Recommendations for Government and Industry (Booz Allen Hamilton, 2006), 1.





fully protecting the interests of the United States because it is damaging the health of the space industrial base.

One of the reasons that the U.S. space industry finds fault with the current regulatory regime is because it perceives ITAR as a barrier to fair competition. A U.S. government study conducted in 2007 revealed that export controls were considered to be the number one barrier to entry for U.S. firms attempting to penetrate foreign markets, with foreign purchasing preferences ranked as a distant second.[5] Since foreign firms do not have to deal with an equivalent set of export regulations, it gives them a competitive advantage in the global marketplace.

In the fast-moving world of the telecommunications industry, a company might issue a request for proposals with a significantly shorter timeline than would allow a U.S. company to receive the necessary approval from the State Department's Directorate of Defense Trade Controls (DDTC) to bid on the project. Foreign companies may view this as regrettable if they are interested in buying from the United States, but foreign governments sometimes intentionally set deadlines that they know U.S. companies will be unable to meet due to ITAR, thereby effectively creating a trade barrier and protecting their own space industries without the risk of diplomatic repercussions.[6] In this way, the security measures of the United States can have a negative effect on the health of its domestic space industry, even in circumstances where the export would have been approved by the U.S. government eventually.

The length of the licensing process has long been a cause for complaint; there are several factors that contribute to the delays. Due to the nature of the items and services being traded, the expertise required to understand the technical details often lies outside the State Department and consultation is time-consuming. However, there have been some positive actions on the part of the government in this regard. New management of DDTC since May 2007 has been instrumental in reducing the backlog of some 10,000 licensing applications. On January 22, 2008, President Bush signed National Security Presidential Directive 56 (NSPD 56) on defense trade reform. NSPD 56 directed the State Department to complete its review and adjudication of licensing applications within 60 days of receipt, unless national security exceptions are applicable.[7]

The U.S. House of Representatives supported and expanded upon NSPD 56 in May 2008 with H.R. 5916, the Security Assistance and Arms Export Control Reform Act of 2008.8 The bill acknowledged several of the problems inherent in the export control regime and prescribed changes to the licensing process.

Government statistics showed the median processing time for arms export cases (of which space tech-

[5] U.S. Government, Defense Industrial Base Assessment, 14.

[6] John Hillery, U.S. Satellite Export Control Policy, Center for Strategic and International Studies, http://www.csis.org/media/csis/pubs/060921_sat_export_controls.pdf (accessed August 4, 2008).

[7] U.S. Department of State, "Policy on Review Time for License Applications," Federal Register 73, no. 73 (April 15, 2008): 20357.

nology forms a subset) had doubled over the period from 2002 to 2006.[9] Space-related deals are typically complex and may require multiple licenses at various stages of the project as modifications are made and as construction of the final product progresses. This opens the door to cumulative delays and the House recognized that the backlog in applications and the long processing times "led to an impairment of United States firms in some sectors to conduct global business relative to foreign competitors."[10]

The legislation under consideration by Congress determined that DDTC should have at least one licensing officer for every 1,250 applications.[11] It also set forth a minimum number of personnel to review applications for commodity jurisdiction (i.e., whether or not something is controlled by ITAR). According to an estimate from the Congressional Budget Office, an additional 35 licensing officers would need to be hired in order to meet these thresholds.[12]

Recommendation

Due to the increasing technical complexity of licensing applications, the State Department should include several employees with space-related expertise in its plans to fulfill the staffing requirements under consideration by Congress.

On the diplomatic front, the U.S. Senate should ratify the treaties with the United Kingdom and Australia and the government should seek out other possibilities for cooperation with allies. If wars in the future are to be multilateral affairs, it is essential for the U.S. military to achieve interoperability with the forces supplied by allied nations. The battlefield is the worst place to accomplish this task; it is safer for the troops if they are prepared beforehand to work with their allies when the time comes. Ideally, this would involve joint training exercises, personnel exchanges, and shared classes in military doctrine. It would also be beneficial if the equipment of U.S. allies were compatible with U.S. space systems or at least capable of being easily adapted for interoperability. Unfortunately, it is difficult to achieve any of these steps in the environment of distrust that is engendered by the U.S. approach to export controls for space technology, which encompasses technical information as well as hardware. It would be regrettable if the United States was forced to engage primarily in unilateral action because it was incapable of integrating allied forces into its battlespace.

A different approach to licensing for the United Kingdom and Australia should not be considered as a reward or an incentive for providing assistance in the future; it is a practical change to make in light of the trade relationship that already exists. In 2007, the State Department processed 8,000 licenses for these two nations, 99 percent of which were approved.[13] By changing from a transaction-based system to an end-user system of approval, more opportunities for cooperation would arise and close U.S. allies would have prompt access to the equipment and support they need to engage in future coalition operations.[14] Companies and agencies would be able to perform the same tasks that they are already doing, but in a more timely and efficient manner, which increases the likelihood of undertaking more projects of mutual benefit.

8 The House of Representatives passed H.R. 5916 on May 15, 2008. The Senate had not yet considered the bill at the time this paper was written.

9 U.S. House of Representatives, Security Assistance and Arms Export Control Reform Act of 2008, 110th Cong., 2d sess., 2008, H.R. 5916, 7.

10 House of Representatives, Export Control Reform Act, 8.

11 House of Representatives, Export Control Reform Act, 21. This is not intended to be a quota for each licensing officer since licenses vary in complexity. However, it is supposed to ensure that DDTC's staffing levels are appropriate to the volume of licenses.

12 House Committee on Foreign Affairs, Report on H.R. 5916, the Security Assistance and Arms Export Control Reform Act of 2008, 110th Cong., 2d sess., 2008, H. Rep. 110-626, 25.

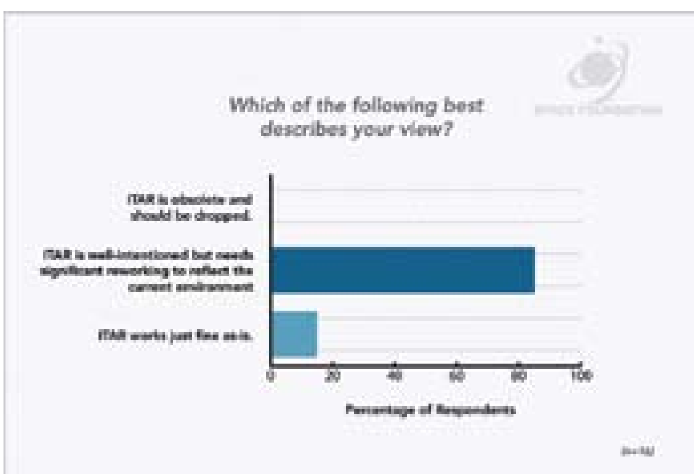
13 Frank Ruggiero, interview by Vago Muradian, Washington, DC, April 21, 2008, http://www.state.gov/t/pm/rls/rm/104012.htm (accessed August 5, 2008).

14 Expedited processing is available for items urgently needed by coalition troops in Iraq and Afghanistan, but this does not cover long-term cooperative projects which can fall behind schedule due to a slow export system. This adds to the financial cost for the parties involved. A reduction in unnecessary export-related delays would be a prudent fiscal policy.

Recommendation

The Senate should ratify the defense trade treaties with the United Kingdom and Australia. This would enhance collaboration with two strong U.S. allies and it would decrease the volume of licensing requests substantially.

The Administration is not seeking similar treaties with other countries because there are no other candidates with whom the U.S. government has a similar "special relationship." In response to the difficulty of doing business with U.S. space companies under the constraints imposed by ITAR, some foreign companies have begun to advertise their products as "ITAR-free," highlighting the fact that potential customers will not have to navigate the complex and demanding terrain of ITAR compliance.[15] This is a particularly strong selling point for foreign companies that provide components for spacecraft. It is more convenient for a foreign satellite builder to use ITAR-free components because it will then be able to sell the final product to whomever it pleases (in compliance with the domestic laws of its home nation). For example, several European governments are financing the development of a commercial telecommunications satellite that will be available both with and without ITAR-controlled components. The ITAR-free version is expected to be more expensive, but customers may see this as a viable tradeoff for avoiding the prospect of ITAR-related delays.[16] It would also enable customers to take advantage of low-cost Chinese launch services, which are currently off-limits for products controlled by ITAR.



The legislation under consideration by Congress instructs the President to submit a report on satellite export controls, which takes into account "the extent to which comparable satellites and related items are available from foreign sources without comparable export controls."[17] The space industry would welcome such a review, both for satellites and for other space goods and services, as the majority of the industry is of the opinion that ITAR needs significant reworking to reflect the current environment.[18]

The terms of the treaties between the United States and its allies, the United Kingdom and Australia, hint at a possible solution. If it were possible for DDTC to issue a license for a particular project or enterprise rather than overseeing each distinct detail, then the State Department could review a proposed deal and approve it with the proviso that further review would be necessary only if the terms of the deal changed according to a specific set of conditions. This would remove the necessity for multiple licensing applications unless the scope of the project went beyond the limits imposed by DDTC. Alternatively, a "validated end-user" system could be implemented in which it is understood that the recipient of technology is in compliance with U.S. security requirements, thereby promoting joint business ventures between these trusted foreign partners and U.S. companies.

Recommendation

The enforcement of ITAR should shift its focus from a system that regulates individual transactions to a system that reviews the scope of the project.

Recommendation

A validated end-user program should be created for ITAR-controlled exports, enabling transactions that

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15 Wolfgang Demisch, "ITAR's End," Aviation Week & Space Technology, July 17, 2006.

16 Peter B. de Selding, "ITAR-Free Version of Small GEO Planned," Space News, May 28, 2008, http://www.space.com/spacenews/marketmonitor/SmallGEOweb052808.html (accessed August 5, 2008).

17 House of Representatives, Export Control Reform Act, 42.

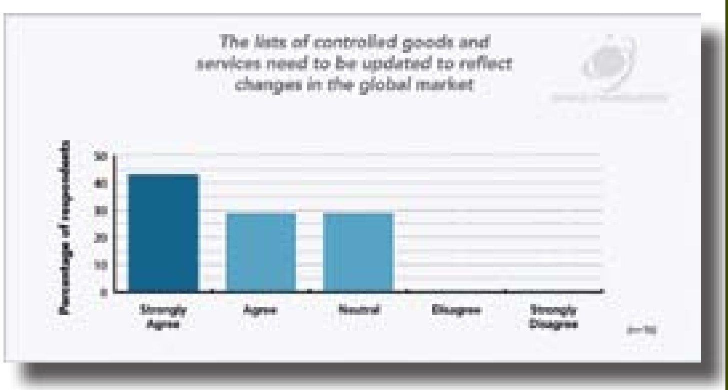
18 U.S. Government, Defense Industrial Base Assessment, 43.

19 Bollinger and Boehm, Moving Toward a Faster Process, 3-4.

require exporters to notify the State Department instead of applying for a license.

If the goal of export control is to prevent sensitive technology from falling into the hands of parties hostile to the United States, then the government needs to define the categories of goods and technical knowledge more clearly and appropriately. The U.S. military should assess the current state of military technology and determine what is inappropriate for export. As has been mentioned previously, one part of this assessment should take into account the availability of spacecraft components on the global market so as not to prevent U.S. companies from selling goods that could have been purchased from a foreign competitor. On a broader scale, the list of controlled items should be narrowed significantly to include only the parts of a spacecraft that can truly be said to be sensitive technology.

