SatCom For Net-Centric Warfare July 2009

MilsatMagazine

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INCOMING

FACT: MILSATCOM saves lives. *Such requires constant work. No sooner is one technology implemented than another requires testing and consideration and then implementation. Certainly a never-ending process, but one that's crucial to those who are laying their lives on the line to ensure the safety of a nation's citizens. In this info-packed issue, we present a variety of topics to assist with this process that should be of interest to NGOs, government agencies, first responders and our military muscle to consider as routes to more secure, more reliable, and more effective communications.*

I wish to add it would behoove all to read our the current issue (July/August 2009) of our sister publication, ***SatMagazine****, as this issue's — BEAM — section alone offers analysis regarding today's SATCOM market and where it may well be heading in the future. Articles from the pros at the Satellite Industry Association, Near Earth LLC, World Teleport Association, Euroconsult and NSR all tackle informative themes ranging from the state of our satellite industry, to what satellites are expected to be launching between now and 2018, with a most comprehensive overview of the 2nd Annual Space Business Forum, Earth Observation, and MSS Financing, among other articles. Select* ***this direct link*** *to access that issue online in your web browser.*

TWITTER *is a highly effective method of relaying immediate information to those who "follow" a specific individual… getting TWEAKED or TWITTED means you are receiving the thoughts and news of an almost instant nature, delivered directly from the sender to the display device of your choice.* ***SatBoy*** *is our publication group's TWITTED OUT representative and, daily, the latest info from* ***SatNews*** *is sent as a TWEET message to those who follow (subscribe) to his missives. To join in the fun and the information, head over to* ***http://www.twitter.com*** *and make your request to follow SatBoy… easy to do, and simple to receive. Additionally (we haven't told this to SatBoy yet), you can easily remove yourself from SatBoy's tweets anytime you wish! — Hartley Lesser, Editorial Director*

ARINC Incorporated and its partner, **Impeva Labs**, have received a U.S. Army contract for additional test deployments of their mesh network, satellite-based, global asset visibility system, known as *Next Generation Wireless Communications* (**NGWC**) *for Logistics Applications*. This award follows recent successful testing of NGWC at Moffett Field, California,

where the system demonstrated continuous visibility of large quantities of assets during simulation of depot storage as well as simulation of transport by truck or rail convoy. The new contract covers deployments of the NGWC system in two very different environments. The first environment, just completed, includes tracking of individual military assets during sea transport and offloading in the **2009 JLOTS** (*Joint Logistics Over-The-Shore*) amphibious exercise at Camp LeJeune, North Carolina. Later this year, the second environment will be tested, that being the NGWC tracking system at the Army's 36,000-acre *Sierra Army Depot* (**SIAD**) in California, where it will provide continuous real-time visibility of containers, rolling stock, and other selected assets.

Ball Aerospace & Technologies Corp. has been awarded a $13.4 million U.S. Air Force con-

STP-SIV spacecraft (Ball Aerospace)

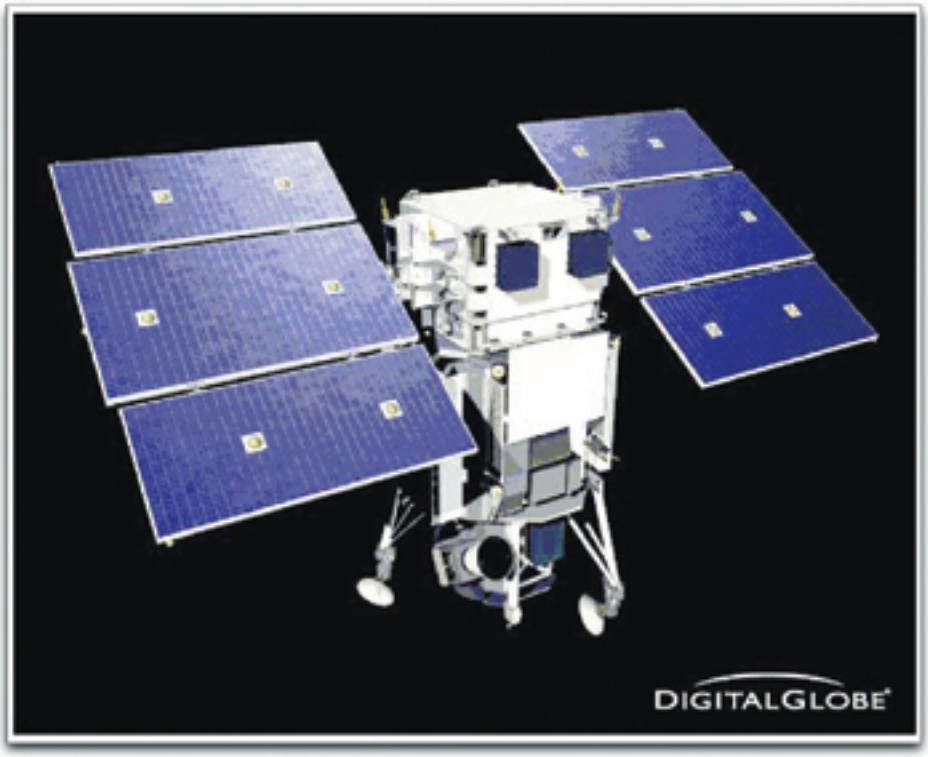
tract to procure long-lead hardware for a second ***Space Test Program Standard Interface Vehicle*** (**STP-SIV**) spacecraft. The first STP-SIV spacecraft launch is expected in the first quarter of 2010. The contract follows the prime contract signed in April 2006 for the first ***Department of Defense*** (**DoD**) STP-SIV vehicle, that included a provision for as many as six vehicle orders for the ***Air Force Space Development & Test Wing***'s (**SDTW**) ***Space Development Group*** at **Kirtland Air Force Base**, Albuquerque, New Mexico. The system is a key enabler for the DoD Space Test Program. The contract is a follow-on to the first STP-SIV space vehicle, which recently completed the initial phase of system environmental testing including electromagnetic interference and compatibility, to be followed by vibration and thermal vacuum testing.

Ball Aerospace & Technologies Corp. has also completed environmental testing for **NASA**'s

NASA's Widefield Infrared Survey Explorer (WISE) (Ball Aerospace)

Widefield Infrared Survey Explorer (**WISE**) and has begun post-environmental performance testing. WISE is working to a date of November 1, 2009, for launch from **Vandenberg Air Force Base**, California. WISE environmental testing included thermal vacuum, electromagnetic compatibility, electromagnetic interference, vibration, shock and acoustic testing to confirm the design integrity of the spacecraft. Earlier this year, Ball Aerospace integrated the WISE infrared cryo-

genic science instrument built by **Space Dynamics Laboratory**. The ***WISE RS-300*** spacecraft derives from the Ball Aerospace ***NextSat*** spacecraft built for the successful ***Orbital Express*** mission launched on March 9, 2007. The flight system has an estimated mass of 560 Kg (about 1,175 pounds) and will fly at an altitude of about 313 miles. The spacecraft will be three-axis stabilized, with body-fixed solar arrays and use a high-gain antenna to transmit to ground through the TDRSS geostationary system. In addition to building the spacecraft, Ball Aerospace will perform testing requirements and flight system integration.



DigitalGlobe's WorldView-1 satellite

Craig Moen has been promoted to lead the government sales and marketing effort for **EMS Sky Connect**, a division of **EMS Technologies, Inc.** The newly named manager of *Government Sales* joined EMS Sky Connect in 2005. He will work to expand the company's profile and build sales with a range of government customers, both domestically and internationally, who have mission-critical communications needs. *Moen*, like many members of the EMS Sky Connect sales and marketing team, is an experienced pilot with multiple ratings.

DigitalGlobe has signed a contract to extend the Company's *Service Level Agreement* (**SLA**) with the ***National Geospatial Intelligence Agency*** (**NGA**) for $12.5 million per month. The SLA extension provides NGA with continued access to the ***WorldView-1*** satellite. NGA has agreed to extend the SLA through March 31, 2010, for a total of $100 million during the extension period, with an option for NGA to extend the contract for an additional nine months on the same terms, from April 1, 2010 to December 31, 2010.

General Dynamics SATCOM Technologies recently received a $119 million modification to an existing delivery order to provide additional satellite communications Earth terminals and support services for *Increment One* of the U.S. Army's ***Warfighter Information Network-Tactical*** (**WIN-T**) program. Under the contract, the Company will provide 293 *Satellite Transportable Terminals* (**STT**), six *Unit Hub SATCOM Trucks* (**UHST**) and 534 *Ka-band upgrade kits and spares*. The nexgen STT terminals enable network operation over Ku- or Ka-band satellite frequencies. The new UHST unit hubs provide Ku- or Ka-band access and more modem capacity. Both the STTs and UHSTs are interoperable with MILSATCOM units currently in use by the Army.

Harris Corporation has submitted its proposal to provide advanced communications and information assurance solutions for the ***Global Positioning System*** (**GPS**) ***Next-Generation Advanced Control Segment*** (**OCX**) as a member of the **Northrop Grumman** team — the proposal starts the downselect phase of the program. The open-architecture, advanced control segment will support the entire constellation of current and

GPS OCX

future GPS satellites. The company's proposed communications architecture applies *software-defined radio* (**SDR**) technology to GPS monitor stations. This approach significantly reduces life-cycle costs by enabling software/firmware upgrades across the network, supporting new signals from new satellites, and enabling future re-use without requiring completely re-designed hardware. Five generations of Harris SDR solutions have been fielded for missions ranging from highly survivable Anti-Jam telecommunications to advanced signal intelligence receivers. This proven capability is currently in use by thousands of United States military personnel serving in global operations.

Latitude Technologies has been selected to provide the ***U.S. Drug Enforcement Administration*** (**DEA**) *Air Wing Division* fleet of aircraft with a suite of SATCOM hardware products and related services. The Air Wing Division maintains a fleet of rotorcraft, light fixed wing aircraft as well as larger, pressurized fixed wing aircraft on which the **Latitude *SkyNode*®** equipment will be installed. The DEA was created in 1973 in order to establish a single unified command to combat "an all-out global war on the drug menace." Today, the agency continues that mission as the agency responsible

Latitude SkyNode products

for enforcing the controlled substances laws and regulations of the United States.

MTN Government Services (a **SeaMobile** company) has been formed by **MTN Satellite Services** to offer expanded integration services and *one stop* turnkey solutions across multiple satellite technologies to government agencies. MTN Government Services already provide airtime, hardware, installation, network engineering and management, customer support as well as value added services to agencies such as the DoD, Federal and State Government agencies.

NASA has awarded a contract to the **University of Colorado at Boulder**'s ***Laboratory for Atmospheric and Space Physics*** for the development of the ***Total and Spectral Solar Irradiance Sensor***, or **TSIS**, a key instrument for the future ***National Polar-orbiting Operational Environmental Satellite System***, known as **NPOESS.** The total estimated value of the cost, no-fee contract is approximately $42 million. The UoC lab will be responsible for the design, engineering analyses, hardware and software development, fabrication, integration, algorithm development, test, evaluation and support for integration of the instrument with the NPOESS spacecraft. The sensor will continue key climate measurements of solar irradiance that contribute to determining the Earth's energy balance and understanding how Earth's climate responds to solar variability. The sensor will fly on the ***NPOESS, C1*** mission. NASA is developing the ***TSIS Flight Model 1*** under a reimbursable agreement with ***National Oceanic and Atmospheric Administration***, or **NOAA.** NPOESS is a joint program to develop the nexgen of polar-orbiting operational environmental satellites

that form the basis for weather forecasting, and is co-funded by NOAA and the Department of Defense, with NASA as a technology provider.

Raytheon Company and the U.S. Army recently completed successful testing of the first ***Advanced Extremely High Frequency***, or **AEHF**, satellite communications production terminals. Raytheon's ***Secure Mobile Anti-jam Reliable Tactical Terminal*** (**SMART-T**) offers the nexgen of protected communications with AEHF satellites. It is the first AEHF system across the U.S. Armed Services to enter production and achieve this first article testing milestone, verifying that it meets all performance, function and production requirements. The testing follows Raytheon's $97.5 million contract to produce and install AEHF upgrade kits that increase the data rate of existing SMART-T systems four fold. The award, which is part of an indefinite delivery-indefinite quantity contract originally awarded in 2007, increases the total value to $290 million.

Raytheon Company and the ***National Geospatial-Intelligence Agency*** (**NGA**) marked the transition to an improved capability that will rapidly ingest and disseminate imagery from U.S. commercial satellite companies to warfighters and intelligence analysts worldwide. NGA has also tasked Raytheon to provide the nexgen of services to disseminate data from multiple sources to its users. The new ***Geospatial Intelligence Data Transformation Services***, an effort under a current Raytheon program, permits NGA to ingest and disseminate data from numerous data providers with varying formats and sensor platforms. Integrating these data sources

into the *National System for Geospatial Intelligence* will provide warfighters and the intelligence community with a broad set of new and improved geospatial intelligence products to meet mission needs. "Improved dissemination of imagery acquired through commercial sources is a key component of an ongoing mission objective of NGA," said NGA Director Vice Adm. *Robert Murrett*. "The data acquired by these sources provide a means to supplement and back up the existing national capabilities." The effort was related to the agency's *NextView* program, in which NGA receives imagery from U.S. commercial satellite companies. With the new dissemination capability, NGA systems can now ingest and disseminate greater amounts of commercial satellite imagery daily, providing it to users more quickly.

Research and Markets has added Frost & Sullivan's new report *Military Satellite Communications - Business and R&D Prospects* to its offerings. Presently, satellite communications are the core of all military communications, especially during wars on foreign territory and unfriendly terrains. Contemporary satellite links support a significant amount of IP traffic, especially video feeds and high-resolution imagery, apart from conventional voice communications. The emergence of new applications such as *communications-on-the-move* (**COTM**) and ballistic missile defense are opening considerable business opportunities for technology vendors and solution developers in the MILSATCOM sector. The report also notes that technological developments such as improved satellite network communications protocols and novel compact antennas with signal locking capabilities are greatly speeding up the adoption of COTM solutions. COTM vendors feel hopeful as several militaries are keen on obtaining advanced communication capabilities. Moreover, there is a high demand for compact, transportable, and easily deployable satellite antennas, especially in vehicle-mounted configurations.