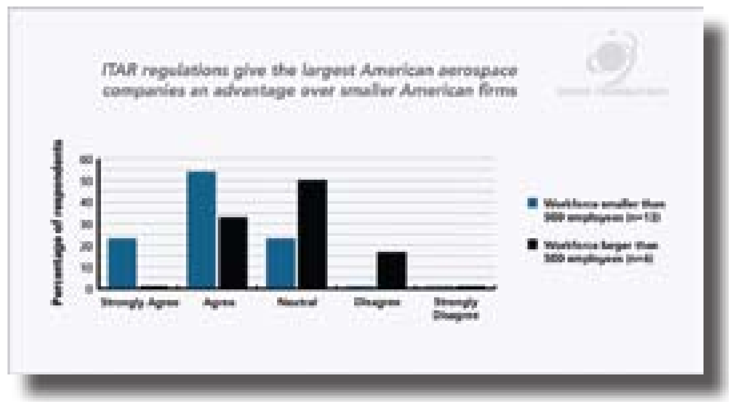
These lists have not been subject to regular review in the past, so they have not been kept in sync with the reality of the marketplace. In addition, the definition of "military" usage as opposed to "dual-use" is often unclear, but the penalties for non-compliance are so high that companies are often inclined to submit excessive license applications, many of which are improperly written, thereby contributing to the workload (and backlog) at DDTC.[19] The U.S. space industry understands that there are some things that must be protected, but it is frustrated by the excessive resources that go into protecting things that have no strategic military significance.[20] It is encouraging to



note that the House of Representatives wants the Secretary of State to review the United States Munitions List (USML) and ITAR, with the assistance of United States manufacturers and other interested parties.[21] The purpose of this review is to determine which technologies warrant different or additional controls.

Recommendation

When reviewing the USML and ITAR, the State Department should take into account the availability of space technology in the global market. U.S. companies should be allowed to compete freely to sell goods and services that are not materially different from those offered by international competitors. In addition, exports should only be governed by ITAR if they represent a technological advantage that is militarily significant.



In terms of creating an uneven playing field, ITAR does not only engender a disparity between domestic and foreign companies, but it also imposes costs upon U.S. companies unequally. A large prime contractor is likely to have an entire department of staff working on ITAR compliance for the company as a whole, and these people have the experience necessary to handle any space-related ITAR paperwork. By contrast, second- and third-tier suppliers are more likely to be at a disadvantage as they may not have the personnel to ensure that everything is being done in accordance with ITAR. The proportional cost of ensuring compliance is much higher for them, up to

19 Bollinger and Boehm, Moving Toward a Faster Process, 3-4.

20 U.S. Government, Defense Industrial Base Assessment, 42-44. For additional information on the discrepancy between critical technologies and export controls, see: U.S. Government Accountability Office, Defense Technologies: DOD's Critical Technologies Lists Rarely Inform Export Control and Other Policy Decisions, GAO-06-793 (Washington, DC, 2006).

21 House of Representatives, Export Control Reform Act, 25.

22 U.S. Government, Defense Industrial Base Assessment, 36.

23 U.S. Government, Defense Industrial Base Assessment, 28.

eight times that of a first-tier supplier, and this is a significant concern since many lower-tier suppliers have relatively small profit margins.[22]

The extra costs imposed by ITAR constitute a barrier to entry for small companies, thereby discouraging them from seeking to expand their customer base on a global scale. Consequently, they rely on U.S. domestic space activity, which is cyclical in nature. If it were easier to compete globally, these small companies would have a better chance of survival during the lean times in the U.S. market. Lower-tier suppliers play a significant role in innovation, so the loss of these companies could lead to a decline in the development of new technology.[23]

An example of a subsection of the space industry that is facing difficulty is the entrepreneurial sector, comprised of the companies which are developing commercial passenger spacecraft and orbital habitats. Often funded privately, these companies are under extreme pressure to keep their costs down and they would like to work with foreign suppliers whenever it is more cost-effective to do so. However, the barriers to communication imposed by ITAR make it a slow and arduous process to provide technical requirements to the foreign suppliers and to engage in follow-up discussions that could improve the safety and reliability of the end product. One such entrepreneur, Elon Musk, is working to provide an orbital launch vehicle that is intended to conduct flights for NASA and the Department of Defense, among other customers. In public statements, Musk has emphasized the importance of minimizing the regulatory burden on startup companies and has questioned the wisdom of government-imposed obstacles to cooperation with companies in trusted nations such as New Zealand, the United Kingdom, and Canada.[24]

The House of Representatives has suggested that DDTC examine the possibility of placing itself on a 100 percent self-financing basis.[25] This is potentially problematic for smaller suppliers, which may rely on a high volume of relatively low-value sales to sustain themselves. Depending on the mechanism for assessing licensing fees in order to finance DDTC, lower-tier suppliers may find the cost of international sales too high to contemplate. According to the U.S. government's industrial base assessment of the space industry, some of these small companies have already self-eliminated from foreign markets because of ITAR restrictions and the unwillingness of foreign customers to deal with ITAR-related bureaucracy.[26] An increase in licensing costs is likely to reinforce this behavior.

Recommendation

Any plans to use export licensing fees to sustain additional duties by the State Department should avoid placing undue financial burden on lower-tier suppliers. The barriers to communication imposed by ITAR exist not only between U.S. companies and foreign entities, but also within companies that have sites located around the world. By imposing barriers that affect intercompany operations, the U.S. government is discouraging the space industry from harnessing the talent and expertise that exists in foreign countries. Companies are able to apply for licenses to conduct specific joint ventures involving their foreign offices, as would be the case for any foreign partnership; however, it may be more efficient to adopt a long-term solution that allows for regular interchanges. If a company is willing and able to meet the conditions of ITAR at its foreign sites, it makes sense to permit continuous collaboration, possibly within a certain set of parameters established by DDTC in advance.

Recommendation

Transfers of technology between U.S. and overseas divisions of the same company should not require a license, provided all sites are ITAR-compliant.
If the export system makes the transition from transaction-based approval to end-user approval, it will be necessary to provide the U.S. space industry with the information it needs to determine who it can trade with. The U.S. government currently maintains lists of countries, entities, and persons who are prohibited from receiving ITAR-controlled goods and services. A corresponding list could be created of trusted agents who have been verified as ITAR-compliant. This would allow U.S. companies to see which foreign entities are easiest to trade with and it would also help lower-tier suppliers to find business opportunities overseas, thereby funding the creation of new technology for use domestically. Ideally, the list would be updated as licenses are approved, allowing the space industry to gain a real-time picture of which entities are trusted by the government.

Recommendation

A database of recipients should be made available to exporters, enabling them to see which customers have been granted access to certain categories of ITAR-controlled exports and which customers require greater scrutiny for certain transactions. This database would also provide incentives for foreign entities to maintain ITAR compliance, since a negative listing would decrease their chances of doing business with U.S. companies.

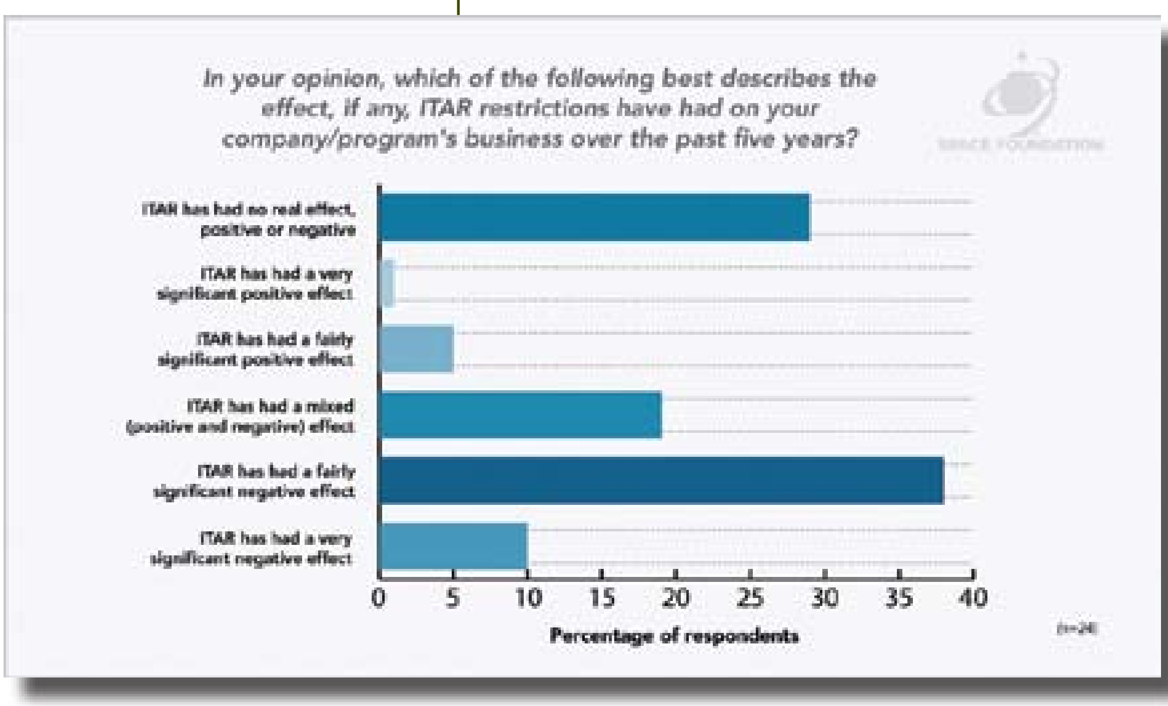
The U.S. space industry is interested in working with the government on the issue of export controls, but such efforts will not succeed unless there is a free flow of information in both directions. Companies can supply expertise and advice, but they also need to know the reasoning behind government decisions. If licensing decisions are made available to the space industry, with safeguards in place to protect industrial secrets and competitive data as necessary, then the industry as a whole will be able to adapt its business strategy in the interest of efficiency while still complying with (modernized) ITAR. This is nothing new for the industry – most companies have already had to adopt strategic changes due to the present export regime – but companies would be able to make their decisions based on a better understanding of the government's behavior. The information would also enable the industry to better engage with the government on a regular basis to discuss the changing face of the global market and the appropriate updates to ITAR that should follow.

Recommendation

The licensing process should be as transparent as possible, without harming national security or the competitiveness of the companies involved. This will enable the industry to engage in regular dialogue with the State Department to reach a better consensus regarding what needs to be controlled and how to make the process more efficient.

Conclusion

On the political front, the space industry needs to do a better job communicating the message that it is an important commercial and national security asset to the nation. Space advocates must work to build an understanding within the government that there should be a balance between necessary export restrictions and the health of the industry. The national security implications of an enfeebled and uncompeti-



tive domestic space industry must be made clear, in order to explain why an overly restrictive export control regime can ultimately do as much damage to national security as a lax regulatory system. If the expertise of the U.S. space industry is allowed to deteriorate, or if it is slowed to the point where other nations catch up (and this has already happened in some areas), then the United States is effectively ceding the dominant position in space that it has enjoyed for some time. Considering the dependence of modern militaries on space assets, especially the U.S. military, the danger of falling behind in terms of technological progression is not to be taken lightly.

The control of space exports under the International Traffic in Arms Regulations is a contentious issue that pits national security concerns against the desire to cooperate with foreign entities for purposes of profit or scientific research. By working together, it should be possible to create a regulatory environment that protects militarily critical technologies and technical expertise, while allowing commerce and international partnerships to flourish and the space industry to prosper.

The difficulty lies in overcoming the arguments of parties on both sides who have become entrenched in their positions and who are more willing to recount the injustices or misdemeanors of the past than to work toward a better future. To succeed, it will be necessary to muster the political will of the Executive Branch to oversee the necessary alterations in the regulatory process, and the cooperation of the Legislative Branch with regard to adjusting the laws to allow the State Department more latitude in terms of determining the trustworthiness of end-users. The space industry must also play a role in the process and it will need to make solid information available to policymakers so that any policy changes will be helpful and well-reasoned.

Space Foundation Survey Methodology

The Space Foundation conducted its ***ITAR*** survey, facilitated by **The Everett Group, LLC**, from late May through September 2007, gathering inputs from invited space industry members through a web-based online questionnaire, custom-designed and hosted at www.itarsurvey.org (the domain's registration was allowed to lapse after the completion of the survey fieldwork).

The initial survey invitations went to the ***Space Foundation's Corporate Members*** and to members of the ***Space Supplier Council***. The Space Foundation prepared and issued a press release announcing the survey and invited participants to log onto the survey site. Additional invitations containing the survey URL were posted on various industry listservs and message boards. The organization gathered usable responses from 24 different organizational representatives (including 16 Space Foundation Corporate Members). As the survey invitees were not selected randomly from the population of U.S. space industry members, the quantitative results cannot be generalized to that population and inferential statistical tests are unsupported. The survey results should be interpreted as intuitive, non-statistical evidence.

If you have questions about the study or the survey methodology, please contact research@spacefoundation.org.

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202.463.6122

Micah Walter-Range
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To learn more about the **Space Foundation**, select the banner graphic below...

The MILSATCOM Joint Terminal Engineering Office (JTEO) conducts end-to-end terminal interoperability assessments of military satellite communication systems in support of the Military Satellite Communications Systems Wing (MCSW).

Background

The **JTEO** was established in 1982 as the ***Milstar Joint Terminal Program Office*** (**JTPO**) working Milstar terminal interoperability issues. In 1997, JTEO was reorganized with an expanded MILSATCOM role covering the full spectrum of protected, wideband, and narrowband frequencies.

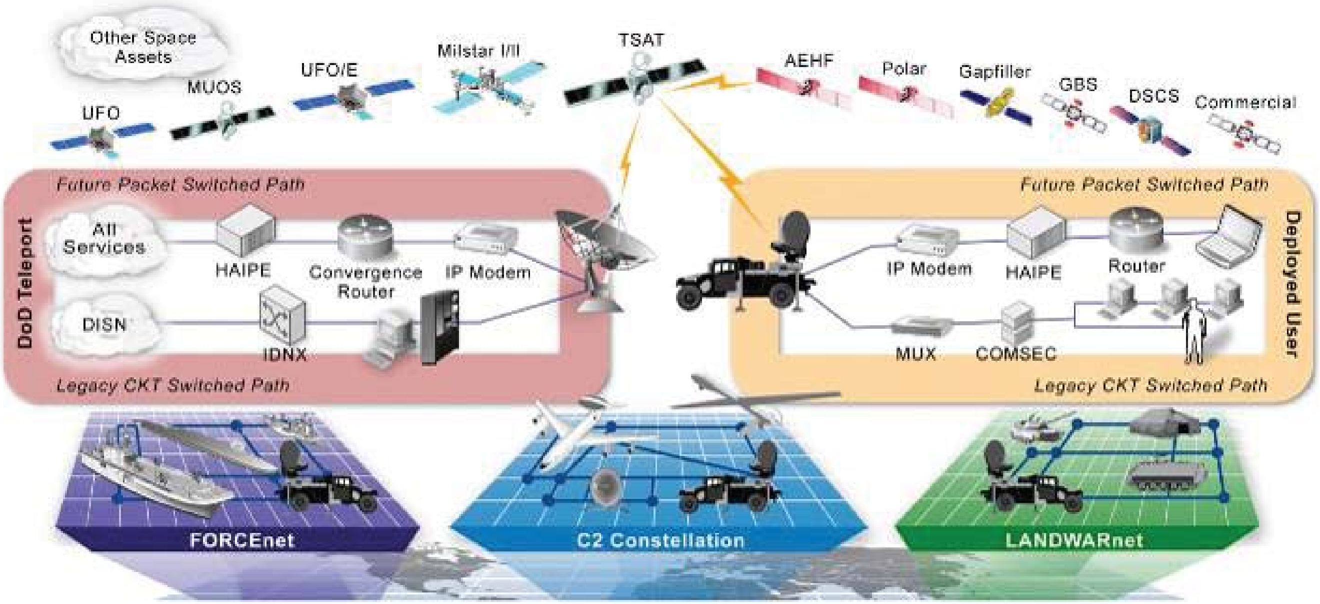
Features

A multidisciplinary team of government/industry engineers, **JTEO**'s tenured technical capability works through the MILSATCOM community's technical and program forums to accomplish resolution of critical Joint terminal issues across the MILSATCOM spectrum. JTEO's primary role is to ensure MILSATCOM terminal end-to-end interoperability and integration into the ***Global Information Grid*** (**GIG**). To accomplish this, JTEO works with the terminal development community to develop interoperable terminal requirement specifications. These technical documents provide guidance to the Joint terminal community to ensure interoperability at all levels of development throughout the terminal life-cycle.

JTEO supports the test and evaluation of MILSATCOM systems through interoperability requirements verification, terminal and system test planning and execution, data analysis, discrepancy resolution, test reporting and certification recommendations. JTEO's test and evaluation activities form the basis for Joint Interoperability Test Command's interoperability certification of ***Milstar***, ***AEHF***, ***DSCS***, ***WGS*** and ***TSAT*** terminals.

In response to ASD NII policy direction, JTEO develops the bi-annual ***National Security SATCOM Systems Synchronization Roadmap*** (**NS4R**). This analysis is used by acquisition decision makers to better synchronize Space, Control and Terminal segment developments to assure warfighters get needed capability on time. As required, JTEO uses results of NS4R analysis to aid development of ***Transformational Communications Architecture*** updates, ***National Security Space Program Assessments*** (NSSPA), and ***OSD PDM*** directed or other special programmatic studies that require authoritative input regarding MILSATCOM joint terminal segments.

JTEO's ***Network Engineering*** capabilities provide



JTEO Global Information Grid

interoperable end-to-end solutions to facilitate MILSATCOM system integration into terrestrial architectures and rest of the GIG. The JTEO develops and refines network protocols and terminal specifications to optimize MILSATCOM networks and develops solutions for next generation MILSATCOM network architectures. The JTEO plays a prominent role in defining the terminal to network interfaces for TSAT and AEHF. In addition, JTEO represents the MILSATCOM terminal perspective in GIG development forums, working to ensure interoperability among elements in the GIG.

JTEO program execution requires detailed coordination with OSD (NII, PA&E), respective ***Services Terminal Program Offices*** (**TPO**s) to foster terminal development collaboration; the ***Joint Staff***, Services Staffs and ***National Security Agency*** (**NSA**); the ***National Security Space Office*** (**NSSO**) ***Communications Functional Integration Office*** (**COMM FIO**); ***Defense Information Systems Agency*** (**DISA**); **Air Force Space Command**, ***Army Strategic Command***, and Combatant Commanders to resolve terminal issues for the MILSATCOM community.

JTEO chairs the MILSATCOM Terminal Collaboration IPT under the ***Joint SATCOM Acquisition Council*** (**JSAC**). In this role, it leads the Service TPOs in collaboratively developing future terminal modules, and addressing ASD NII's guidance for incorporation of the Software Communications Architecture (SCA) into MILSATCOM terminal developments.

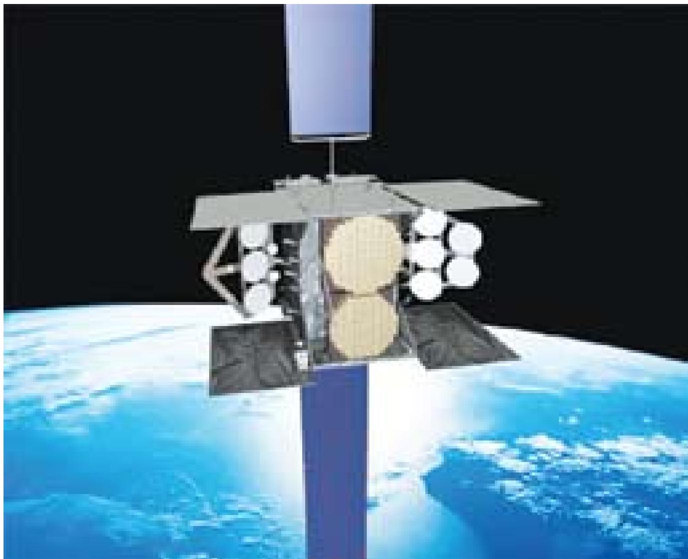
Military Satellite Communications Systems Wing

Previously known as the MILSATCOM Joint Program Office (MJPO), the Space & Missile Systems Center established the MILSATCOM Systems Wing on 1 August 2006. The team is made up of Joint Service Military, Govern-

Milstar Satellite Communications System

AEHF System

Defense Satellite Communications System



Wideband Global Satcom (WGS)

ment Civilians, **The Aerospace Corporation**, **MITRE**, **Lincoln Labs**, **Systems Engineering and Technical Assistance** (**SETA**), **National Security Agency** (**NSA**), our industrial partners and the contract work force that support us.

MCSW has ***five*** Groups and ***one*** squadron which deliver three primary *Satellite Communications* (SATCOM) product lines:

The **Protected Communications Group** provides the DoD survivable, global, secure, protected, jam-resistant communications for high priority military ground, sea, and air assets. The group provides operations and sustainment support to on-orbit ***Milstar*** constellation. In addition, the group executes the US$6.7B ***Advanced Extremely High Frequency*** (**AEHF**) and US$1.2B ***Enhanced Polar SATCOM*** (**EPS**) programs. The user equipment or terminals for the DoD protected communication systems in the currently operational ***Milstar Command Post Terminal*** (**CPT**) and US$3.2B ***Family of Advanced Beyond-Line-of-Sight Terminals*** (**FAB-T**) development program.

The **Wideband Communication Group** provides worldwide, high-volume, voice and data communications to the warfighter. The group provides operations and sustainment support for the on-orbit ***Defense Satellite Communications System*** (**DSCS**) constellation. In addition, the group executes the US$1.9B ***Wideband Global SATCOM*** (**WGS**) system and US$0.9B ***Global Broadcast Service*** (**GBS**). Wideband communication terminals include the ***Ground Multi-band Terminal*** (**GMT**), the ***High Data Rate - Radio Frequency*** (**HDR-RF**) ground terminal program which is an evolutionary upgrade to the GMT, and the ***FAB-T Increment 2***.

The ***Transformational Satellite Communications System*** (**TSAT**) is the DoD's future MILSATCOM System. The US$24.0B TSAT system will provide real-time connectivity of all ***Global Information Grid*** (**GIG**) assets; provide ***Battle Command-On-The-Move*** capability for Small Mobile Units; worldwide persistent connectivity of high/low resolution ***Intelligence Surveillance and Reconnaissance***; and survivable communications for Strategic Forces. The TSAT program office consists of the ***TSAT Network Integration Group***, the ***TSAT Space Group*** and the ***TSAT Mission Operations Group***.

Satellite command and control system development for all MILSATCOM systems is the responsibility of the **MILSATCOM C2** Squadron. The squadron directs the ***Command and Control System-Consolidated*** (**CCS-C**) program, the command and control system of record for ***Milstar***, ***DSCS***, and ***WGS*** satellites currently on-orbit. Ultimately, CCS-C will control more than 26 military communications satellites across four families, including DSCS; Milstar; WGS; and AEHF System, using state-of-the-art commercial telemetry, tracking and commanding (**TT&C**) technology.

The MCSW is headquartered at Los Angeles Air Force Base (AFB) with an Alexandria, Virginia, operating location. Air Force terminal programs are executed by the **Electronic Systems Center** at Hanscom AFB, Massachusetts. MILSATCOM terminals are sustained by the ***Space Logistics Group*** in Colorado Springs, Colorado. MSM

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dustry 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 multinational forces from around the globe.