A Russian ***Meridian 2*** military satellite was placed into orbit in early May 2009 by a ***Soyuz-2*** carrier rocket that was launched from

Russian Meridian-2 military satellite

the *Plesetsk* space center. The ***Meridian*** series communication satellites will replace the older, ***Molniya*** series spacecraft and will provide for military uses as well as communication, navigation and surveillance services for civilian customers. The Soyuz-2 has been the launch vehicle workhorse of Russia's manned and unmanned space programs since the 1960s and features upgraded digital flight control and telemetry systems as well as a higher performance rating and higher payload capacity than previous Soyuz rockets. In addition to carrying Russian satellites aloft, the Soyuz-2 is also used for commercial space launches from the *Kourou* launch pad in French Guiana via an agreement with the **European Space Agency**. The ***Molniya-M***, ***Soyuz-U,*** and ***Soyuz-FG*** rockets are all expected to be replaced by the Soyuz-2 in the future.

Scalable Network Technologies, Inc. (SNT) has been awarded a *Phase 2.5 Small Business Innovation Research* (**SBIR**) grant, jointly sponsored by four DoD agencies: **U.S. Army ATEC** (*Army Test and Evaluation Command*); the **JTRS** (*Joint Tactical Radio System) Program Executive Office* (**JPEO**); *PM Future Combat Systems, Modeling & Simulation Office*; and **U.S. Army TRADOC** (*Training and Doctrine Command)*. The intention is to create an enterprise solution for network communications simulation for *JTRS Ground Mobile Radio* (**GMR**) testing, training, and experimentation. Tasks include leveraging the *JTRS Modeling & Evaluation Environment* (**JMEE**) that SNT developed under *Phase I* and ***II*** SBIR's to create a live-virtual-constructive test architecture that can accurately and realistically represent the operation of thousands of on-the-move radios, including verification and validation. The plan involves SBIR and outside matching funds totaling $2M and is scheduled for completion in October 2010.

Thrane & Thrane has received **PMA** certification for the Company's new ***SwiftBroadband*** solution, as their ***Aero-SB Lite*** becomes the lightest and most compact SwiftBroadband offering on the market to receive PMA. The *Parts Manufacturer Approval* (PMA) by the *Federal Aviation Administration* (**FAA**) was received on July 7th.

The Aero-SB Lite with full SwiftBroadband data functionality harnesses the power of the Internet, email, VPN, fax and telephony in one package. Aero-SB Lite includes built in WiFi capability and VoIP technology, where users can use their own compatible handsets or WiFi enabled PDA devices. The data and voice functionality of Aero-SB Lite can be used simultaneously, ensuring total flexibility for the end user.

Thrane & Thrane Aero-SB Lite

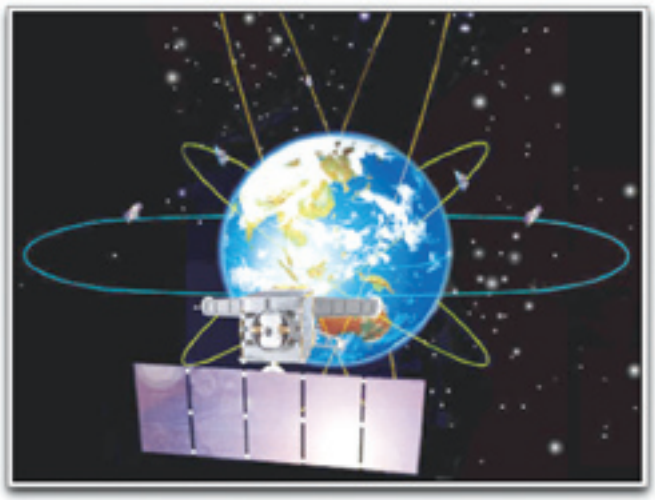
Thrane & Thrane has also signed a sponsorhip agreement with **Télécoms Sans Frontières** (TSF). Thrane & Thrane will assist the high profile humanitarian NGO in providing a year long telecommunications training program for

Thrane & Thrane EXPLORER 700

emergency responders from 40 international NGOs. The sponsorship involves the donation of Thrane & Thrane ***EXPLORER BGAN*** terminals for training courses, which start at the end of July 2009 at the TSF bases in Bangkok and Managua.

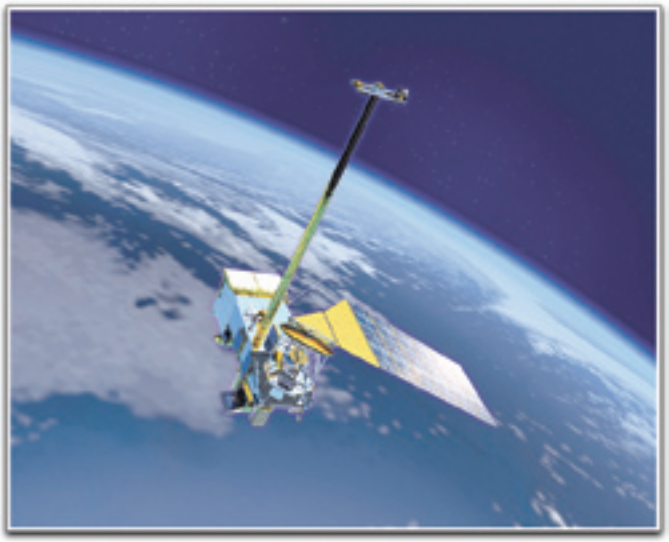
To ensure that TSF training program covers all aspects of emergency communication, the sponsorship scope of supply covers the core of the EXPLORER portfolio: ***EXPLORER 300***, ***EXPLORER 500*** and ***EXPLORER 700***. All EXPLORER models have been proven to offer effective communication for disaster and emergency management anywhere on the planet.

The **U.S. Air Force**'s second ***Space Based Infrared System Highly Elliptical Orbit*** payload and associated ground system has entered trial period operations in preparation for use by the warfighter — this is a major program milestone for the **SBIRS** team. SBIRS is designed to provide early warning of missile launches and simultaneously support other missions including missile defense, technical intelligence and battlespace awareness for unified commanders, Joint Task Force Commanders, and other users. A joint U.S. Air Force/Lockheed Martin team, the ***HEO-2*** payload has recently completed all testing and training necessary before beginning on-orbit operations for the user. During trial period and the operational utility evaluation, **Air Force Space Command** satellite operators will demonstrate the full range of HEO-2 capabilities to enhance the nation's ***Overhead Persistent Infrared*** architecture. The crews will also highlight the ability of the ground system to operate, schedule, and process two HEO payloads simultaneously. The two HEO payloads will provide additional in-



SBIRS illustration

frared coverage with unprecedented sensitivity, timeliness and accuracy. The SBIRS development and operations team is partnered with the ***Air Force Operational Test and Evaluation Center*** to ensure a successful trial period and operational utility evaluation, leading to full *Integrated Tactical Warning/Attack Assessment* certification and operations. HEO-2 is operated by the ***11th Space Warning Squadron*** at **Schriever AFB**, Colorado. HEO-2 will now send data to the *Mission Control Station* at **Buckley AFB**, Colorado, to be fused with other OPIR sensor data, and released as operational messages to users in support of missile warning, missile defense, technical intelligence and battlespace awareness missions. Upon successful completion of trial period in late July 09, formal **USSTRATCOM/J65 ITW/AA** certification is expected to occur in August 2009. The Space and Missile Systems Center, located at Los Angeles Air Force Base, California, is the U.S. Air Force's center of acquisition excellence for acquiring and developing military space systems including GPS, military satellite communications, defense meteorological satellites, space launch and range systems, satellite control network, space based infrared systems, intercontinental ballistic missile systems and space situational awareness capabilities.



A new company has been formed by former military commanders that would build and launch MILSATCOM satellites. Named **U.S. Space LLC**, the focus will be on the manufacture of hardware that is relatively inexpensive and small in size, all designed to target and satisfy military needs. The warfighter requires immediate solutions in regards to battlefield engagement information. Mission commanders and those whose boots are on the ground are unable to count on the latest and greatest technologies to assist in their endeavors, due to the lengthy deployment cycles currently encountered This company hopes to change that paradigm. Three U.S.A.F. generals comprise the board members of U.S. Space: ***Major General James Armor***, ***Major General Craig Weston***, and ***Lieutenant General Michael Hamel***. Individual and company backers include ***William Cohen***, a former Defense Secretary, and ***John Ashcroft***, former U.S. Attorney General, and **Orbital Sciences Corporation**. The latter company will be responsible for the manufacture and launch of the hardware using a super version of their ***Minotaur*** rocket. Although no contracts with the Pentagon have yet been signed by this fledgling firm, U.S. Space hopes to have their first models ready for deployment within three years — that's far less than the average of 10 development years for most military satellites.

VSD, LLC and **AMERICOM Government Services, Inc.** (**AGS**) have completed negotiations effecting transition of programmatic responsibilities for the ***Television Direct to Sailors*** (**TV-DTS**) ***Terminal Program*** from AGS to VSD. For the past 12 years, the TV-DTS program has provided for the welfare and morale of USN, USCG, and merchant marine personnel at sea through access to *Armed Forces Radio and Television* (**AFRTS**) broadcast service on the world's oceans. VSD personnel have supported TV-DTS since its inception in 1997. The inclusion of TV-DTS programmatic support to U.S. government clientele significantly enhances VSD's valued SATCOM and telecommunications offerings for antenna systems sales, parts support, and technical engineering services. Additionally, this formal transition notably expands and strengthens VSD's relationship regarding our strategic alliance with **Orbit Communication Systems, Inc.** (**Orbit-CS**) with regard to their maritime communications equipment offerings. AGS is a wholly-owned, government facing subsidiary of **SES AMERICOM, Inc**. While AGS will no longer sell TV-DTS antenna systems, they will continue to leverage SES's fleet of 40 satellites to provide space and shore segment end-to-end solutions for TV-DTS, including the satellite communications solutions for the AFRTS program.

UAV/UAS

AAI Corporation, an operating unit of **Textron Systems**, a Textron Inc. company, has offered the newest in its ***Aerosonde*** fleet of *small unmanned aircraft systems* (**SUAS**), the ***Mark 4.7***, as a contender for the U.S. Navy and Marine Corps' joint ***Small Tactical Unmanned Aircraft System*** (**STUAS**)/***Tier II*** program. The expeditionary Mark 4.7 system participated in flight demonstrations on June 23-24 at **Yuma Proving Grounds** in Arizona. Developed as a part of AAI's growing Aerosonde fleet of SUAS, including the ***Mark 4.4*** and ***Mark 5.0***, the Mark ***4.7*** incorporates unique aircraft, ground control, and system features designed with the Navy's and Marine Corps' mission requirements in mind. The system's modest footprint and integrated launch and recovery system enable fast, flexible ground and/or shipboard automated launch and recovery capability. The Mark 4.7 aircraft delivers greater than 10-hour endurance, a low acoustic signature, and a small footprint, all of which make it ideal for confined-area land or maritime intelligence, surveillance and reconnaissance missions as well as for communications relay. Its modular payload installation allows the rapid addition of new payloads and capabilities as they become available, enabling technology refresh with little to no aircraft or system modifications. The system also uses AAI's *Expeditionary Ground Control Station* (**EGCS**), which is based on the company's ***One System***® command and control architecture to provide interoperability between the Aerosonde Mark 4.7 and other One System platforms, including the ***Shadow***® *Tactical Unmanned Aircraft System* (**TUAS**). Users receive digital and analog data from the aircraft's electro-optic and infrared payloads on compact, ruggedized laptops.

In the "this is better than nature itself" segment, **AeroVironment, Inc.** has been awarded a Phase II contract extension from the *Defense Advanced Research Projects Agency* (**DARPA**) to design and build a flying prototype for the *Nano Air Vehicle* (**NAV**) program. As part of this program, AV has

AAI's Aerosonde Mark 4.4 SUAS

AeroVironment Nano Air Vehicle

achieved the controlled hovering flight of an air vehicle system with two flapping wings, with the vehicle carrying its own energy source, using only the flapping wings for propulsion and control. AV achieved the milestone in December 2008 with the successful 20-second flight of the *Mercury* interim test vehicle. The nano aircraft is capable of climbing and descending vertically, flying sideways left and right, as well as forward and backward, under remote control. Quite amazing, actually.

Advanced networking, tactical communications, and situational awareness technologies from **Harris Corporation** were instrumental in the successful demo of streaming video over a simulated mobile, ad hoc tactical network for representatives of Australia's Army, Navy, and Defence establishment. The laboratory demonstration of production hardware included the transmission of recorded unmanned aerial vehicle (UAV) video and meta data, along with real-time dismounted soldier digital and voice data, to a simulated *Boeing CH-47 Chinook* helicopter Mission Commander's station. The ***Harris Adjunct Network Processor*** and **Boeing**-developed middleware and software applications provided real-time interface between the CH-47 and dismounted soldier user equipment. A variety of Harris solutions, including the *Adjunct Network Processor* (**ANP**), *SeaLancet* tactical radio, *Falcon III* tactical radio, and *FliteScene* software digital map, enabled high-bandwidth ad hoc networking among the Chinook, the UAV ,and multiple dismounted soldiers' kits. The SeaLancet radio served as the airborne network backbone, providing streaming video and digital data among air platforms. The Harris ANP — a real-time processor that provides network connectivity for aircraft — hosted the Boeing-developed *System of Systems Common Operating Environment* (**SOSCOE**) and mission management applications. Harris participated in a similar successful technology demonstration with Boeing last year during the *C4ISR On-the-Move* exercise at Fort Dix, New Jersey.

Harris Adjunct/Network Processor (ANP)

The ***GPS Wing*** announced the **Raytheon *Modernized User Equipment*** team has achieved live satellite **M-Code** tracking with an **MUE** receiver. The team has developed both the modernized versions of the *Avionics GPS Receiver Application Module* and *Ground Based GPS Receiver Applications Module* receivers under the ***MUE Receiver Card Development Program*** awarded in June of 2006. This effort was performed using a **Raytheon GB-GRAM-M**. M-Code acquisition and tracking is one of many steps taken towards completion of the MUE receiver, but a very important step that indicates the proper operation of many receiver functions. The team will continue integration throughout the summer culminating in the delivery of pre-production **GRAM-S/M** and **GB-GRAM-M** modules to the GPS Wing in November of this year. The GB-GRAM-M and GRAM-S/M will replace legacy **GB-GRAM** and **GRAM-S** embedded GPS receivers in systems such as the ***Raven*** unmanned air vehicle and *Miniature Airborne GPS Receiver* and provide full modernized capabilities for the warfighter.