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Monday November 17, 2008

6:30 a.m.-8:00 a.m.—Continental Breakfast
8:00 a.m.—Opening Ceremony and Welcome

MilsatMagazine — November 2008

8:30 a.m.—Keynote Address
9:15 a.m.—Classified Technical Program
9:30 a.m.—Noon—Unclassified Technical Program, San Diego Convention Center
9:30 a.m.—11:00 a.m.—Naval NeTWAr
10:00 a.m.--12:30 p.m.—Classified Technical Program SSC, Pacific
10:15 a.m.-11:15 a.m.—Refreshment Break
12:00 p.m.-1:30 p.m.—Luncheon
1:30 p.m.-2:00 p.m. Exhibition Hall Grand Opening and Dessert (Exhibits remain open until 6:00 p.m.)
2:00 p.m.-5:00 p.m.—Classified Technical Program SSC, Pacific
2:15 p.m.-5:00 p.m.—Unclassified Technical
2:45 p.m.-4:30 p.m.—Defense Forum 1
3:15 p.m.-4:15 p.m.—Refreshment Break
4:30 p.m.-5:30 p.m.—Reception
6:30 p.m.—10:00 p.m.—Midway Magic aboard the USS Midway USS

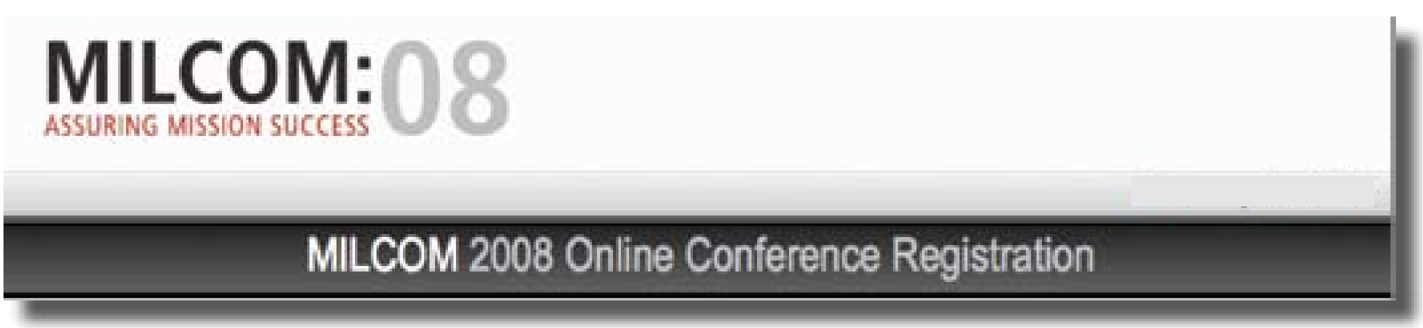
Tuesday November 17, 2008

8:00 a.m.—Opening Remarks + Keynote
9:00 a.m.—6:00 p.m. Exhibition Hall Open
9:30 a.m.—12:00 p.m—Unclassified Technical Program
9:30 a.m.-1:00 a.m—Defense Forum 2—Addressing C4I Impact on Mission Assurance
10:00 a.m.-12:30 p.m. Classified Technical Program SSC, Pacific
10:15 a.m.-11:15 a.m. Refreshment Break
Noon-1:30 p.m. Luncheon + VIP Guest speaker: The Honorable John Grimes, Assistant Secretary of Defense Networks And Information Integration (ASDNII) and DoD Chief Information Office (DCIO)
2:00 p.m.-5:00 p.m—Classified Technical Program SSC, Pacific
2:15 p.m.-5:00 p.m.—Unclassified Technical Program San Diego Convention Center
2:45 p.m.-4:30 p.m. Defense Forum 3 - Industry Perspectives on Assuring Mission Success
4:30 p.m -5:30 p.m. reception SDCC (Hall B)
6:30 p.m.-9:30 p.m.—Chairman's Gala Hyatt (Elizabeth Ballroom)

Wednesday November 19, 2008

8:00 a.m.—Opening Remarks + Keynote
9:00 a.m.-3:00 p.m. Exhibition Hall Open
9:30 a.m.-Noon—Unclassified Technical Program
9:30 a.m.-11:00 a.m. Defense Forum 4 - Counter Terrorism, Homeland Security & Disaster Recovery Mission Assurance Challenges
10:15 a.m.-11:15 a.m. Refreshment Break
Noon-1:30 p.m. Closing Ceremonies followed by Luncheon in Exhibit Hall SDCC (Exhibit Hall B)
2:15 p.m.-5:00 p.m.—Unclassified Technical
3:15 p.m.-4:15 p.m.—Refreshment Break
5:00 p.m.—Conference Adjourns

To learn more about **MILCOM: 08**, or to register to attend this informative event, select the graphic below to be taken to the registration page, or enter **https://reg.jspargo.com/milcom08/** into your web browser... we hope to see you in San Diego! MSM



...To Distributed Satellite Networks

by Bert Wilhelm, UPLOGIX

Satellite communications represent a cost-effective and reliable means of transporting voice, video, and data to and from remote locations. However, as the adoption of satellite based networks continues to grow, so do the security challenges for operational and IT staff. Maintaining network connectivity and availability, preventing outside intrusions especially from foreign grounds, and closing the loop on vulnerabilities due to natural disasters and power outages, have all become mission critical components to managing the remote infrastructure at the edge. Even more critical is having secure, always-available access to the remote infrastructure, especially when the network is compromised.

Should you lose your network connection, one of the most commonly used forms of access control is through ***out-of-band*** (**OOB**) connections, which have been largely unaddressed from a security standpoint. When a problem arises with an enterprise network connection via satellite, the OOB connection acts as the 'back door' to provide a secondary means of accessing devices and systems if the primary connection has been lost.

Unfortunately, OOB connectivity for remote console management has not seen the same degree of security improvements that have been made to production networks. For example, access to an OOB connection may require only a static username and password and the connection may not be encrypted. This is a risky practice because remote administration requires access to the device console. If the unsecure OOB connection is hacked, then the thief has console access to the network equipment and/or servers. This means 'carte blanche' to execute operations and changes to the devices and could gain access to other parts of the network. If configuration changes or updates don't work, it's critical to be able to retrace the steps that were taken. If contractors or other third parties do work, logging provides a record of their activities.

Entering the picture is a new technology called ***secure remote management*** (**SRM**). SRM brings new functionality and intelligence that takes an integrated approach to solving the OOB security predicament. SRM does this by locking the 'back door' to ensure internal security and management policies are always enforced, even during a network outage.

Secure Remote Management: Locking the Back Door

Compared with traditional network and systems management tools that rely on the network and remains labor-intensive, secure remote management combines the localized control and connectivity of a console server with the intelligence of an enterprise software solution. The platform 'front-ends' a remote office's equipment by safeguarding against the vulnerability of the OOB dial connection, allowing only outbound dialing or answering calls when the primary connection has been lost. Secure remote management controls access to routers, switches, and servers by enforcing AAA policies and integrating with IAM systems.

Schlumberger, one of the world's leading oil services company, was faced with the challenge of maintaining constant connectivity with isolated locations. Communications between customers' remote sites, such as offshore oil rigs, and Schlumberger's land-based teleports is conducted via VSAT satellite communications, which are often interrupted due to rain-fade and other types of unavoidable interference. An out-of-band solution was required that could maintain constant communications and manageability even when the main communications link was down or disrupted.

Implementing secure remote management has allowed IT staff to automate network fault diagnosis and recovery, as well as perform routine network maintenance (such as the configuration and provisioning of devices). SRM ensures network availability, even when the primary connection is down. Furthermore, if the main broadband satellite link goes down or is disrupted, the secure remote management appliance deployed at the disconnected remote location automatically dials out to a low earth orbit (LEO) satellite via an integrated external modem to re-establish an alternate, out-of-band network connection.

Losing access to your distributed network or being blind-sided by internal security threats has been greatly overlooked. By locking the back door with new secure remote management practices, military and energy organizations now have access and control regardless if the network is up or down — putting IT staff at ease knowing they aren't the easiest target on the block.

About the author

Bert Wilhelm is the Director of Product and Technical Marketing at Uplogix and can be reached at bwilhelm@uplogix.com.

How Secure Remote Management Works

As secure remote management (SRM) appliances are deployed at remote locations, they can locally manage a wide variety of networking gear, including switches and routers, intelligent racks, and power and environmental control systems.

To ensure the SRM appliances can communicate during a network outage, a secure and reliable alternative communication path is designed into the architecture. Through this direct connection to the console (serial) ports of the remote devices, the appliance can query the connected devices every few seconds, storing the data locally.

As the data is stored locally and doesn't need to be transmitted on a regular basis, there isn't a cost penalty for sampling frequently. Detailed event logs are available on an as-needed basis to help with problem resolution. Once a sufficient repository of data has been gathered, it can then be analyzed. For an SRM appliance polling console ports at a remote location, the amount of data to indicate a problem can usually be gathered in 30 seconds or less.

Once the data has been gathered, a policy engine inside the appliance determines if a parameter is in or out of specification, and either resolves the incident based on pre-approved guidelines, or communicates the problem back to the network management center.

Once a problem signature is recognized, the SRM appliance can take steps to automatically resolve the incident and restore the service.

In addition to restoring network connectivity, the logged and stored management data enable IT and service providers to establish root cause that required the reboot so it can be avoided in the future, or established as a routine device issue that the SRM appliance is authorized to address automatically.

Unexpected downtime is always a possibility during software upgrades of network hardware. In some cases, the devices fail to boot after a new software load, thereby requiring a reliable and secure way to backtrack. In these cases, the SRM appliance needs to be able to restore the last-known-good-configuration automatically. The local control logs can then be examined once the network has been restored to understand what caused the network aberration.

Management actions and associated logging data exchanged between the NOC and the remote sites should be safeguarded. Designing a remote management platform with a robust AAA (authentication, authorization, and audit) security model, combined with the physical properties of a specific purpose appliance, ensures the protection of the systems and network devices and the network itself. This way, all actions are logged and stored locally, giving visibility to all management actions to these devices.

Isode's Messaging and Directory Server software is used by Government, Militaries, Intelligence Services, Aviation Authorities and Commercial organizations worldwide. Isode is an Open Standards company that excels in providing robust, scaleable products and excellent support. Isode products are most often delivered as part of a larger system implemented by our network of solutions partners.

In the military arena, Isode products conform to all of the relevant military messaging and directory standards including:

- STANAG 4406: The NATO standard for Military Messaging based on X.400
- STANAG 4406 Annex E: Support for very low bandwidth links such as HF Radio
- ACP 133: The military directory standard
- STANAG 5066 SIS protocol: Enabling an application to connect to a HF Modem through a STANAG 5066 server over TCP/IP

Military Messages often need to be transferred over low bandwidth networks, in particular HF Radio and Satellite Networks. The two military specifications for this type of messaging environment are NATO's **STANAG 4406 Annex E** and **ACP 142** developed by the **CCEB** (***Combined Communications-Electronics Board - AU, CA, NZ, U.S., U.K.***). There are a number of basic technical challenges that arise from military messaging deployments, some of which are particularly relevant to constrained communications channels.

- Low bandwidth. Many of the communication channels used are very slow, down to as little as 75 bits per second. With bandwidth this constrained, it is imperative that protocols make efficient use of it.
- High latency. Very often, slow links have long round trip times. Satellite links are usually faster, but have very high latency. To work well in high latency environments, protocols should be "non-blocking" as much as possible.
- High error rates. Typical communication channels will often have high error rates, and applications must be robust to this.
- Multicast. Many of the communication channels used are inherently multicast (e.g., radio, satellite). Messages are often sent to multiple destinations, and it is desirable that protocols can take advantage of the multicast nature of the underlying media. To some extent, this can compensate for low bandwidth.
- EMCON (Emission Control). Deployed units will in many situations wish to not broadcast signals, in order to help hide their location. The situation where signals can be received but not sent is referred to as EMCON. It is important to be able to send messages to a unit in EMCON.
- Priority. Formal military communications have an associated priority (precedence). In a low bandwidth environment, it is easy for message queues to build up, and so it is critical to have mechanisms which will ensure that the highest priority messages get through first.