— Pattie & Hartley, Editorial Team

COMMAND CENTER

The Commander of the 21st Space Wing at Peterson Air Force Base in Colorado is Colonel John "Jay" W. Raymond. With a work force of more than 5,000 officers, enlisted, civilian and contract employees, this is the U.S.A.F.'s largest wing, both geographically and organizationally. The 21st Space Wing is responsible for missile warning and space control for combat forces and the national command authorities of the United States and Canada.

Colonel Raymond is a career space and missile officer and he command experience at the Squadron and Group levels. He also served on the staffs at **HQ AFSPC**, **HQ United States Air Force**, as well as with the **Office of the Secretary of Defense**. He served as the Director of Space Forces in support of *Iraqi Freedom* and *Enduring Freedom* operations. Prior to his current assignment at **Peterson AFB**, the Colonel was the *30th Operations Group Commander*. He has been awarded a number of decorations, ranging from the Defense Superior Service Medal, Legion of Merit, Meritorious Service Medal with four oak left clusters, Air Force Commendation Medal and more. In 2007, Colonel Raymond received the 2007 Air Force Association's *General Jerome F. O'Malley Distinguished Space Leadership Award*.

We discussed a number of topics with Colonel Raymond and appreciated his time to talk with our readers.

MilsatMagazine (MSM)

Colonel, how did you decide upon a career in the U.S. Air Force? How do you balance family with the intense pressure of your command position?

Colonel Raymond

I grew up in a military family. My great-great grandfather, great-grandfather, grandfather, and father all served in the United States Army. I am very proud that I am able to continue this legacy of service. I work hard at balancing the love for my family and my country. One way I try to strike that balance not only for my family but for the families of the Airmen assigned to the Wing is to make sure we build family functions into our Wing events.

MSM

The mission statement for the 21st Space Wing states, "Conduct flawless missile warning and space control operations, provide unsurpassed installation and support and protection, while developing and deploying Warrior Airmen to defend America and our Allies." Considering how crucial Air Force Space Command is to our country's defense and space environments, what bases and missions are folded under your command?

Colonel Raymond

The Wing operates the global missile warning and space surveillance networks. To do so we are spread out all over the globe. In fact, we are the largest geographically dispersed wing in the Air Force. We have 39 units in 27 locations across the United States and five additional countries. In all we span 13 time zones. In addition to **Peterson AFB**, we are responsible for **Cheyenne Mountain Air Force Station**, **Clear Air Force Station** Alaska, **Cavalier AFS** North Dakota, **Cape Cod Air Force Station** Massachusetts, and **Thule AB** Greenland.

Our missile warning sites located across the United States, in Greenland, and the United Kingdom ensure flawless missile warning and tracking to ensure critical deci-

sions can be made quickly as to the safety of North America and our allies. These sites, as well as others dedicated to space surveillance, operate day and night to maintain space situational awareness for 18,000 man-made objects in earth orbit.

The wing has three space control squadrons at **Peterson Air Force Base**, Colorado, and **Holloman AFB**, New Mexico. The **16th SPCS** is the first ever dedicated defensive counter space unit in the Air Force and provides countermeasures against satellite jamming. Both the **76th SPCS** and **4th SPCS** are responsible for delivering defensive and offensive counterspace effects to combatant commanders worldwide.

MSM

From ICBMs to space control, the 21st Space Wing is the largest wing within the U.S.A.F. Would you please describe the components that comprise the 21st Space Wing? What missions are currently being managed under your command?

Colonel Raymond

The **21st Space Wing** *is geographically the largest wing in the Air Force. As discussed above, we are America's Space Superiority Wing operating the missile warning and space surveillance network. Additionally, we operate both defensive and offensive counterspace capabilities. Additionally, we provide installation support and protection for Peterson AFB and the five other installations we are responsible for. Finally, like all Air Force Wings, we develop and deploy warrior Airmen. The 21st Space Wing deploys approximately 700 Airmen every year which equates to a third of our active duty population.*

(Note: the 21st SW does not control any ICBMs or satellites)

MSM

How did your previous assignments as 21st Operations Group deputy commander prepare you for your current role?

Colonel Raymond

The Air Force does a great job of developing Airmen… in fact, it is one of the five stated priorities of the Air Force. In effect, I have been preparing my entire career for my current role. Specifically, the 21st Operations Group deputy commander position gave me experience in the Wing's diverse operational missions that has proved beneficial over the past two years.

MSM

You have a number of interesting assignments under your belt, from being a Minuteman ICBM crew commander to Headquarters U.S.A.F. as the Chief of the Expeditionary Aerospace Force Space and Program Integration, as well as time spent with the Royal Air Force in the United Kingdom as the Commander of the 5th Space Surveillance Squadron. Now here you are, the Commander of the 21st Space Wing, and we would appreciate your thoughts on your career and what, to date, has been your most challenging assignment.

Colonel Raymond

I've been an Airman for 25 years, serving in the space and missile community since day one. With each assignment comes new challenges and I can't put my finger on any specific assignment that was most challenging.

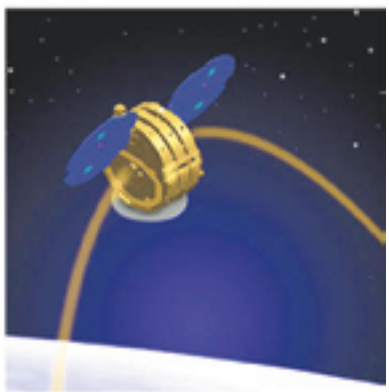
MSM

What were your duties when you were assigned to the Office of the Secretary of Defense? And while at Vandenberg AFB in California as operations group commander for the 30th Space Wing?

Colonel Raymond

I was assigned to the Office of Secretary of Defense's Office of Force Transformation. I was the space officer assigned to the office to help develop an alternative business model for space. Specifically, I was the Department's lead on the **TACSAT-1 Operationally Responsive Space Experiment**.

As the 30th OG commander, I was responsible for the operations of the Western Range to assure access to space. We operated a network of radars and optical sites necessary to safely and effectively conduct nationally critical space launches. The range also supported ICBM test launches and supported the Missile Defense Agencies ground based interceptor testing. The Range also has an offshore operating area that is used to support aircraft testing.



TacSat-1 spacecraft

AN/FPS-85 Spacetrack Radar

MSM

As the Director of Space Forces, you supported ongoing operations during Iraqi Freedom and Enduring Freedom. What were your responsibilities during those assignments?

Colonel Raymond

As the Director of Space Forces (DIRSPACEFOR) I worked for the Coalition Forces Air Component Commander (CFACC). I was his advisor on all space matters. Additionally, the CFACC is designated as the Space Coordinating Authority. As the Space Coordinating Authority, the CFACC coordinates the actions of all of the joint space forces in theater. I executed that authority on his behalf. Professionally and personally it was a very rewarding assignment. It was the first time I had the opportunity to deploy. As the DIRSPACEFOR, I saw firsthand the critical role that space capabilities play in the joint fight.

MSM

Could you tell us about the Deep Space Tracking System and how it parlays into the overall U.S. space program?

Colonel Raymond

The Deep Space Tracking System was a passive sensor that we used to track satellites in "Deep Space." The squadron I commanded operated that sensor as part of the larger space surveillance network. The Deep Space Tracking System is no longer operational.

The ***Space Surveillance Network*** defines "Deep Space" satellites as any object that is at an altitude greater than 7,000 nautical miles and requires 225 or more minutes to make one revolution around the earth. More than 1,200 objects are in Deep Space orbit today. These objects are tracked using a network of ground-based radars and electro optical sensors. The bulk of the work is done using the *Air Force Fence*, *Eglin Phased Array Radar*, and the *Ground-Based Electro-Optical Deep Space Surveillance* (**GEODSS**) system. The **AN/FPS-85** located at the ***20th Space Control Squadron***, Site C-6, Eglin AFB, Florida, is the only phased array radar weapon system that is capable of tracking deep space orbiting satellites. Generating an overall power output of more than 32 megawatts (enough to power a city of 6,000 people) the 20 SPCS's radar at Eglin can actively detect, track

and identify an object the size of a basketball up to 22,000 nautical miles away. This capability allows the 20 SPCS to provide high quality observations to the JFCC-Space and NASIC on many satellites, especially those located in geostationary orbits. The Eglin radar celebrated its 40th anniversary in January 2009.

The **AN/FPS-133**, or ***Air Force Fence,*** is also part of the "Deep Space" capability. Using a series of nine transmitter and receiver sites along the 33rd parallel of the United States, this weapon system can detect objects out to approximately 15,000 nautical miles. Some form of the Fence has been operating continuously for the last 50 years, reaching that milestone in August 2008. The Fence is essentially a wall of energy stretching across the southern United States.
When combined, the Fence (positioned from Georgia to California) and the Eglin Phased Array Radar can collect observations on 90 percent of the manmade objects orbiting the planet.

The ***Ground-Based Electro-Optical Deep Space Surveillance*** system is a key contributor in tracking Deep Space objects. Our electro optical sensors can track objects as small as a basketball more than 20,000 miles in space. These sensors bring together the telescope, low-light-level television and computers — three proven technologies. Each site has three telescopes, two main and one auxiliary, with the exception of Diego Garcia, which has three main telescopes. The main telescopes have a 40-inch aperture and a two-degree field of view. The system only operates at night when the telescopes are able to detect objects 10,000 times dimmer than the human eye can detect.

MSM

Would you explain RAIDRS? How can satellite interference be countered? Where do you believe most of the interference originates today, and where can we expect it to originate in the future?

Thule Air Force Base, Greenland

Colonel Raymond

RAIDRS is operated by the 1**6th Space Control Squadron**, the Air Force's first and only dedicated defensive counter space unit. RAIDRS operators detect interference to satellite communications being used by the military, determine where it's coming from and whether it's hostile, and then they provide field commanders the information they need to appropriately respond.

The RAIDRS mission is critical to *Overseas Contingency Operations*, as much of our tactical and morale communication ability in the field relies on unimpeded satellite communications. RAIDRS ensure these lines of communication are available free of interference based upon the combatant commander's priorities. The Airmen who operate RAIDRS train tirelessly to be ready to defend satcom resources against current and future interference threats.

MSM

You have seen the results of in-theater warfighter support firsthand. Where do you believe our space assets played their most important role in aiding air and ground activities within the hostile environments within which they operated?

Colonel Raymond

As the **DIRSPACEFOR**, I did get firsthand experience in integrating space capabilities into the joint fight. What I gleaned from this experience is not one particular area of importance, but the fact that space is integrated in all aspects of the fight. These include weather, navigation and timing, communications, warning, and so on. Without space, clearly we would not fight as effectively as we do today.

MSM

In 2007, you were the recipient of the Air Force Association's "General Jerome F. O'Malley Distinguished Space Leadership Award" – what does this award signify, and why do you feel you were selected?

Colonel Raymond

The *Lance P. Sijan Chapter* of the **Air Force Association** established the ***General Jerome F. O'Malley***

Distinguished Space Leadership Award to recognize the contributions of leaders in achieving General O'Malley's vision of "providing an intensified space focus and reorienting AF philosophy toward an operational approach by advocating the operational use of space systems at the highest levels of the Air Force." I was very honored to receive the award and it was largely earned for the work done while deployed as the DIRSPACEFOR. I had a DIRSPACEFOR team that worked diligently to further integrate space capabilities into theater. Of note, this team successfully integrated a refined Global Positioning System capability to enhance the accuracy of the small diameter bomb improving overall combat effectiveness. My deployed team deserves all the credit for this award.

MSM

Within your command is the 721st Mission Support Group, based at Cheyenne Mountain Air Force Station. Considered somewhat invisible to most citizens, what activities is this group responsible for? Tracking elements in space is accomplished by what means? How does the 721st align with the 821st at Thule Air Base in Greenland?

Colonel Raymond

Both the 721st Mission Support Group and 821st Air Base Group are important members of the 21st Space Wing team. The 721st MSG, the landlord of Cheyenne Mountain Air Force Station, provides unsurpassed installation support and protection for seven nationally critical tenant units located inside the mountain. The 821st ABG operates and protects America's northern most military installation, Thule Air Base, Greenland. The 821st ABG supports missile warning, space surveillance and satellite command and control operations missions. The group provides support and protection to remote active duty units in a combined U.S., Canadian, Danish and Greenlandic environment of approximately 600 military, civilian and contractor personnel.

MSM

What are the most serious threats our nation and warfighters face in the next few years? What do you see as the most important taskings for the 721st and for Air Force Space Command?

Colonel Raymond

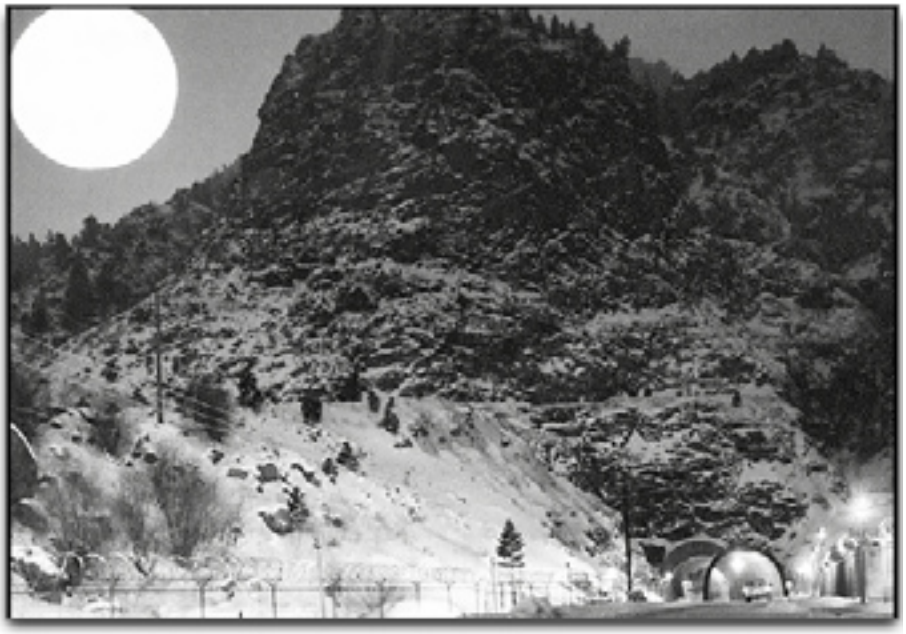
The challenges our warfighters face today and into the future are many and varied. The 721st MSG and the whole wing will continue to be "all in" and ready to face today's fight and tomorrow's challenges. As our warfighters' reliance on space resources increases, America's Space Superiority Wing will continue to flawlessly defend those resources for the nation's use, while preventing our adversaries from using them against us.

MSM

Back in August of 2007, you told the wing "I don't accept mediocrity" and you expected perfection. Has such been accomplished?

Colonel Raymond

Yes. The missions we perform are so vitally important to both the success of our warfighters and the security of our nation that there is no room for error. This is the trust and confidence the American people have placed in this wing. I know that the Airmen of the 21st SW have earned this trust through their tireless work and dedication. The fact that our Airmen, civilians and contractors meet this standard was further attested to by the wing's rating in its 2009 operational readiness inspection. Although nobody is perfect, perfection is the standard we continuously strive to achieve.



Historic Cheyenne Mountain portal entrance photo (Denver Post)

UAV CELLULAR PAYLOAD FOR FIRST RESPONDER EMERGENCY TEAMS

by Robert Varga, Ph.D.

As National Guard, fire, police and other military and civil first responders begin to stabilize a region in the wake of a natural or manmade disaster, they face challenges in coordinating their efforts using standard UHF or VHF radio communications. Reacting to these challenges during the 2007 wildfires in southern California, enterprising first responder groups successfully used their personal cell phones to improve communications interoperability.

What if we could expand on this germ of an idea, leveraging the power of 3G wireless devices to include not just voice, but imagery, location, and other data? The resulting system could provide responder teams and commanders with critical multimedia, street level imagery, or even biometrics for identification or medical status, significantly improving situation awareness and a common operational picture with maps and coordinates of personnel, victims, and threats.

The capabilities of 3G systems, and the portent that 4G network bandwidth will rival cable and DSL performance, strongly suggests that smart cellular phones — which continue to get smarter by the day — are potential disruptive alternatives to legacy UHF and VHF radios. The only limiting factor to this alternative might be the sheer scale of some disasters. For example, hurricane *Katrina* wiped out the cellular infrastructure over large areas of southern Louisiana and Mississippi. And in the aftermath of the 9/11 attacks in New York, cellular networks were saturated with excess demand, all but eliminating reliable communications.

One recent example shows this idea's potential. Within a few days after Katrina moved through the Gulf States, a group of **ViaSat** and **Qualcomm** personnel airlifted portable equipment to provide a localized, private cellular "bubble" for first responder teams. *Figure 1* shows how a Qualcomm mobile CDMA system, consisting of transit cases containing a picocell base station and a media switch, was

Figure 1 — Qualcomm mobile CDMA system on a roof in New Orleans

placed on an office building roof in downtown New Orleans. Pre-registered **Nokia** handsets were distributed to a few key officials, and Verizon granted permission to use its frequencies since its service was knocked out by the extensive hurricane damage.

This private cellular network allowed communications between any pair of handsets that were registered to the network and located within the range of the picocell transceiver. And for calls outside the network, a ***ViaSat IP Satcom Flyaway Terminal*** acted as a gateway to the PSTN. Outbound calls were routed from the base station through the media switch to the flyaway terminal and transmitted via satellite to a ground station at ViaSat headquarters in Carlsbad, California, where a physical connection was made to the PSTN.

This ad hoc exercise clearly demonstrated the viability of establishing emergency, rapid-response, private 3G cellular communications. However there are limitations to the system, including the coverage radius, which was bounded by the height of the base station transceiver, its RF power amplifier, and RF antenna pattern. The tallest office building in New Orleans, at 51 stories, would provide a potential coverage diameter of only about two to three miles. Emergency communication planners can't afford to make assumptions about the proximity of a sufficiently high vertical structure, nor its access, its safety, or the safety of the surrounding environment.

This article expands on this private cellular network idea by placing the picocell base station components at altitude using an *unmanned aerial vehicle* (**UAV**). Flying at several thousand feet or higher significantly improves the coverage area and eliminates any dependency on ground structures. In a context of first responder emergency communication needs, the article describes a baseline system configuration, system performance, and applications that could support mission execution and provide high fidelity situation awareness for first responders and their commanders.

Moving To Altitude Expands The Private Cellular Bubble

The core cellular network includes a small light weight **3G CDMA** base station transceiver and controller that would support three sectors and up to 50 cellular handsets per sector. A choice favoring

either **1xRTT** or **EVDO** technology will depend on whether voice quality or data throughput is more important. Although 1xRTT is capable of higher data rates, most deployments are limited to a peak of 144 kbps. Packet-based EVDO provides end-to-end IP support for both voice and data, with a forward link peak of 3.1 Mbps and a reverse link rate to 1.8 Mbps. EVDO was designed for end-to-end operation as an IP-based network, so it can support any application made to operate on such a network. Both operate within 1.25 MHz channels.

This CDMA equipment is sufficient to define a completely functional cellular network. It can be configured to openly allow access by any CDMA device or restricted to allow communications only among those devices pre-registered within the network. Flown at 3,000 feet with a 5 watt power amplifier, the base station transceiver, PA, and antenna would expand the communications bubble to approximately 13 miles in diameter. At an altitude of 5,000 feet the diameter expands to 20 miles. *Figure 2* illustrates a UAV loitering over New York City. At these altitudes, and with a modest sized power amplifier, the signal strength should be excellent.

The Qualcomm mobile picocell system used in New Orleans has been successfully flight tested in C-130 and other aircraft. **Northrop Grumman** has added this capability to its ***Battlefield Aircraft Communications Node*** (**BACN**). This equipment could possibly fly on the largest UAV platforms, such as ***Global Hawk***, which may have the payload capacity to handle the power, size, and weight of this system.

Tactical UAVs Are A Better Choice To Carry The Cellular Payload

Yet the case is much stronger for using a "tactical" unmanned aerial vehicle, much smaller than the Global Hawk, including a much lower cost of operation, lower cost payload, on site duration, launch readiness, flight control, and ability of lower echelon military personnel to carry out such a mission. A model UAV for cellular payload is the **AAI Corporation *Shadow***. This platform is a proven performer, having exceeded 400,000 flight hours in service with the U.S. Army, Army National Guard, and Marine Corps. More than 90 percent of these operational hours are in support of operations *Iraqi Freedom* and *Enduring Freedom*.

Among the advantages of Shadow is that 33 Army National Guard Units are already trained and equipped with Shadow systems. In addition to the Guard's role

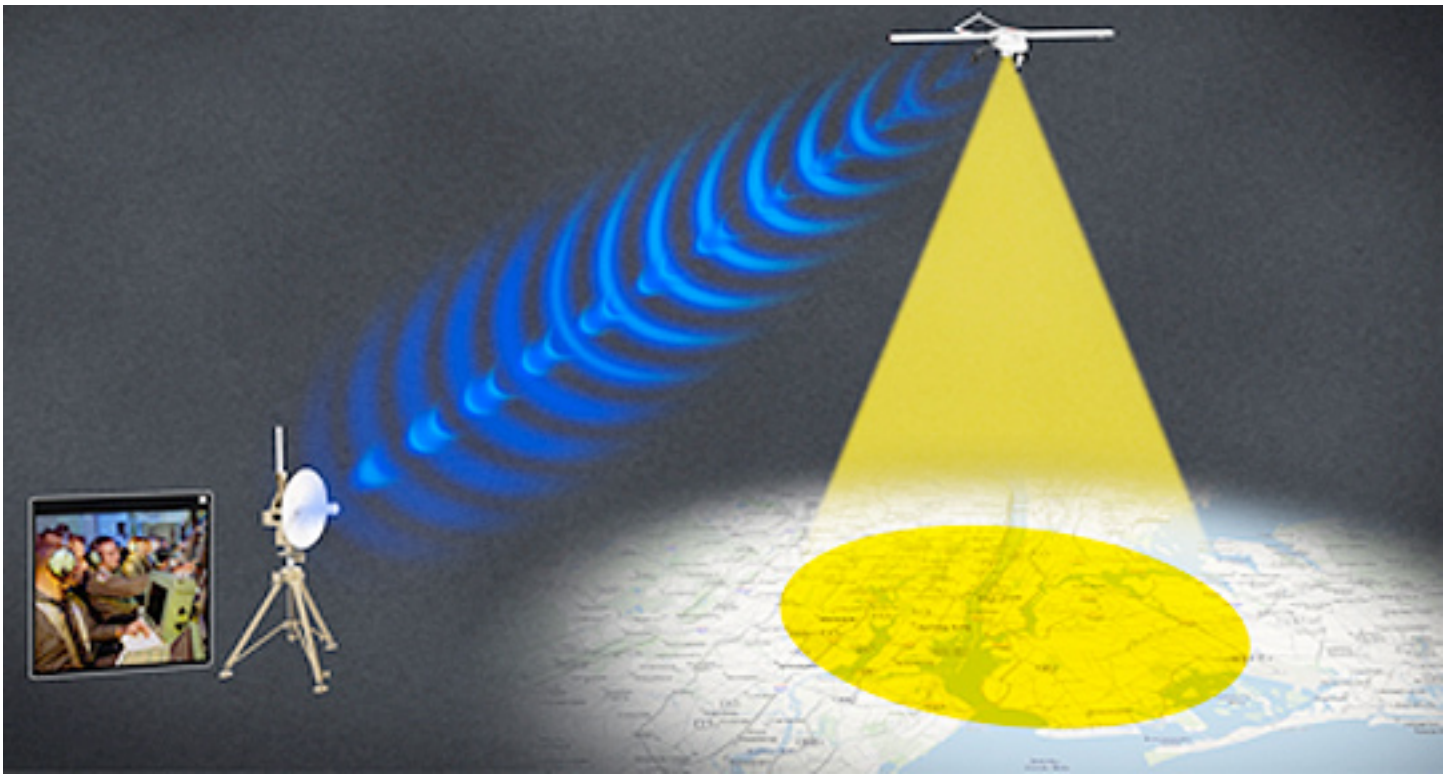


Figure 2 — UAV over New York

in the GWOT, it also has a key role as a first responder, supporting state and local authorities in the event of homeland man-made or natural disasters.

A Situation Awareness Multiplier

A year ago, more than 2,500 Air and Army National Guardsmen teamed with agencies across Iowa to battle what is now considered a 500-year flood. In addition to boots on the ground, Shadow systems could be leveraged to provide aerial video surveillance of local damage, identify threats, find stranded citizens, and monitor rescues. The addition of a cellular payload could provide a 24/7 bubble over a disaster area linking all responders and their commands with a common operational awareness.

The Shadow payload capacity of 45 pounds and power budget of 300 watts is considered substantial for this class of unmanned aircraft, but is a potential challenge for advanced electronics payloads. Nonetheless, trade studies reveal that a COTS base station transceiver, controller, and 5 watt PA from **Star Solutions** are well within the Shadow SWaP budget. In addition, there is adequate budget for an air-to-ground, full duplex digital data link, PA, and antennas, all discussed in detail to follow. The picocell equipment includes a choice for either 1xRTT or EVDO technology. The base station controller system can use the *Windows® XP* operating system, and could be ruggedized to handle UAV environmental specifications. *Figure 3* shows how these components fit into the Shadow payload area.

Downlink To Command Center

One of the key first responder roles is to leverage personal training and experience to provide accurate situation awareness to peers and leaders on the ground, and to higher levels of command. This next layer of communication provides an essential connection between rescue teams and their commanders. In the event of a disaster a command and control center is typically set up to direct personnel, allocate resources, unify efforts to aid victims, and re-establish order. There, commanders and analysts need timely, accurate information. Voice is immediate, but has transient value unless archived, and sharing voice content can be inefficient. Text messaging can provide an accurate situational description, is readily saved and shared, but seems inefficient in emergency situations. Street level still images or even video clips grabbed by smart handsets, when combined with voice and text, greatly enrich the context. Finally, when the locations of rescue personnel, disaster hotspots, or victims are forwarded and displayed on a detailed map, this is an achievement of high-fidelity situation awareness.

A contemporary smart phone can capture every one of these data types, including its own GPS coordinates, and forward them as encapsulated IP to the base station and then through an air-ground data link to the command and control station. For example, the ***EnerLinks®III*** full duplex digital data link can deliver IP traffic over L-, S- or C-band frequencies at any data rate from 50 kbps up to 11 Mbps. Consequently voice, GPS, and other IP data from the cellular handsets, can be routed through this data link to a remotely located ground station.

Designed to meet the constrained size, weight, and power of tactical

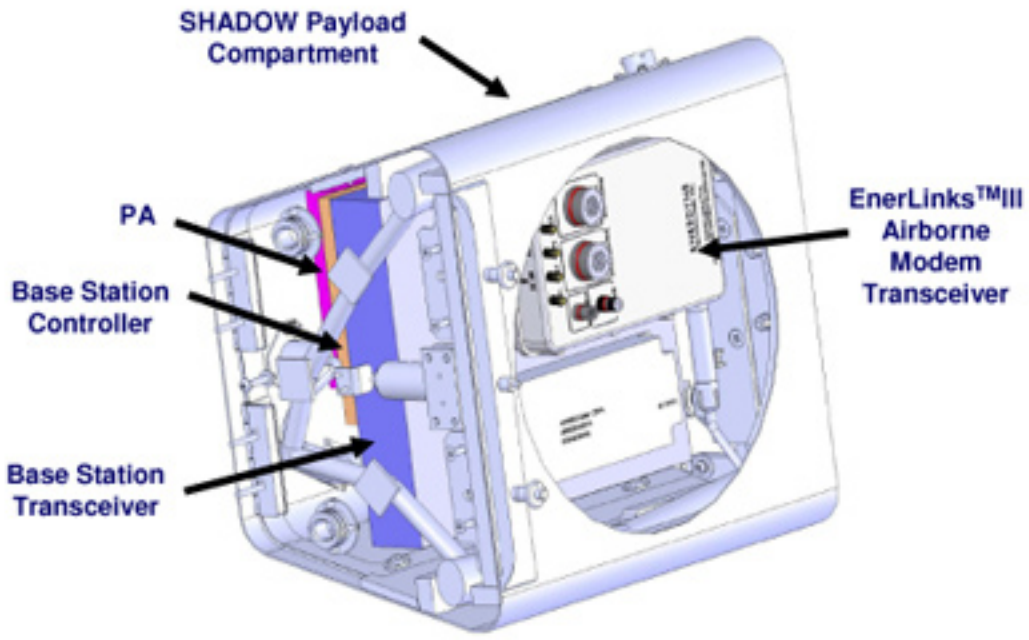


Figure 3 — Fitting components into the Shadow's payload area

UAVs, this data link system accepts **TCP/IP** or **UDP** traffic over Ethernet, as well as two channels of analog video, and six channels of serial digital data. The aircraft's above-ground video feed significantly adds to the command center situation awareness. In fact, the **H.264** compression in the EnerLinksIII, supports two full-motion high-quality video feeds and requires only 4 Mbps in total, leaving another 4-5 Mbps for cellular voice and data. At C-band (4,400 — 5,850MHz) a small "button" 4dBi omni antenna on the aircraft, and a 24-inch parabolic dish with a gain of 28 dBi, will reliably close the link at 50 to 60 nautical miles, allowing location of a command center at a convenient or safe distance from the disaster area as shown in *Figure 2*.