Scenarios

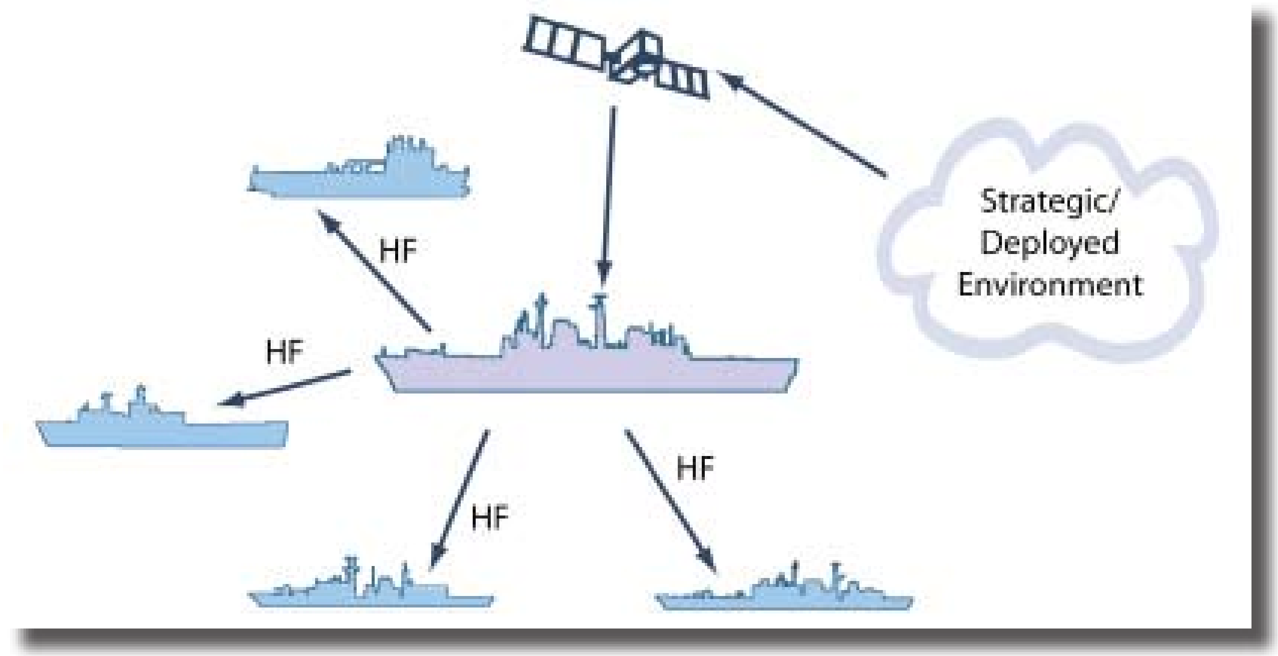
This section considers a number of scenarios where the technologies described here are important and is not intended to be an exhaustive list.

Surface Fleet Communication

Naval communication is a major target. Although communication could flow from the strategic environment directly to task force ships using broadcast radio, this is not generally the approach used.

When ships are deployed as part of a task force, communication will generally go to the designated command ship (usually a larger surface unit with the necessary command, control and communication equipment).

At the strategic level, messages may come from a **COMCEN** (***Communications Centre***) on shore or directly from originators in the strategic environment. Maximum support of messages direct from originators is desirable. Messages are then relayed onwards to



the other ships in the task force, often using the same communications technology as in ship to shore.

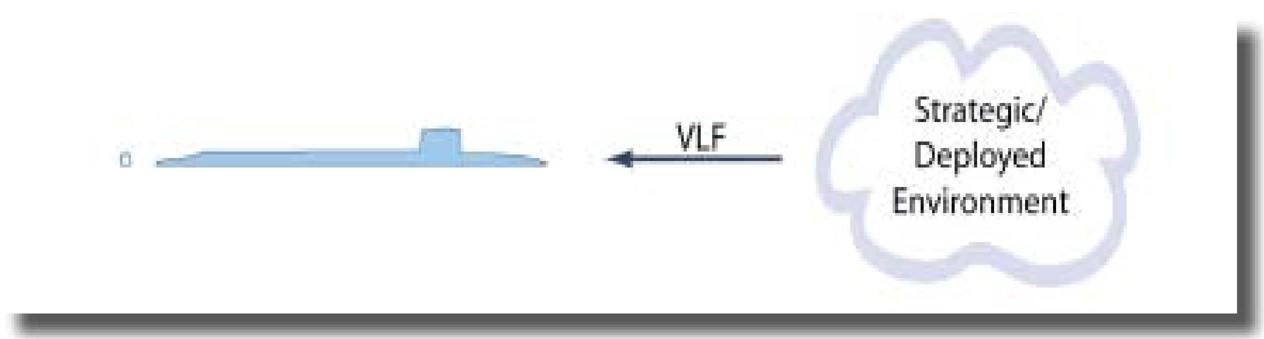
The illustrated scenario above depicts use of satellite to reach the command ship and broadcast **HF** (***high frequency***) radio for communication with the other units in the task force. Multicast can be used for communication from the command ship to the other ships. In **EMCON** (***Emissions Control***), messages can be received from shore or from other vessels, but not transmitted between ships or back to shore. More complex situations may arise with individual vessels in EMCON.

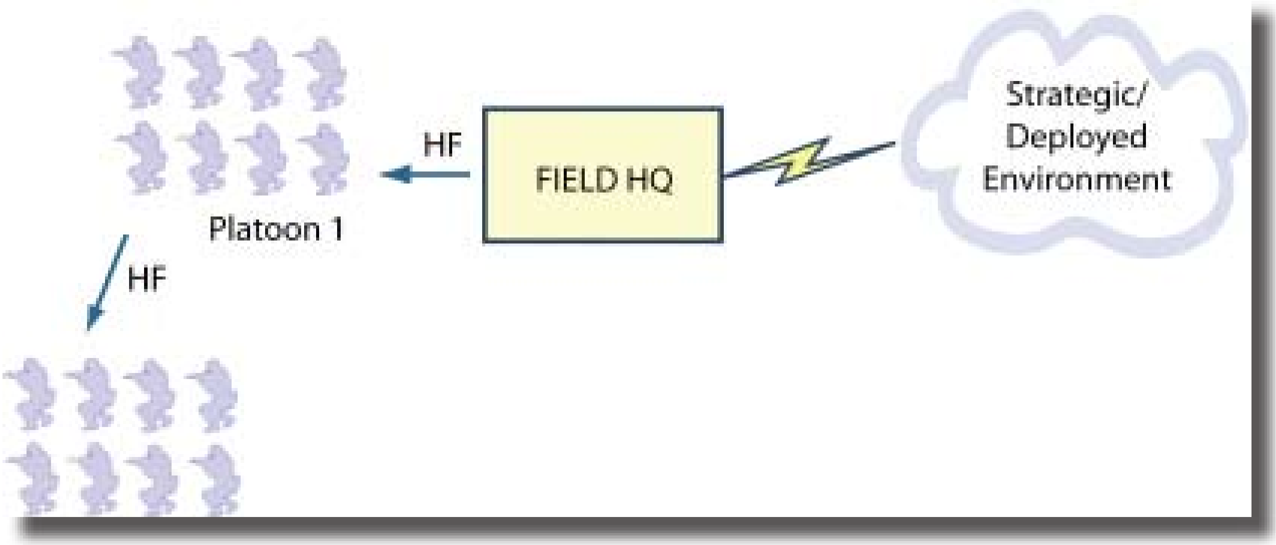
In general, a ship would have a number of potential internal message recipients, and the external message communication needs to be connected with the internal messaging infrastructure.

Submarine Communication

Communication with submarines introduces a number of special requirements. Submarines may make use of higher bandwidth channels when they are on the surface. They will also use **VLF** (***very low frequency***) radio, which has a data rate of around 300 bits per second. VLF radio has the advantage that it will penetrate below the surface for a moderate distance, and so can be used by a submarine without surfacing.

When submarines dive below the level of VLF penetration, they will be out of all communication, and so this leads to three basic states: full communication; EMCON; no communication. These need to be managed, and shore systems will be most effective if they understand the current state of communication, a situation also relevant to the previous scenario. This is achieved by planned timing of communication status, which is shared between submarine and shore.





Army Deployment

The army has similar requirements. Typically, there will be high bandwidth communication to field HQ. Communication to field units may be bandwidth constrained, and there may be requirement for EMCON. In some situations, store and forward messaging is useful, for example to send key information (*e.g.*, map data) or to send a formal message in preference to voice communication.

In the scenario illustrated above, there is no direct communication from field HQ to a second field unit, but messages can be relayed by use of the messaging system in the first field unit. This relay needs to be fully automated, and not require manual intervention at the first field unit.

Special Forces

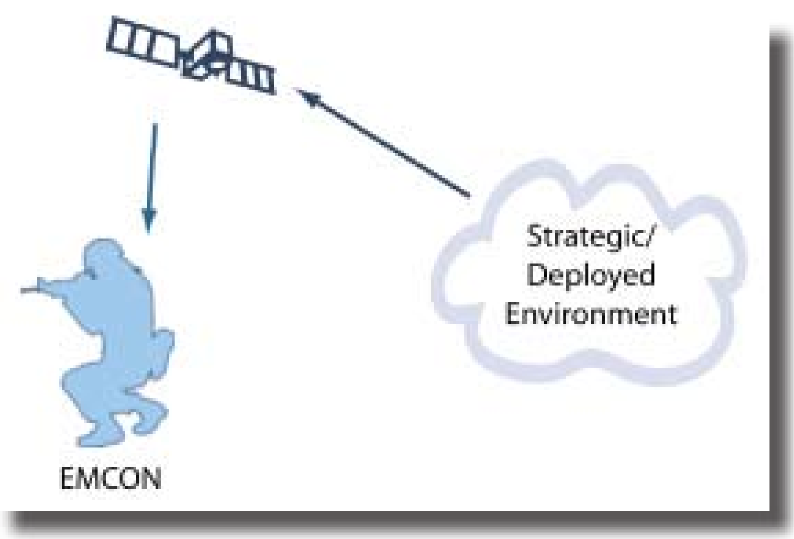
Another requirement is to support special forces operatives, illustrated to the right. It will often be desirable or essential to have radio silence (EMCON), but to retain the ability to listen and to receive messages.

The diagram on ***Page 78*** reveals a ***STANAG 4406 Annex E*** messaging architecture, with protocols down to the ***ACP 142*** level. Mappings below ACP 142 to support Satellite and HF Radio are described later.

STANAG 4406 Messaging

STANAG 4406 defines a family of protocols to support military messaging, based on the **ITU X.400 Standards**.

- STANAG 4406 specifies an end to end message protocol for communicating between a pair of messaging clients, which are referred to as User Agents (UA). This end to end protocol is based on the X.400 P2 Interpersonal Messaging Protocol, extended by the P772 protocol defined in STANAG 4406 that provides enhancements for military service capabilities and military body parts.