The Local "Survivability" Node

While the picocell base station transceiver and controller are sufficient to support cellular communications among 50 to 100 or more first responders, it is limited to just that capability. Adding a ground based mobile unit with a handful of optional network assets can add significant flexibility, including access to public networks. "Survivability" means that there is no dependence on external resources to provide essential communication services. A mobile survivability node includes hardware and software resources that will provide complete self sufficiency to configure, control, and adapt network services as required:

Media Gateway (MG): An IP connectivity system that allows local, long distance, or international calls from the private cellular network into or from public telco networks, via PSTN, PBX, or satcom access. In disasters of the scale of hurricane Katrina or the 9/11 attacks on the Pentagon and World Trade Center, open communications between first responders, command centers, DHS, and FEMA leadership could only have improved decision making and response effectiveness.

Mobile Switching Center (MSC): The most important feature of this system is its administrative capability for registration and authentication of mobile users using a database server known as the Home Location Register. While a number of pre-provisioned, charged, and registered handsets could be part of a first responder "jump kit", it would be useful to add a specific name to each handset, and update the handset address book. In the course of an emergency response, phones can be lost or damaged and additional personnel resources, authorities, etc., may be directed to support and communicate with deployed disaster response teams. Other handsets could be added to the network on an ad hoc basis.

Figure 4 — major components of a conceptual COP for disaster relief support

Serial Port Server: This is an interface for support personnel to connect a terminal for access to the Survivability Node. All administrative, setup and support functions, such as adding phones, updating the configuration, and trouble shooting, can be accomplished in the field using this terminal.

Media Resource Function (MRF) Server: This server provides the tones you hear when you are making phone calls to other Survivability Node users. The tones are as basic as ring and busy tones, but can be announcements that let you know when a phone is not connected to the network.

Packet Data Service Node (PDSN): The PDSN is the server that allows the node to connect a mobile handset to the Internet. Allowing the handset to access remote or local websites can aid first responders in their ability to send and receive information.

Ethernet Switch: An Ethernet Switch within the node provides all of the IP connectivity between network elements allowing them to communicate to one another.

Situation Awareness Increases First Responder Effectiveness

In the course of disaster relief, a first responder's personal performance, safety, and team coordination greatly improves with knowledge of his or her surroundings. Likewise when field commanders have a comprehensive view and location of personnel, victims, equipment, resources, and physical damage, and when they can see the evolution of events, or potential threats in a *Common Operational Picture* (**COP**), they can respond more capably and in less time.

A good example of a commercially available COP for everyday use is ***Google Maps***. This software is downloadable for free and runs on PCs, Macs, and smart phones. It has accurate street maps and can reveal building details with a satellite view. A selection of "Street View" gives rich imagery showing details of buildings and landmarks in any direction and at any location. On a cell phone your location is shown on the street map when the GPS radio is on. Directions from your location to another destination can be obtained through a text entry or graphically using the map. It is easy to imagine how much this current capability would aid a first responder in an unfamiliar urban environment.

Today, ***Google Maps*** and ***Google Earth*** are used as a framework for very complex military command control and intelligence systems. The integration of such applications with a relational data base and data mining applications can provide an extremely rich operational picture for military, government, or commercial use.

Figure 4 depicts major components of a conceptual COP for disaster relief support. The colored dots on the street map are the locations of first responders, automatically plotted from the cell phone GPS coordinates that are downlinked from the UAV. Individual names shown are obtained by correlating registration information from the phone with the MSC address book. A click on any dot gives options for reviewing archived information in the form of text, images, or video clips. There are options for calling, email, or texting. Other valuable features could include the ability to search content using a filter specified by combinations of date, time, free text, and a latitude / longitude region. Archived information retrieved from this system would be invaluable for after action reports, forensic support, and training.

An excellent example of a system that provides these capabilities and more is the patented software called ***LifeRing™*** from **AGIS Inc**. This application runs in a Microsoft Windows environment and has been ported to a number of smart phones and PDAs with the Windows operating system. By pushing the COP to the mobile unit, it becomes a hand-held command, control, and communications device.

Satellite Connectivity

For disaster relief it seems paramount to connect the survivability node at the command center to the public telephone network. The first order need is basic voice contact to higher authorities. For example, the heads of **DHS**, **FEMA**, and **U.S. NORTHCOM** and their subordinates are likely to remain in close contact with disaster relief operations. In the current government administration, it would not be surprising if the U.S. president requested to speak directly with first responders. In addition it would be possible to provide a comprehensive near real time COP to these same authorities, in a war room environment, or on their personal handsets.

Otherwise, connection with the PSTN is achievable through a satellite link. The ***ViaSat IP Satcom Flyaway Terminal*** provides tactical deployment of broadband, network-centric satcom to any location. This rugged terminal can be set up in about ten minutes and offers two-way, IP over existing C-, Ku-, or Ka-band transponders, allowing wireless and secure connections from any location in a theater of operations or in an emergency response area. As mentioned earlier, the flyaway provided the broadband backbone for mobile communications during hurricane Katrina. A comprehensive view of the communications network appears in *Figure 5*.

Extensible Applications

The concept can be scalable and transportable to support military operations in remote parts of the world such as the horn of Africa or Afghanistan, which suffer from a lack of communications infrastructure. Cellular communications among U.S. or coalition forces could be activated or terminated as required by each mission.

In an entirely different operational concept, the cellular system may be used to receive and control a call from a third party that would otherwise be controlled by another cellular network. In a rural environment where the UAV is at 3,000 to 5,000 feet, the signal strength to the UAV is likely to be dominant. Control may include completing or terminating the call. In an urban environment, especially a dense one with many cellular base stations, control would be very difficult to achieve.

In the recent Gaza war, Israel and Hamas claimed to have hammered each other with threatening text messages, bringing a new dimension to psychological warfare. A loitering UAV could be used to capture opposition cellular numbers and later disseminate text messages.

Unattended ground sensors equipped with cellular technology could be monitored from a loitering UAV.

In a more peaceful application, UAVs equipped with base station equipment could be used to locate persons who may be lost, provided they have an activated handset and a GPS radio.

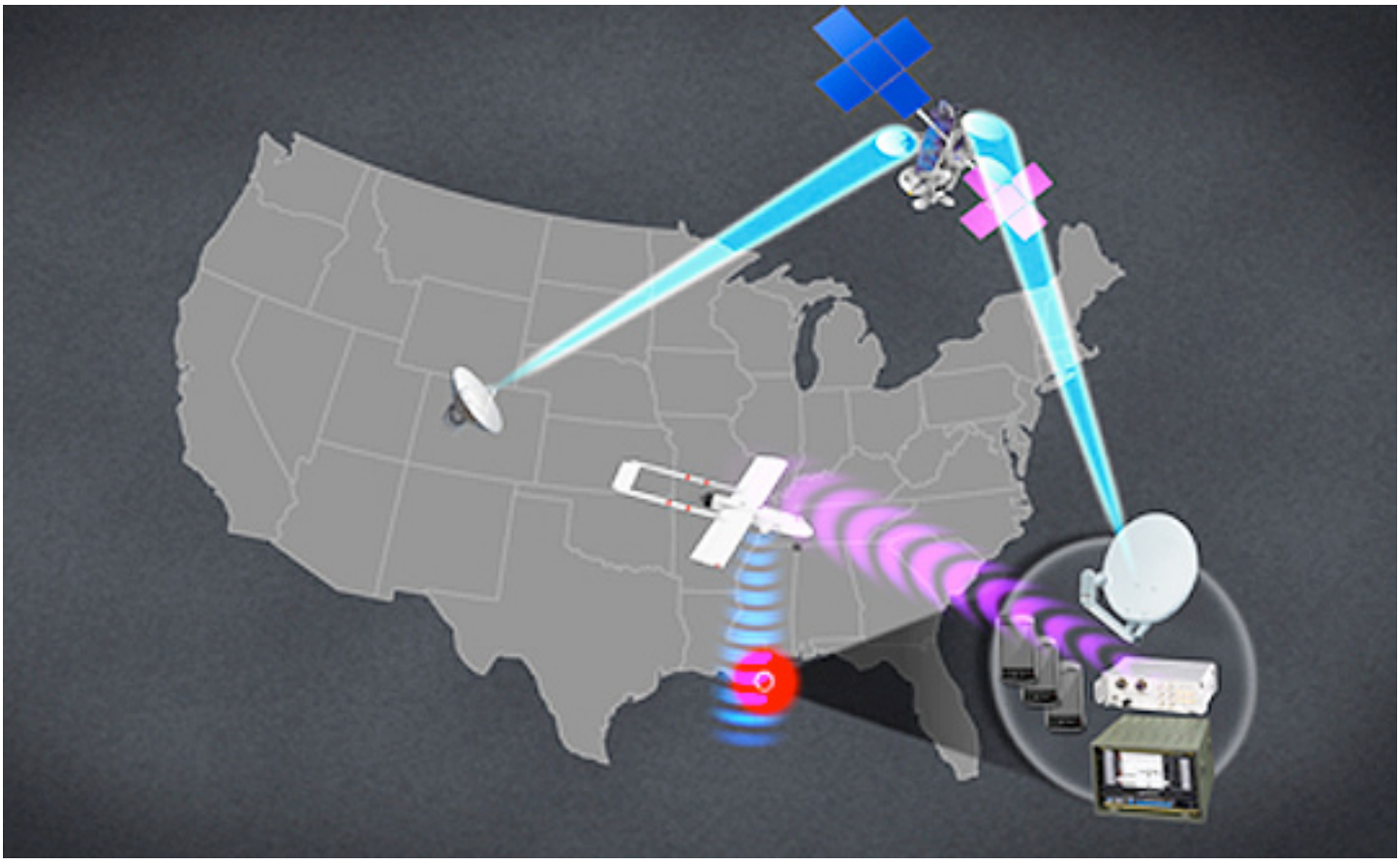


Figure 5 — the communications network

Network Security

In some applications network security may be essential. Several degrees of security are available. The noise-like signature of a CDMA signal, which is a 42-bit PN sequence, scrambles voice and data transmissions to make over-the-air eavesdropping very difficult.

CDMA uses the standardized **CAVE** (***Cellular Authentication and Voice Encryption***) algorithm to generate a 128-bit sub-key called the "***Shared Secret Data***" (**SSD**). An **A-key** is programmed into the mobile unit and is stored in the ***Authentication Center*** (**AC**) of the network. The A-key, the **ESN** (***phone electronic signature number***) and the network-supplied random binary number **RANDSSD** are the inputs to the CAVE that generate the SSD. The SSD has two parts: **SSD_A** (64 bit) for creating authentication signatures and **SSD_B** (64 bit) for generating keys to encrypt voice and signaling messages.

Blackberry offers AES encryption in conjunction with its enterprise server, which could reside in the survivability node. Another option is the **General Dynamics *Sectéra® Edge™*** smartphone, which is an NSA-certified Type1 phone and PDA for making secure phone calls, with secure access to classified networks, e-mail, and web browsing via high-speed GSM or CDMA cellular networks worldwide.

In Support Of Loitering

The application of 3G cellular technology to support homeland defense, disaster relief, or military operations is transformational, with the clear potential to displace the use of tactical radio systems. At the handset level there is a clear confluence of high bandwidth wireless technology, computing, software applications, and multimedia. This confluence is revolutionizing a broad component of how we conduct our lives in so many areas, such as personal communications, entertainment, shared experiences, shopping, business management, and education.

There are a few nascent military R&D projects that are testing and evaluating the capabilities for private cellular networks supported with airborne base stations, but before the next generation of military leadership is in place, the use of this technology should be ubiquitous. In any case, a large-scale disaster can bring the cellular infrastructure to its knees. A loitering UAV system can recover essential capabilities and provide 24/7 coverage for disaster relief teams.

About the author

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PRIORITY BRIEFING

ENABLING THE WARFIGHTER: COMMERCIAL OR MILITARY BANDWIDTH?