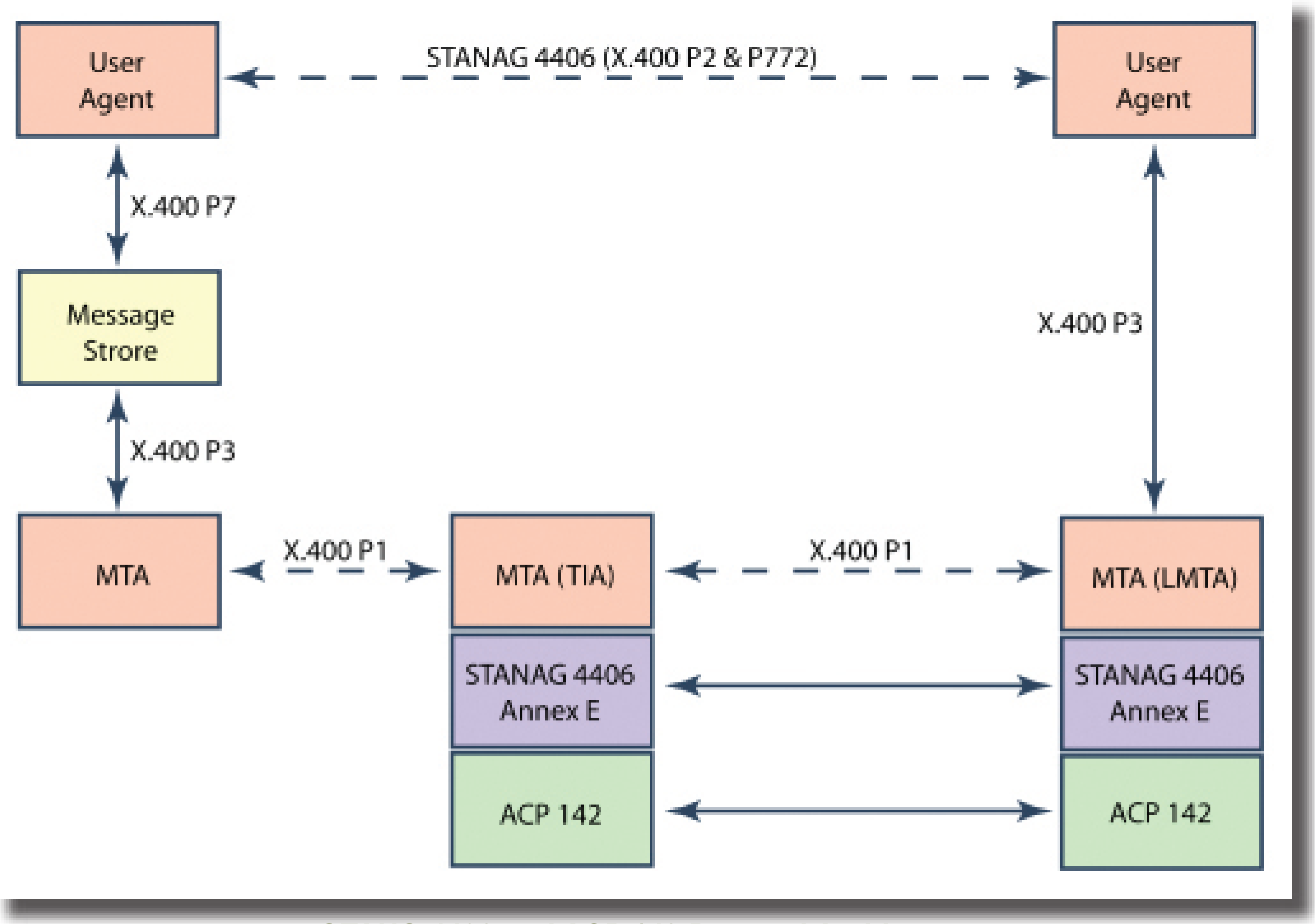


- STANAG 4406 messages are switched by store and forward message switches, which are referred to as Message Transfer Agents (MTA). When MTAs communicate over a high speed network they use the X.400 P1 Protocol, which has a mapping onto TCP/IP referred to as "full stack". The TIA and LMTA are special types of MTA, which are described in more detail later. The diagram above shows two of the MTAs communicating using X.400 P1.
- A UA may communicate directly with an MTA using X.400 P3, or indirectly by a Message Store (MS) using X.400 P7. Both options are shown above. Further information on use of a Message Store is given in the Isode Whitepaper Why X.400 is good for high reliability messaging.

STANAG 4406 Annex E

STANAG 4406 Annex E defines a light weight alternative to (full stack) X.400 P1 for communicating between a pair of ***mail transfer agents*** (MTAs). This is shown in the diagram above, communicating between the MTA (TIA) and MTA (LMTA).

STANAG 4406 Annex E specifies operation over ACP 142, which is described below. Annex E uses the core format of X.400 P1, but replaces the "full stack" mapping with a light weight mapping



STANG 4406 and ACP 142 Protocol Architecture

that comprises:

- A simple protocol that provides the necessary services over ACP 142, and minimizes overhead. This provides a block of data to ACP 142 that encapsulates the X.400 P1 information
- Annex E provides general purpose data compression, that helps reduce data transfer volume for protocol, addressing information, and general data transferred (e.g., text). This compression complements application specific compression techniques (e.g., map and image compression)

Distributed operation procedures for an X.400 MTA, to correctly integrate with EMCON and multicast. The key functions of Annex E are to reduce to a minimum the amount of data transmitted, and to integrate ACP 142 multicast and EMCON functionality into an X.400 MTA.

ACP 142

ACP 142 "***P_Mul – A Protocol for Reliable Multicast Messaging in Constrained Bandwidth and Delayed Acknowledgement (EMCON) Environments***" is a CCEB standard for multicast and EMCON support, specifically designed to support NATO's STANAG 4406 Annex E.

ACP 142 is an end to end protocol, that can map onto various underlying transport mechanisms described later. It works to transfer data reliably from one system, to one or more recipient systems. A brief summary of how it works is as follows:

1. It works out the address to use for the set of intended recipients. There are three options:

- Single recipient (Unicast). ACP 142 is fundamentally a multicast protocol, and unicast is a special case. For Unicast, the standard address of the recipient is used.
- Static multicast. Here a multicast address is assigned to a fixed set of recipients. This is useful for very small networks, and for frequently used combinations of recipients in larger networks. A static multicast address can be used without any special negotiation.
- Dynamic multicast. Each sender has a set of multicast addresses reserved for dynamic multicast. ACP 142 allows the sender to negotiate a specific set of recipients to be associated with one of these addresses. This allows dynamic multicast to be used for an arbitrary set of recipients.

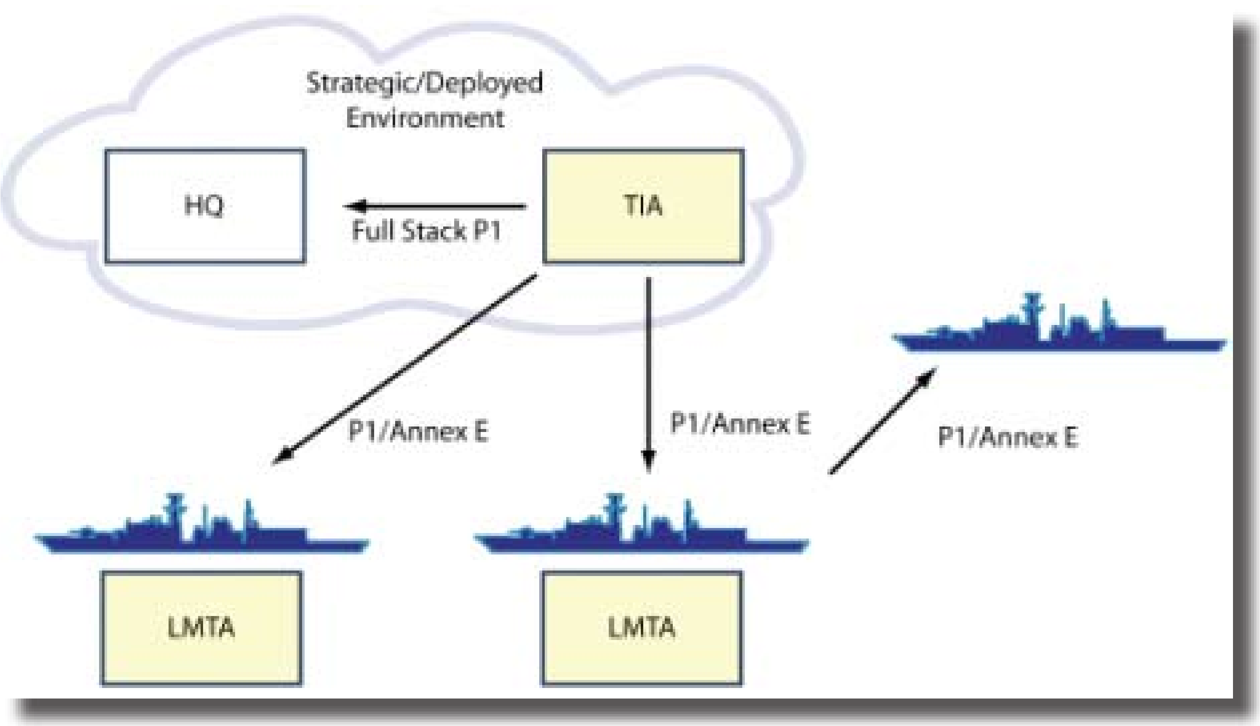
2. The sender breaks up the data to be sent into a fixed number of packets, and communicates the number of packets to be sent.

3. The sender then starts sending out data packets, at a rate appropriate to the underlying communication channel.

4. In non-EMCON, each recipient will communicate back to the sender a list of packets that it has not received. This will allow the sender to retransmit lost packets, and to efficiently complete transfer of the data to all recipients.

5. In EMCON mode, a recipient will not be able to send any data back to the sender. In this situation, the sender will simply retransmit the entire message at intervals, to maximize the likelihood that all packets are correctly received.

6. ACP 142 is aware of STANAG 4406 (six level) message priority. Higher priority packets are always sent first by ACP 142. This means that a higher level message will naturally “overtake” a lower priority message that



is partially transmitted.

The details are more complex, but the essence of how ACP 142 works is quite straightforward. It can be seen that ACP 142 provides the core EMCON and multicast functionality needed.

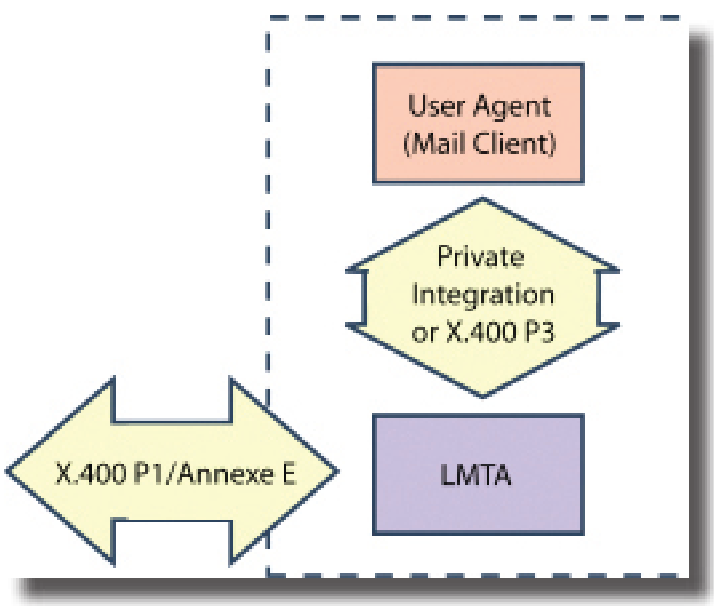
LMTA and TIA

Annex E (see illustration on previous page) defines protocols and procedures for integrating an X.400 MTA with ACP 142. Annex E defines two basic configurations of MTA.

1. LMTA (Lightweight MTA). This is an MTA where the only external communication makes use of P1/Annex E. An LMTA is appropriate for a ship where all internal communication goes direct to the LMTA.

2. TIA (Tactical Interface Agent). This is an MTA which makes use of P1/Annex E to communicate with LMTAs (or other TIAs). It will also communicate with "full stack" P1 to other MTAs, to enable LMTAs to be interconnected to a general X.400 network.

Isode's ***M-Switch X.400*** can act either as an LMTA or as a TIA. This is a configuration choice, and there is no product difference between TIA and LMTA.



Supporting Small Systems

For a large unit, such as a ship that has multiple users, it is natural for the system to contain an MTA (LMTA or TIA). The MTA will enable local message distribution and give a natural external interface. For small systems, typically supporting only one user, Isode recommends the architecture as illustrated in the diagram at the bottom of the previous column:

This approach uses an LMTA on the same machine as the mail client. The LMTA would have a very simple local and routing configuration. The benefits of this approach are:

1. There are no changes to the mail client needed to support a bandwidth constrained environment.

2. The LMTA is optimized to handle the constrained communication channel, and can efficiently manage retransmission and other procedures.

For a modern platform, and efficient MTA such as Isode M-Switch X.400, there is little functional or system overhead in having an MTA on the local system.

Supporting Different Networks

ACP 142 and STANAG 4406 Annex E can be used over multiple network technologies — this article looks at use of Satellite Networks and HF Radio.