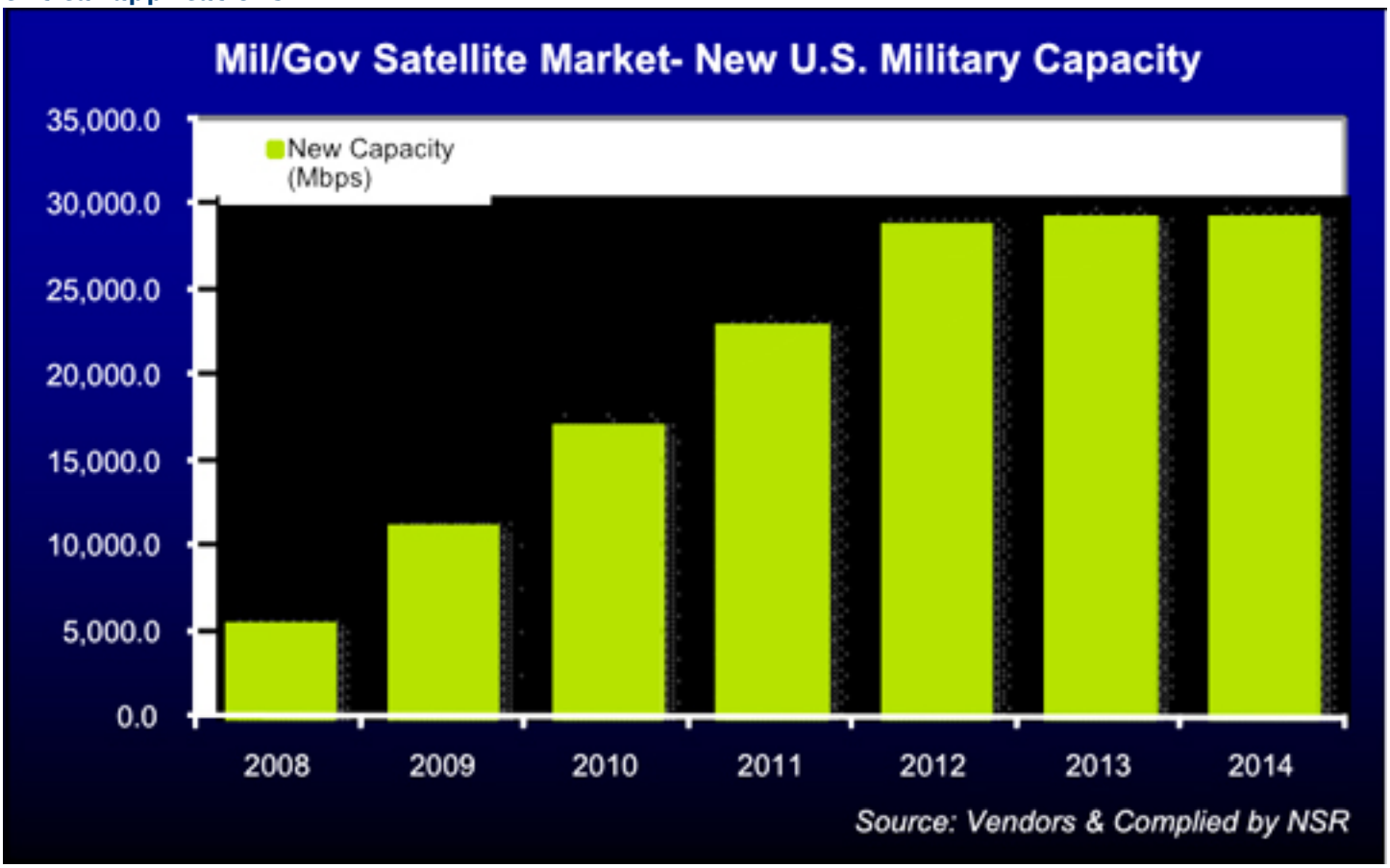
by Jose Del Rosario
*Senior Analyst & Regional Director — **NSR***

Flashpoints around the globe continue to drive demand for commercial satellite capacity despite the availability and launch of military satellite bandwidth. The first *Wideband Global Satcom* (WGS) launched in 2007 and the second in early 2009 provide the U.S. Department of Defense (DoD) with much needed internal capacity in its goal to attain self sufficiency or at least achieve its aim of relying less on commercial capacity in its current operations as well as for future missions. More WGS satellites are on the way as well as other U.S. DoD programs including the AEHF and MUOS, which should provide even greater capabilities for enabling the warfighter for future bandwidth-hungry and critical applications.

By 2014, or a few years after this date, the U.S. Military should have close to 30 Gbps of capacity based on its next-generation satellite program deployments. It is unclear whether this capacity will be adequate or whether the U.S. Military is close to becoming self-sufficient. But as developments around the globe continue put strains on internal capabilities, the need for commercial capacity would appear to continue, if only to achieve some sort of flexibility for military IT planners.

Iraq and Afghanistan and now Pakistan are requiring ground troops, aerial support and (to a lesser extent) maritime capabilities. Other trouble spots could develop in the near term including but not limited to: Continued or even increased piracy in the Horn of Africa that require greater Naval support to safeguard goods, but not limited to:

- ***Continued or even increased piracy in the Horn of Africa that require greater Naval support to safeguard goods, including oil***



- ***Greater surveillance of North Korea and other nations as well as potential conflicts that could spark ground troop deployments***
- ***Preparation for the deterrence of Russia in flexing its muscle in the former Soviet Republics***
- ***Greater instability in the Middle East***
- ***Increased activity in the war on drugs***
- ***An arms race with China***

Future satcom requirements are likely to further increase such that managing the bandwidth, hardware and software available to militaries around the globe will be a tremendous challenge. In enabling the warfighter, the mix and the management of proprietary and commercial satellite capacity will have to be fairly easy and seamless in order for the warfighter to continue to be effective.

Internal Versus External Capacity

In a perfect world, choices can be made on which type of capacity can and will be used for warfighters for specific missions. To a certain extent, this has been tried in past conflicts where so-called critical communications links were run on proprietary military frequencies. Battlefield and theater communications ran on internal military capacity, keeping security and high levels of reliability intact.

With bandwidth per soldier requirements as well as bandwidth for machine-to-machine (M2M) type applications exploding, militaries worldwide had to outsource some "non-critical" requirements on commercial or external capacity. Videoconferencing, communications to and from family members of soldiers to boost morale, and shooting video footage for public relations purposes among others were some of the "non-critical" traffic that were first managed by the Pentagon to preserve vital internal resources.

But increasingly, the line between critical and non-critical applications running on commercial bandwidth has and continues to blur. Applications such as Blue Force Tracking, reconnaissance missions on UAVs and munitions transport that are (in NSR's opinion) mission-critical are increasingly run on commercial bandwidth.

In examining the commercial capacity available as well as the internal capacity that is about to be launched by the U.S. Military and other military agencies around the globe, choices on which pipe to use, whether internal or external, is likely to become impractical and thus unimportant. For the warfighter who is equipped with weapons, supplies and other systems that are more directly linked towards warfighting, the choice of the communications link or the RF platform has to be an after-thought or immaterial. Whether receiving critical information from a UAV for situational awareness or identifying allies from foes, the available pipe on standard issue equipment should be able to work seamlessly for a mission in Afghanistan, Iraq, a former Soviet Republic, North Korea or even in the jungles of Latin America in the war on drugs. A multinational force, which is likely to become even more pronounced for future conflicts should likewise easily integrate into a network-centric architecture using a variety of frequencies and communication modes.

And here, the key lies in bandwidth availability and footprints. Given that the entire globe's military internal capacity will not be launched concurrently and will likely face delays in the deployment schedule, choices in whether to use internal or commercial capacity and more importantly in choosing which applications run on proprietary or non-proprietary assets become highly difficult if not impossible to conduct effectively.

Intelligence On The Ground

If bandwidth is to become "unimportant," intelligent terminals, hubs and networks will have to be developed. For the pipe to remain ubiquitous and available, the commercial pipe has to be allowed to remain, for lack of a better word, "unintelligent or standard" such that any intelligent terminal can point, shoot and communicate securely and reliably on whatever bandwidth is available in the area of operation.

In tapping the future market, satcom systems in the ground segments will have to incorporate these features:

- ***Multi-frequency terminals* — terminals on military mode are secure, reliable and relatively intelligent. When available, military**

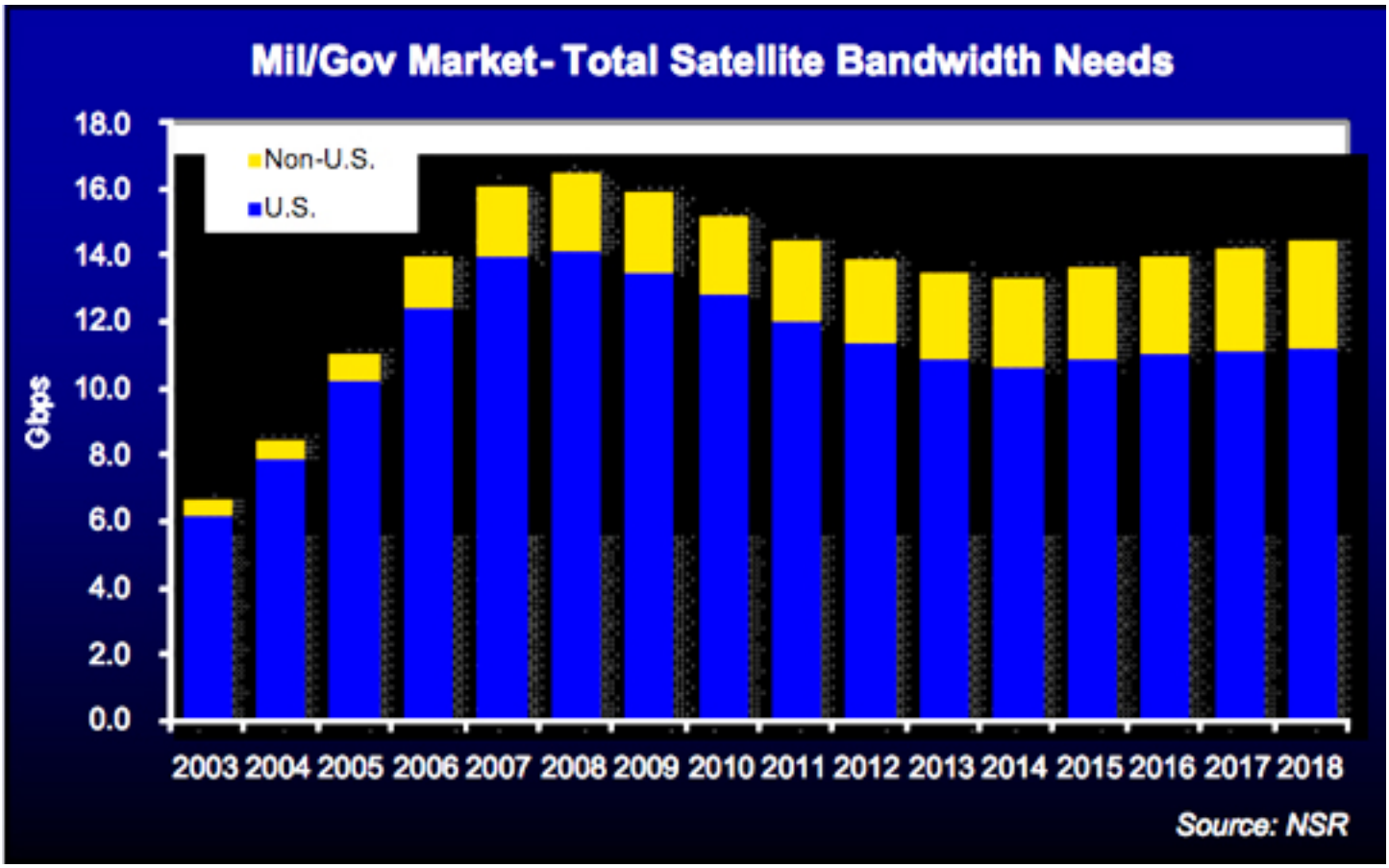
capacity will likely be the default mode of warfighter terminals when switched on. But should a military satellite be unavailable or over-subscribed, the same level of security and reliability has to be achieved in commercial bandwidth mode. Ground terminals used by the warfighter as well as terminals that support the warfighter such as UAVs for reconnaissance data will have to become multi-frequency that can run on both military and commercial frequencies. And here, the intelligent terminal allows for secure communications using a "standard" commercial pipe.

- *Security in hubs and networks for commercial bandwidth — Secure links, high service level agreements (SLAs) and other technical and contractual agreements have to be implemented with commercial operators to achieve the security requirements that proprietary military systems achieve.*
- *Software — encryption, acceleration, virtual private network solutions and other software packages have to be developed within terminals once commercial mode is activated to achieve security, reliability, robustness and availability that military bandwidth offers.*

Impact on Commercial Bandwidth

It is tempting to conclude or forecast that commercial bandwidth use and demand from military agencies around the globe will continue on its historical growth track, which has displayed relatively robust growth. It is **NSR**' view, however, that commercial demand will be negatively impacted in the long term given that almost 30 Gbps of capacity will be added by the U.S. Military. As of end 2008, more than 16 Gbps of commercial capacity was leased for military/government use worldwide, mainly due to a lack of internal capacity by the U.S. Military. With new and growing capacity being deployed in key regions of the globe, as well as terminal development being geared towards military frequencies such as the WGS, some re-pointing of terminals to military-owned capacity is bound to take place.

For the moment, it is difficult to foresee commercial bandwidth outsourcing doubling until 2014, given the pullout in Iraq. Although presence in Afghanistan is growing, at best, the same levels of commercial



bandwidth use are expected as resources and activities are re-missioned from Iraq to Afghanistan. It is even more difficult to justify continued robust bandwidth growth of commercial capacity outsourcing given the launch of internal capacity from the U.S. Military as well as other governments around the globe.

However, that is not to say that commercial bandwidth demand will evaporate in a relatively short period of time. Rather, demand should decline incrementally as military entities begin to rely more heavily on internal resources as well as shift traffic towards their own assets. But the need for redundancy and the recognition that hotspots around the globe can develop virtually overnight where military capacity may be lacking ensures that commercial bandwidth will continue to play an important role in military planning over the long term.

In fact, it is **NSR**'s view that with applications being developed, which will become even more bandwidth-hungry, commercial capacity demand should pick-up once again at around the 2015 timeframe. In looking at the future warfighter, developments are taking place to enable the ***Future Force Warrior*** (**FFW**) to reach Gbps of throughput where tactical intelligence/collection, enhanced situational understanding, embedded training, and on-the-move planning are achieved. The broadband requirements of the FFW ensure commercial bandwidth demand to once again increase.

The warfighter is deployed in many parts of the globe, based on developing situations or what happens to be the global hotspot at the time. Bandwidth has in the past hampered the warfighter, simply because bandwidth requirements have to be internal capacity for security reasons or commercial capacity is unavailable, expensive or already owned/leased by commercial entities such as news networks.

Militaries around the globe have learned from past experience and continue to deploy internal capacity in anticipation of future needs. At the same time, the military has professed its continued reliance on commercial bandwidth as part of its bandwidth planning efforts. The next step in enabling the warfighter lies in building smart ground terminal equipment and ground networks in order for commercial satellite bandwidth to approximate or even be at par with the security and reliability features of internal military resources. The bottom line is — the warfighter shouldn't need to make a choice or configure his/her terminal between commercial or military bandwidth in order to be enabled and effective. The warfighter should be able to simply point-and-shoot. The availability of bandwidth — regardless of the frequency — has to be integrated into future warfighting efforts.

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.

Jose Del Rosario
NSR

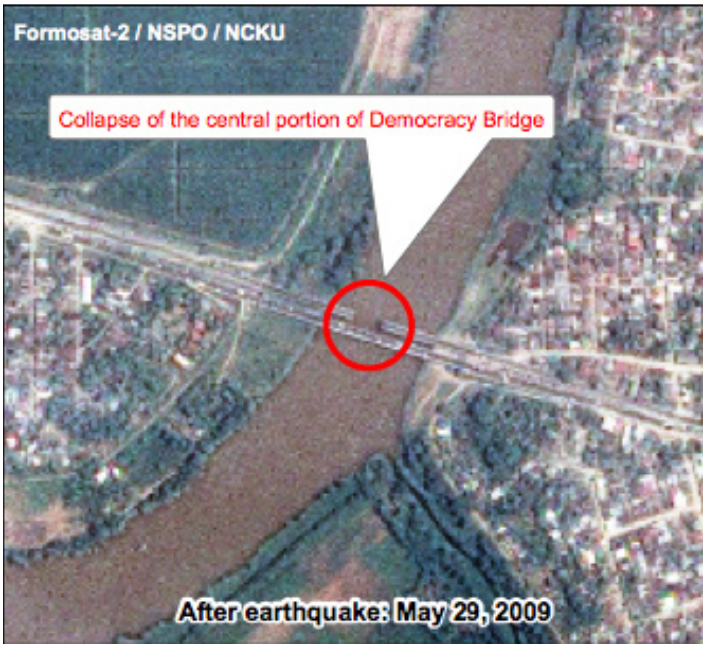
CASE WORK-NASA

On Thursday, May 28th, 2009, at 2:24 a.m. local time, a deadly earthquake rocked Honduras, killing seven people and injuring several others, demolishing homes, damaging scores of other buildings, and sending terrified residents running through the streets.

"I woke up immediately, and all I could do was hug my youngest son and pray," says *Dalia Martinez* of San Pedro Sula, Honduras. "After a few minutes, my family and I went outside, where my neighbors were already gathered, likewise terrified about what happened but grateful we were all okay. Since then, we've been sleeping with flashlights and telephones within reach, because the aftershocks have been strong."

Fortunately for *Martinez* and other shaken residents, disaster officials knew exactly where to send help. A state-of-the-art Earth observation system called **SERVIR1** directed them to the hardest hit areas.

Meaning "to serve" in Spanish, SERVIR is a joint effort of **NASA**, **CATHALAC2**, the **U.S. Agency for International Development**, the **Regional Center for the Mapping of Resources for Development**, and other partners. The system uses satellite imagery to zero in on places where a flood, fire, hurricane, or earthquake has left destruction in its wake. Team members combine satellite data with ground observations,



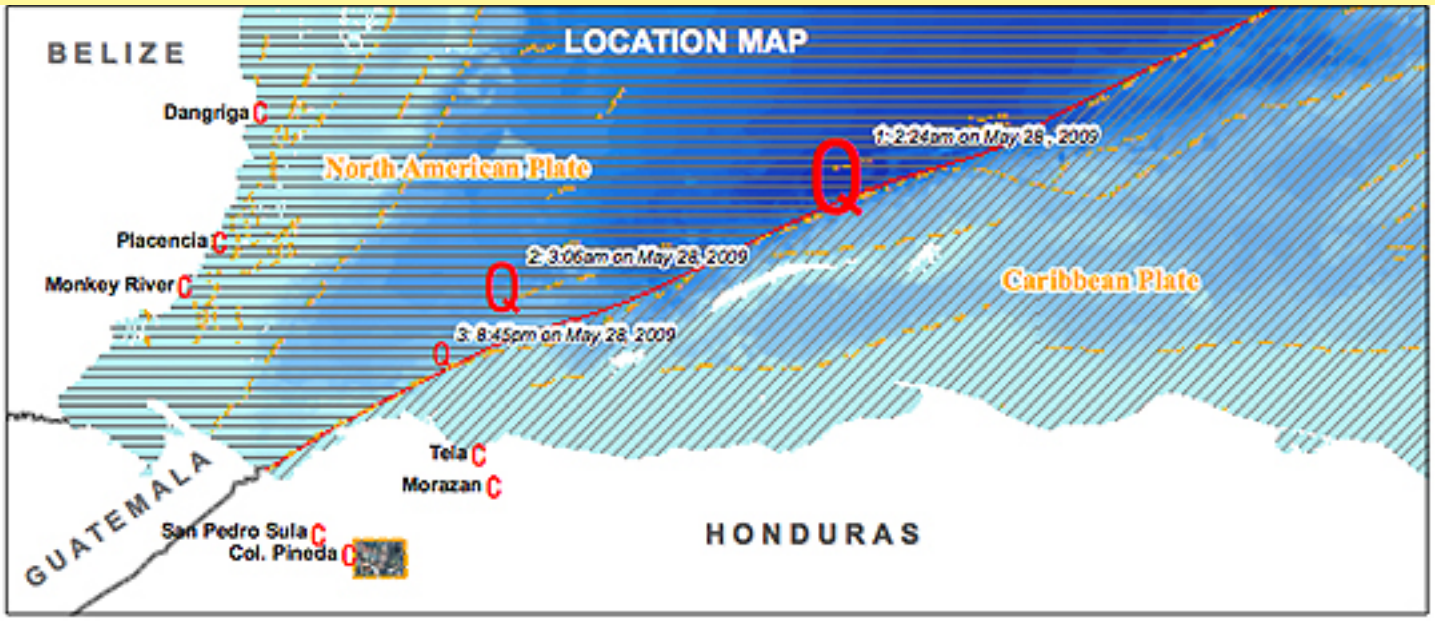
Satellite images pinpoint the collapse of the Democracy Bridge in San Pedro Sula, Honduras.

Left image: Ikonos satellite image, courtesy of GeoEye
Right image: Formosat-2 images provided by Dr. Cheng-Chien Liu of National Cheng-Kung University (NCKU) and Dr. An-Ming Wu of the National Space Organization (NSPO) of Taiwan

***EFFECTS**: In Honduras, deaths were reported in la Colonia de Pineda de la Lima, Morazán y Tela, and the earthquake damaged bridges, including the Democracy Bridge near San Pedro Sula and El Progreso. In Belize, the earthquake caused damage to buildings and streets in Monkey River and Placencia, as well as the death of a woman in Dangriga. In Guatamela, minor damage was reported.*

***DAMAGE TO INFRASTRUCTURE**: The earthquake damaged three bridges in Honduras, including the collapse of the central segment of the Democracy Bridge, shown in the right-hand image above.*

Map generated by CATHALAC / SERVIR on May 30, 2009



Legend

Earthquakes

Magnitude

Q 4.5

Q 4.8

Q 7.3

C Affected towns

International boundaries

Area covered by imagery

Fault lines

Tectonic Plates

Caribbean Plate

North American Plate

MULTIPLE EARTHQUAKES: According to the U.S. Geological Survey, there were three earthquakes in succession, the first being the strongest. Even though the earthquakes mainly affected Honduras and Belize, its effects were felt in various countries in the region, up to hundreds of kilometers away from the epicenter. The three earthquakes occurred in the Cayman Trench, near the boundary between the North American and Caribbean Plates. Boundaries between tectonic plates are known for seismic activity.

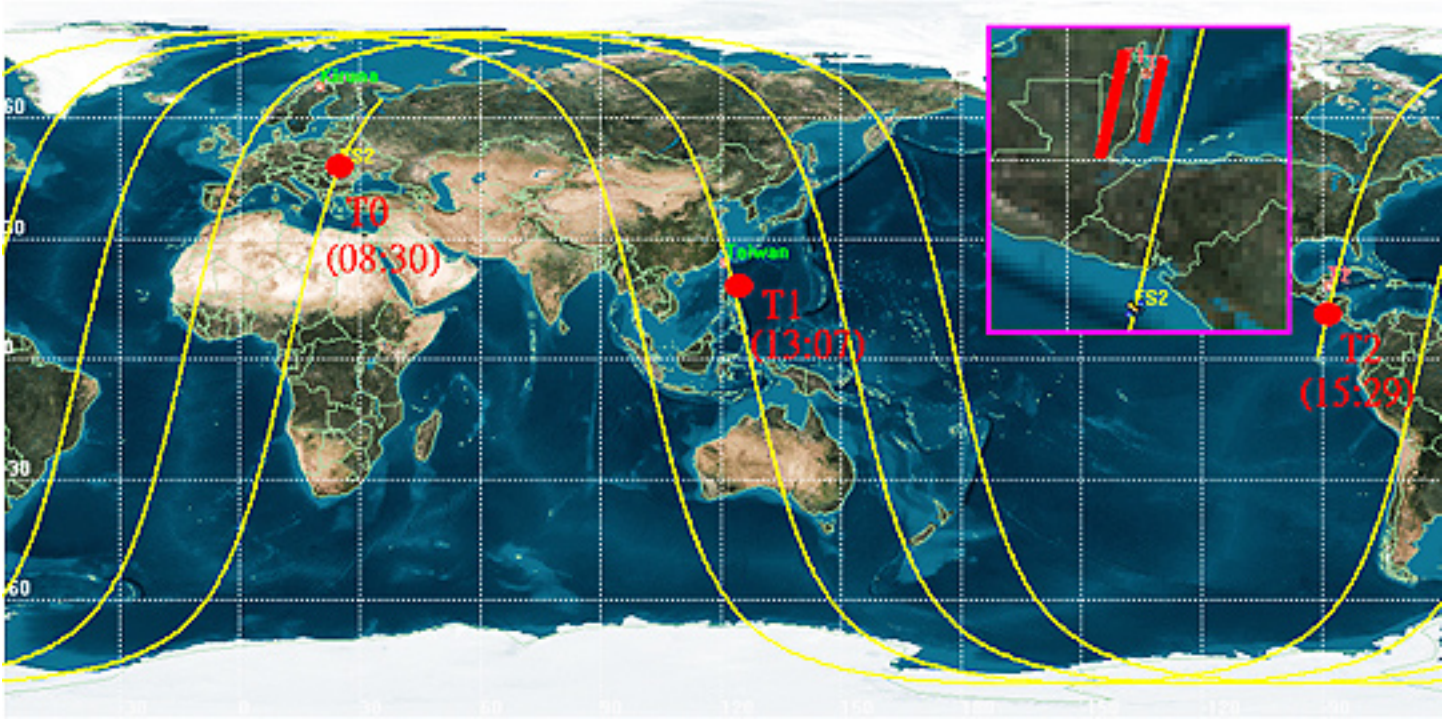
and display a near real-time map of crisis points. At a glance, decision-makers can see the locations of most severe damage so they can send help in a hurry.

"The Honduras earthquake was a perfect example of SERVIR at its best," says *Emil Cherrington,* Senior Scientist at **SERVIR**'s regional operational facility at **CATHALAC** in Panama. "It was like a chain reaction. People from agencies and organizations in several countries worked together after the earthquake to pinpoint precise locations where support was needed."

Breaking news stories revealed that the worst infrastructural damage was restricted, in general, to Honduras and Belize, so the SERVIR team at CATHALAC began to assemble images and data for a bird's eye view of those areas. They contacted *Stuart Frye* of **NASA**'s ***Goddard Space Flight Center*** and asked him to arrange satellite imagery.

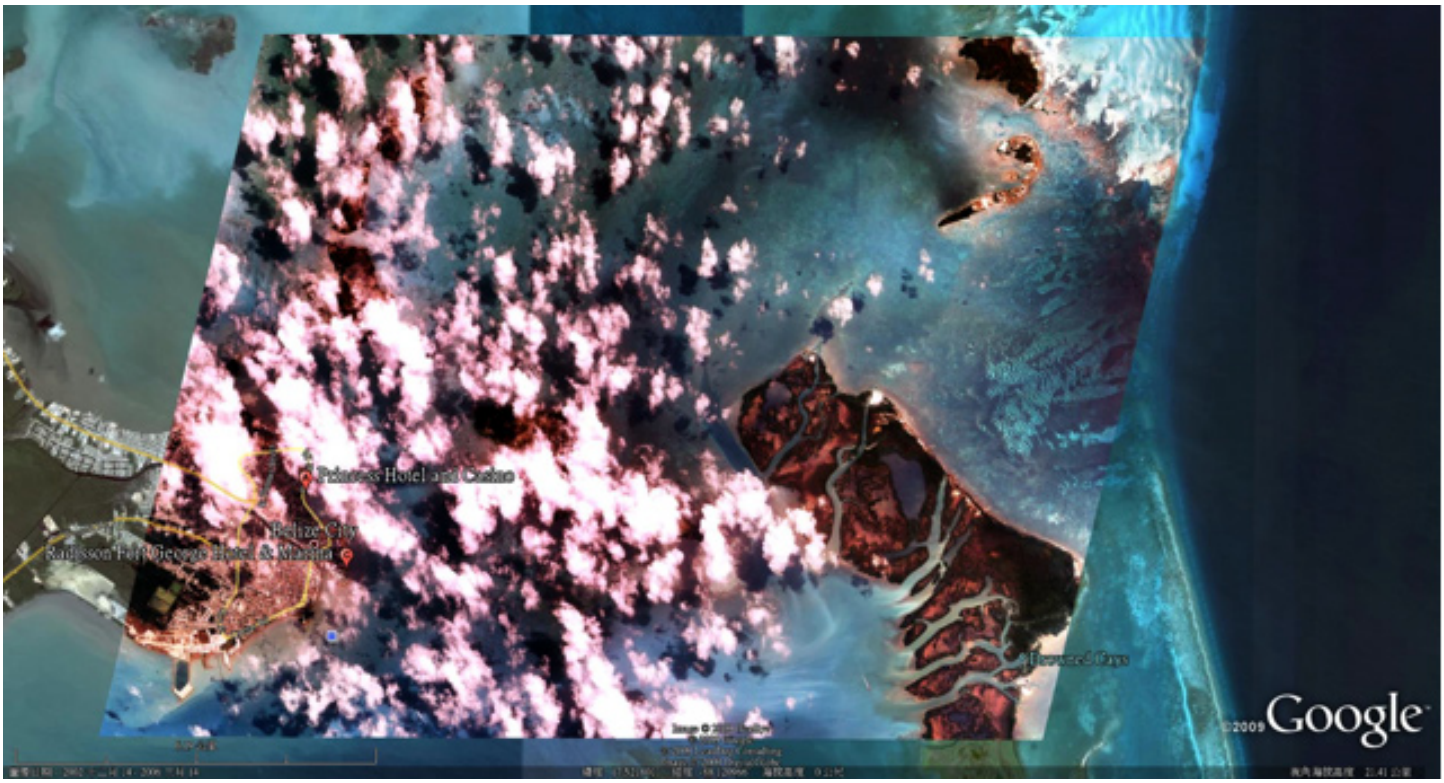
The next day, *Frye* notified the team that the Taiwanese would image the hardest hit areas by using their ***Formosat-2*** satellite. In fact, the Taiwanese were already in action.