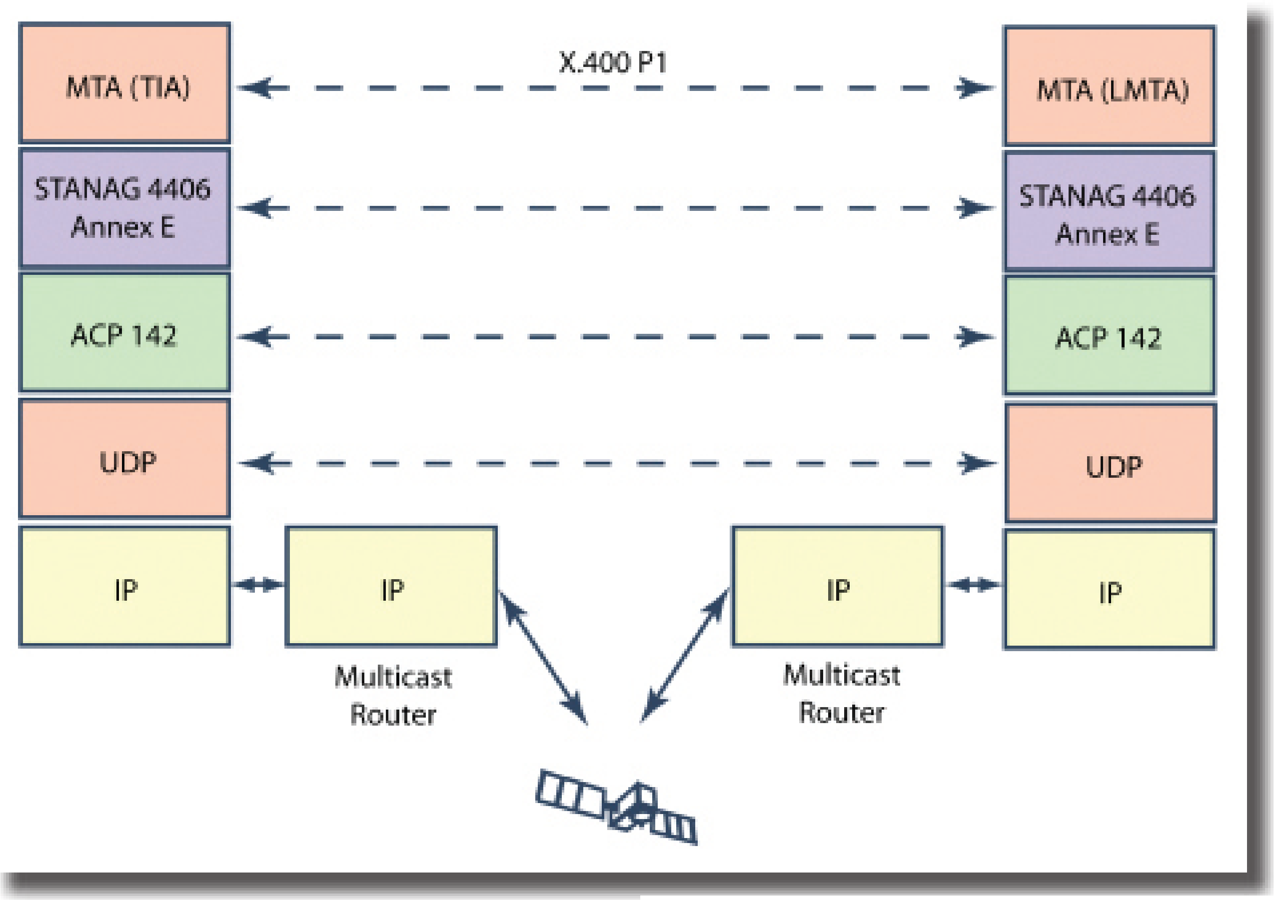
Satellite Networks

Satellite networks provide IP, and so full stack P1 could be used over TCP/IP. This may be done, but in many situations there are the following advantages to using STANAG 4406 Annex E and ACP 142:

1. Satellite networks are often quite slow, and the performance advantages of Annex E to reduce data volumes can be beneficial.

2. Satellites have high latency, and ACP 142 is optimized for high latency networks.

3. For messages sent to multiple destinations, ACP 142 allows the broadcast capability of the satellite to be used, which is desirable to optimize overall network use.

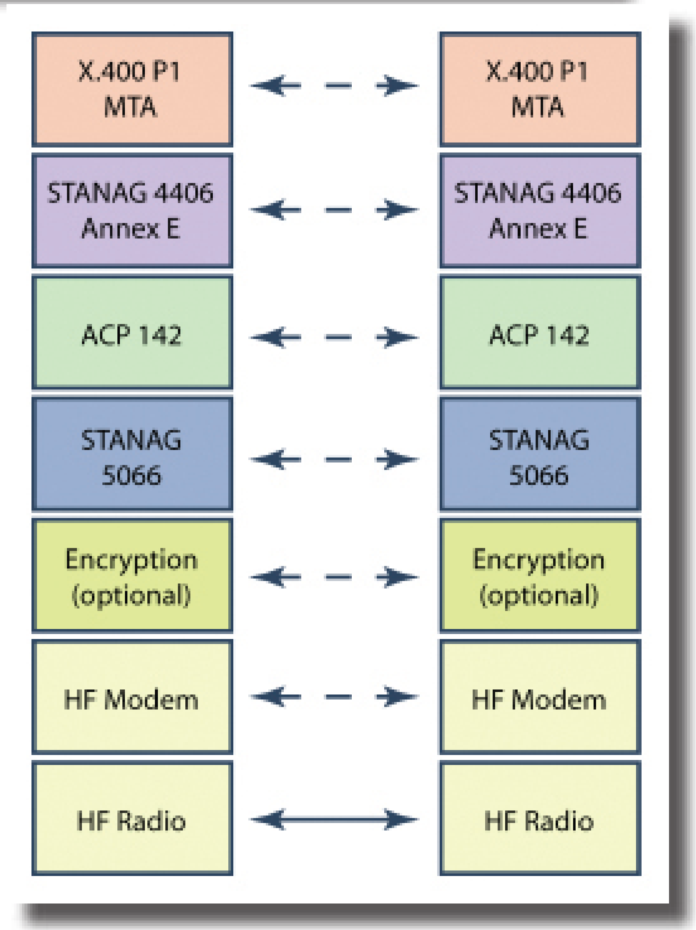


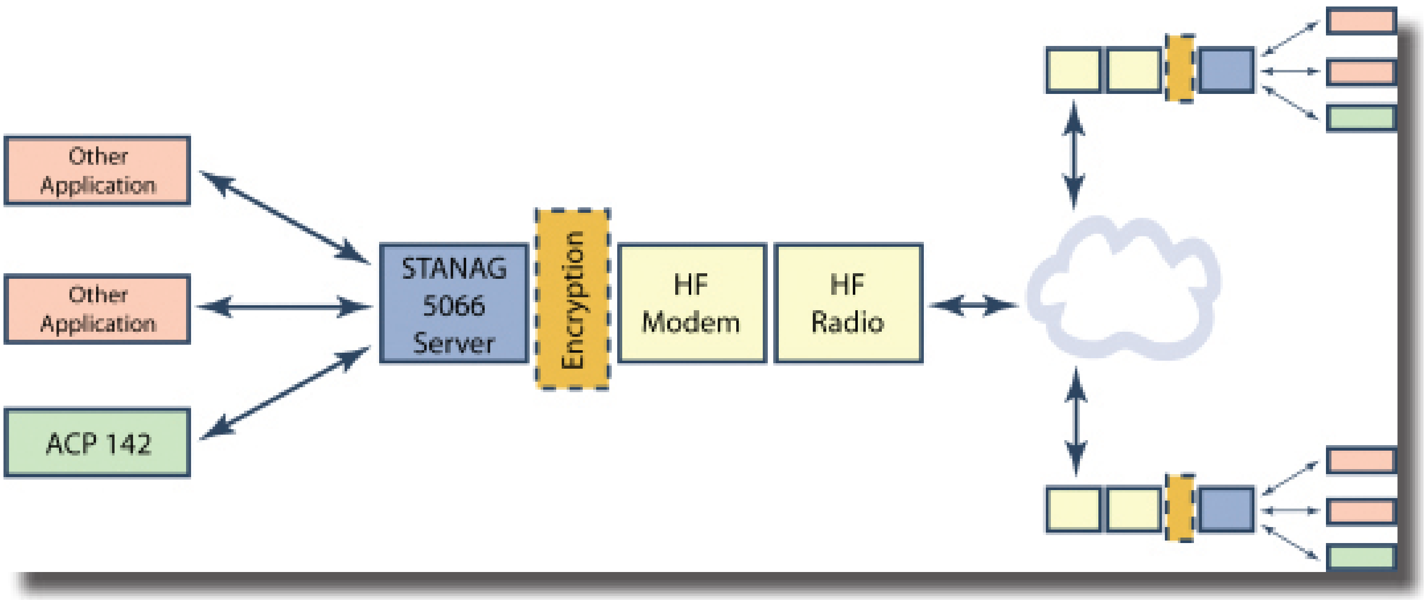
4. ACP 142 supports recipients in EMCON, which is not possible with protocols operating over TCP.

ACP 142 makes use of UDP (User Datagram Protocol) to operate directly over IP. This configuration can work over any IP network, making use of IP multicast. To support multicast, multicast support is necessary in all of the routers used. The example here shows a satellite connection between a pair of routers. This reflects a typical configuration, as in general the MTA will not be connected directly to a satellite router.

HF Radio

HF Radio is important for military communications, because of its effectively unlimited range. Applications running over HF Radio use STANAG 5066.
The diagram to the right shows the protocol stack used over HF Radio. The protocol architecture has ACP 142 operating directly over STANAG 5066. This direct mapping is optimized, and handles priority,





as the priority of each ACP 142 packet is mapped on STANAG 5066 priority. This is important if multiple applications are operation over one modem/radio.

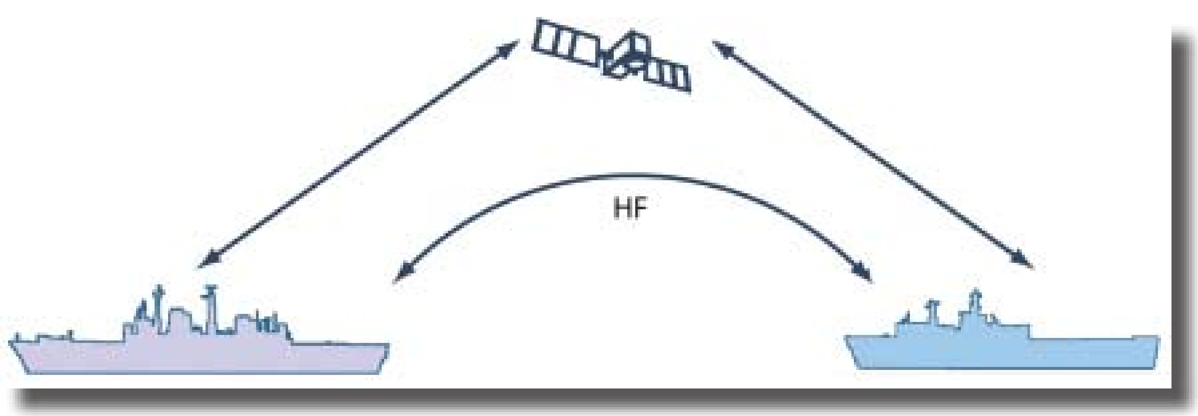
A key capability of STANAG 5066 (***illustration above***) is that it enables multiple applications to share a single modem/radio. STANAG 5066 applications connect by a STANAG 5066 standard protocol to a single STANAG 5066 server associated with the modem/radio. This also allows the application to run on a different computer and connect to the STANAG 5066 server over TCP/IP. This is convenient for large deployments. For small deployments, all components may run on a single system.

Handling Multiple Communication Channels

The article so far has primarily considered use of a single constrained bandwidth communication channel. This section shows that many real deployments have multiple communication channels.

A ship will typically have two or more communication channels (illustration below): HF Radio and Satellite. The combinations in use will depend on threats:

- Both channels in EMCON.
- Both channels active.
- One channel in EMCON. Typically Satellite channel will be in EMCON, because it has a stronger signal and is more visible. However, the "pencil beam" nature of the satellite and location of threat may lead to HF channel in EMCON and satellite active.
- When both channels are open, use of Satellite may be preferred (higher bandwidth) or use of HF radio (lower cost), or a more complex preference dependent



on messaging load.

With a headquarters unit, the EMCON status is simpler (as it would never be in EMCON), but there may be many more channels, for example to support multiple satellites with different ships reached through different satellite services. Other shore based systems, such as Special Operations could be in EMCON. It can be seen that these multi-channel scenarios add some significant complexity.

Multi-Hop Routing

The initial scenarios showed situations where a message needs to be sent from TIA to LMTA and then on to another LMTA. This multi-hop routing can be important where there is not direct connectivity from TIA to an LMTA. A good STANAG 4406 Annex E solution should support multi-hop routing.

Measuring MMHS Performance over HF Radio and Satellite — STANAG 4406 Annex E Encoding/Compression

This section of the article looks at the encoding and compression of ***STANAG 4406 Annex E*** messages, which is common to both HF Radio and Satellite transmission. The information shows that the encoding of messages is reasonably efficient, and that effective compression can be achieved.

What is Being Measured

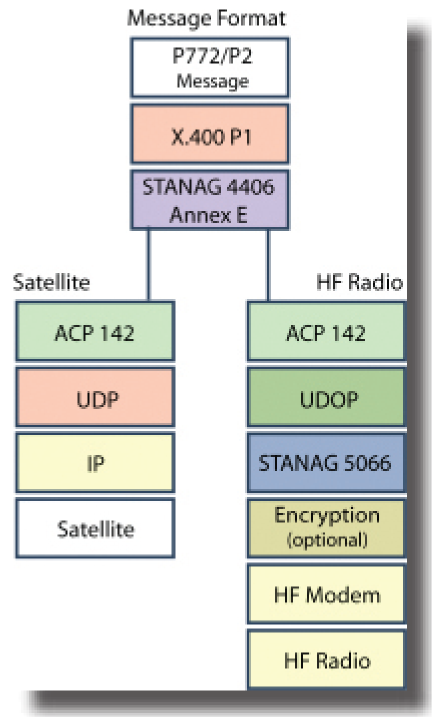
The diagram at the top of the next column shows the protocol layers for MMHS over HF Radio and Satellite. This paper looks at the Message Format (top box), which is the static format common to both **HF Radio and Satellite**.

Network Bandwidth

Constrained bandwidth covers a range of speeds, and the numbers in this article have differing impact across this range of speeds. ***Table 1*** on ***Page 84*** gives notes on different speeds. The implications of the analysis in this paper and its companions will have quite different impact across this range of speeds.

Why Measure?

When communicating over constrained networks such as HF Radio and Satellite, it is important to optimize use of the link. In order to do this, an understanding of the operation of the underlying protocols and the applied load is important. For most scenarios, these measurements need to be interpreted in the context of anticipated traffic load, network configuration and network speed. Outcome of this interpretation may be one or more of:



1. **Information on the best approach to configuration and option selection for the applied load.**
2. **An understanding that the protocols are performing well, and where the limits of performance are.**
3. **Information on how protocols may be adapted to improve performance.**

There are many ways that protocols can be modified. We have observed attempts and suggestions for change that we suspect will make little difference to performance for real traffic. This analysis aims to help determine the most effective points for protocol change to address real operational problems.

How Measurements Were Made

Messages were created using Isode's test User Agent XUXA, and sent over STANAG 4406 Annex E. The size of three things was measured:

1. **The Message Content (P2 or P772) size.**
2. **The size of the uncompressed message envelope (including message content) in P1 format.**
3. **The size of the compressed output of STANAG 4406 Annex E, which is passed to the ACP 142 layer.**

The first two measurements show the **ASN.1** encoded size of the data to be transferred, and the third measurement shows the effect of the STANAG 4406 Annex E encoding and compression. Annex E

Speed	Notes
1 M/bits/sec	Typical, modern satellite throughput. Although ver fast, relative to speeds below, this is slow in comparison to commercial networks and be a significant bottleneck.
9,600 bits/sec	Typical speed for currently deployed military satellites. Top end of HF throughput, which may be achived in good conditions, with good aerials and strong transmitters (e.g., maritime deployment)
1,200 bits/sec	Typical operational HF throughput. This number is taken as a figure for generic HF analysis
75 bits/sec	Bottom end of HF throughput
10 bits/sec	Rate for ELF transmission to submarines

Table 1

allows a choice of compression algorithm, but only one (zlib) is currently mandated.

These tests use ***zlib compression***. An initial "base" test was done, which comprised a message with an absolute minimum of features, and short (but reasonable) X.400 addresses. Subsequent tests added one or more items relative to the "base", to show the effect of different services and attachments.

The Measurements

This table is far too large to comfortably fit within the confines of ***MilsatMagazine.*** Should you wish to view the data in this highly informative table, please either select the following link, or copy and paste the URL into your Internet browser application...

http://www.isode.com/whitepapers/mmhs-hfradio-satellite.html

Analysis & Conclusions

Looking at the data at the linked table above, the following conclusions can be drawn:

1. The basic ASN.1 encoding used in X.400 and STANAG 4406 is a reasonably compact and efficient encoding (unlike Text and XML encodings) and the data sizes are reasonable for the information carried.

2. The "base" size of data transferred of 233 bytes represents an approximate minimum data size. For most environments, this overhead will be quite acceptable. A future white paper will consider situations where this size may be too large.

3. Addition of features appears to give a sensible "per feature" overhead for a range of different extensions. Where it is necessary or desirable to go beyond basic capabilities, the encoding cost of these additional features is acceptable.

4. The standard zlib compression achieves 35-40 percent compression with the core message and message features. This seems reasonable. It is likely that some of this compression is due to regularity of the ASN.1 encoding.

5. Body part compression is very much dependent on the compression achieved for the body part in question, and for larger messages compression will be dominated by body part compression. Compressed data types such as JPEG give almost no compression, whereas text documents and formats such as *Word* compress well. Where heavy use is made of a special body part type, it may be appropriate to use compression algorithms optimized for that sort of data.

The broad summary is that for most deployments and configurations that the STANAG 4406 Annex E encoding is appropriately compact and that the compression will work well, providing clear benefit.

Isode we builds high performance messaging and directory server products, using Open Standard protocols. The Company's ***M-Vault*** (**LDAP/X.500 Directory Server**), ***M-Switch*** (**SMTP and X.400 Message Switch**), ***M-Box*** (**POP/IMAP Message Store**) and ***M-Store X.400*** (**X.400 Message Store**) products are used around the world by Aviation Authorities, Government Departments, Military & Intelligence Services, Financial Institutions, Internet Service Providers as well as a host of other businesses in areas where secure and robust directory and messaging servers are vital. You can locate additional information at their website... either select the graphic below or enter **http://www.isode.com** into your Internet browser.

Further Information

This article has described ***STANAG 4406 Annex E*** from a scenario and protocol architecture perspective. ***Packaging Military Messaging for HF Radio and other Low Bandwidth Links,*** provides a different perspective, looking at hardware and how component products are grouped together.

Isode's military messaging solution is summarized on the web page :

Military Message Handling Systems (MMHS)
http://www.isode.com/solutions/military-messaging.html

MSM

About the author

Steve Kille is the CEO of Isode, which he founded in 1992 and re-launched in 2002. Steve is an Internet pioneer and visionary, who has been closely involved with many key Internet technologies since 1980, and has brought several of them to market with Isode Steve led the original Isode business of high end messaging and directory server products. In 1999, he merged Isode to found MessagingDirect. MessagingDirect developed the e-Courier electronic Document Delivery Product using the Isode products. MessagingDirect was sold to ACI Worldwide in 2001 and Steve negotiated a deal with ACI to re-launch Isode in 2002.

Steve is a well known speaker and recognized industry visionary. He has 20 years of experience with messaging, directory, security, and e-commerce, and has been responsible for a range of widely deployed products and standards. He has written more than 40 RFCs (Internet Standards) and is one of the authors of LDAP *(Lightweight Directory Access Protocol).*

From 1981 to 1992, he was a Senior Research Fellow at University College London and led US and European funded research projects on messaging, directory, networking and distributed systems. He has worked with the Internet and Internet standardization since 1981. He has published a book and numerous papers and articles. Steve has BA and MA honors degrees in Physics from Oxford University, and Masters degrees in Electrical Engineering from University of Manchester Institute of Science and Technology and Stanford University, where he was a Fulbright scholar.

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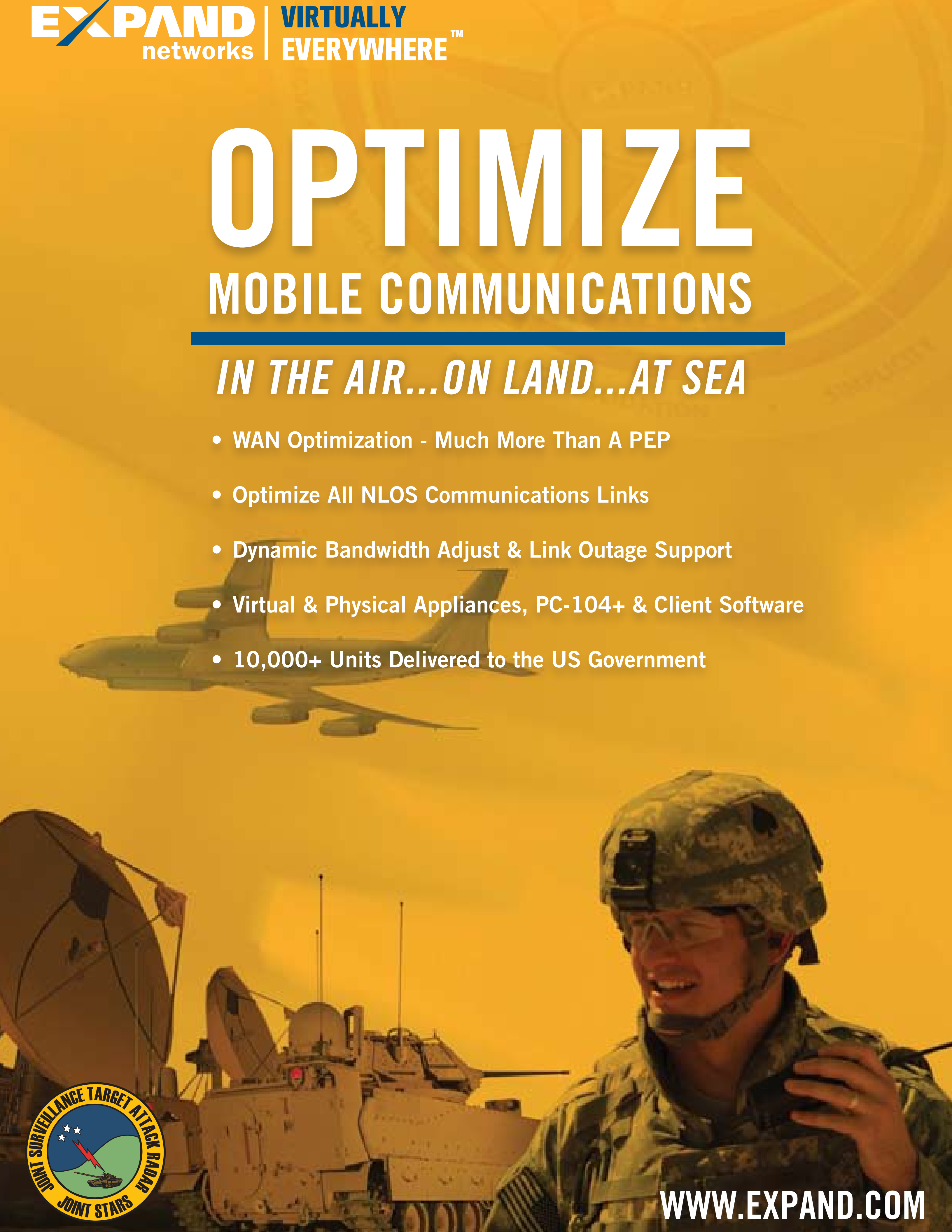
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