Dr. *Cheng-Chien Liu* of the **National Cheng-Kung University of Taiwan** explains: "President Ma Ying-Jeou of Taiwan and his delegation were visiting Belize the night earthquake struck. As news of the quake spread across the Pacific, all Taiwanese were shocked and very anxious to confirm their safety and that of the people who lived in the countries hit."



Formosat-2 Satellite Orbit on 2009.5.28.
T0: UTC Time of Earthquake Occurrence;
T1: UTC Time of Command Upload;
T2: UTC Time of Urgent Imaging.

"We knew the fastest way to capture images of the disaster area would be to use Formosat-2. So I issued an urgent request for assistance to Dr. *An-Ming Wu*, the Deputy General Director of our National Space Organization. Even though it was the *Dragon*



The image of Belize City taken by Formosat-2 at 9:29 Belize time, 7 hours after the earthquake.

Boat holiday and all Taiwanese were enjoying their family reunion, Dr. Wu called the Formosat-2 mission operation team to rush back to the control center. The three critical images were taken in record time!"

Dan Irwin, SERVIR Project Director at NASA's **Marshall Space Flight Center**, recalls the lightning-fast response: "I was in a bus in Berlin when I received an email from Dr. Liu telling me they had the images ready to send. It was early Saturday morning in Panama, but I called and woke Emil [Cherrington] up anyway to let him know."

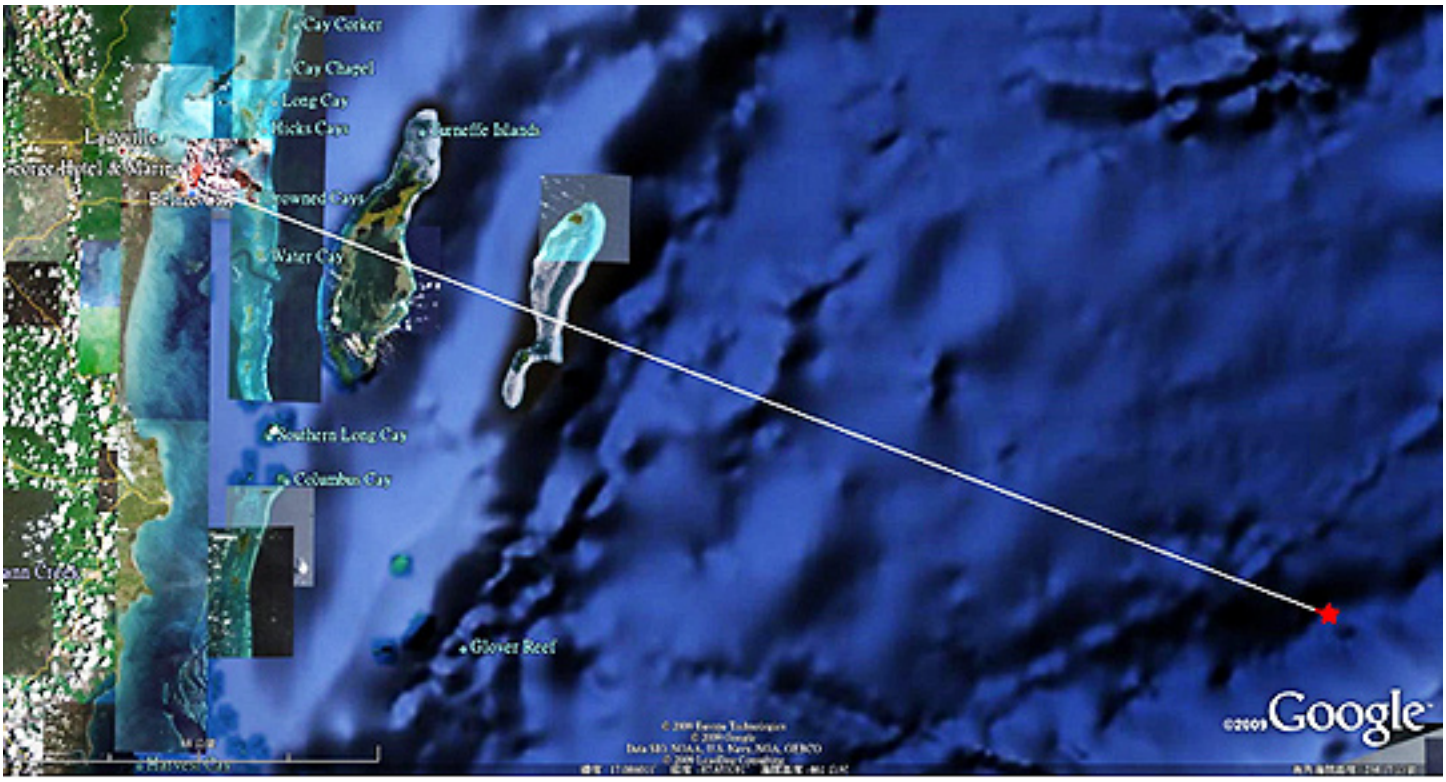
"Dr. Liu was the one who lost sleep," says *Cherrington*. "He stayed up until 2:00 a.m. Taiwan time sending the images to our servers at CATHALAC. The data volume was huge, so the transfer was slow, but he wouldn't go home until he was sure we received all the images."

The **CATHALAC** team processed more than 700 individual image fragments. At 1:21 a.m. on Sunday May 31st, they sent Spanish and English versions of their assessment map to Honduras' national emergency management committee, the Red Cross, the United Nations Humanitarian Relief Network, and several other organizations vital to the relief efforts.5 These agencies then were able to focus their efforts exactly where they were needed.

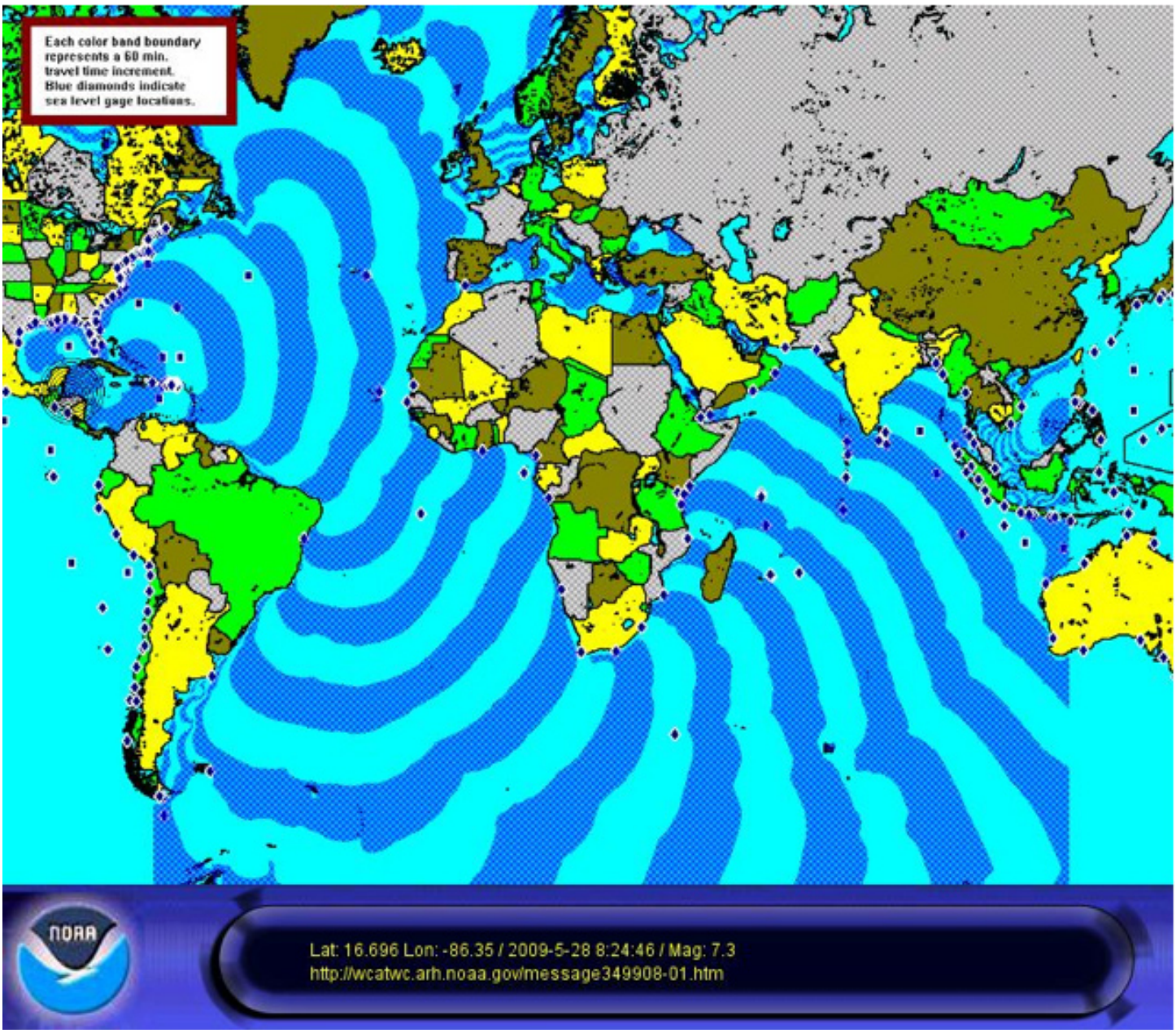
"People from several different nations worked together to pull this off quickly and smoothly," says *Irwin*. "It was a perfect example of why we at SERVIR say 'we're GEOSS6 in action.'"

GEOSS, short for ***Global Earth Observation System of Systems***, is a concept in progress to connect and

This Formosasat-2 image shows that the Radisson Hotel (indicated by yellow circle), where President Ma Ying-Jeou of Taiwan stayed, retained well after the earthquake and there is no sign of tsunami.



The epicenter of this earthquake is a mere 230 km away from the hotel where President Ma stayed. Such an event could have been a catastrophic disaster it such had occurred in Taiwan, especially if a large tsunami were triggered by this earthquake.



This travel-time prediction released by NOAA illustrates how fast the tsunami would spread across the ocean. There is not much responding time for the people live in the coastal region in Belize.

pool several countries' Earth observation tools and data for the benefit of all. It's no wonder that the organization chose SERVIR in 2007 as a template--a sort of "poster child" for how to meet GEOSS goals. "This is the 24th time7 that disaster response has been provided to Mesoamerica and the Caribbean regions in the framework of SERVIR, and the 6th event in 2009 alone," says *Cherrington*. "We also anticipate a busy Atlantic Hurricane Season. In fact, that season is already upon us." "We're ready," say *Cherrington* and *Irwin*.

*This article is courtesy of **SCIENCE@NASA** and Duana D. Coulter.*

SERVIR currently serves Central America, southern Mexico, the Caribbean, and east Africa. Current maps of fire, floods, and severe weather can be found on the bilingual SERVIR web site.

SERVIR, the Regional Visualization & Monitoring System, is a joint initiative among several agencies and organizations. CATHALAC, NASA, the U.S. Agency for International Development (USAID), the Regional Center for the Mapping of Resources for Development (RCMRD), the World Bank, and Central America's Commission for the Environment and Development (CCAD)

and other partners all play roles. A strong emphasis is placed on partnerships to fortify the availability of searchable and viewable earth observations, measurements, animations, and analysis.

CATHALAC, The Water Center for the Humid Tropics of Latin America and the Caribbean, is a regional entity based out of Panama City.

Dr. Liu is also the leader of Formosat-2 Rapid Response Team at National Cheng-Kung University of Taiwan.

SERVIR team members at NASA's Marshall Space Flight Center's test-bed facility view SERVIR data at the same time as their Central American counterparts at CATHALAC play key roles in supporting and coordinating SERVIR projects. For a list of SERVIR team members at all locations, click here.

The assessment map was sent to La Prensa newspaper, Honduras; El Heraldo newspaper, Honduras; Reuters; United Nations Humanitarian Relief Network (REDHUM); ReliefWeb; The Red Cross; World Vision; COPECO (Honduras' national emergency management committee); SERNA (Honduras' Secretariat of the Environment & Natural Resources); Honduran environmental professionals who have attended SERVIR workshops over the past few years; Group on Earth Observations Secretariat; Officials within USAID, NASA and NOAA.

The SERVIR disaster response maps have been syndicated by ReliefWeb and REDHUM.

The Group on Earth Observations (or GEO) is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS). This emerging public infrastructure is interconnecting a diverse and growing array of instruments and systems for monitoring and forecasting changes in the global environment. For more information, click here and here.

List of SERVIR Responses to Disasters in Mesoamerica and the Caribbean:

- ***Red tide event – El Salvador (June 2004)***
- ***Flooding – Panama City, Panama (Sept. 2004)***
- ***Flooding – Rio Sixaola, Costa Rica / Panama (Jan 2005)***
- ***Hurricane Stan – Guatemala, Mexico, El Salvador (Oct .2005)***
- ***Flooding – Colon Province, Panama (Nov. 2006)***
- ***Forest fire – Mountain Pine Ridge Forest Reserve, Belize (May 2007)***
- ***Hurricane Dean – Mexico / Belize (Aug. 2007)***
- ***Hurricane Felix – Nicaragua / Honduras (Sept. 2007)***
- ***Tropical Storm Noel – Dominican Republic (Oct. 2007)***
- ***Tropical Storm Olga – Dominican Republic (Dec. 2007)***
- ***Turrialba Volcano – Costa Rica (April 2008)***
- ***Tropical Storm Arthur – Belize (June 2008)***
- ***Hurricane Gustav – Haiti / Dominican Rep. (August 2008)***
- ***Hurricane Hanna – Haiti (Sept. 2008)***
- ***Hurricane Ike – Haiti (Sept. 2008)***
- ***Landslide – Huahua Michoacán, Mexico (Oct. 2008)***
- ***Tropical Depression 16 – Belize / Guatemala / Honduras (Oct. 2008)***
- ***Flooding – Costa Rica / Panama (Nov. 2008)***
- ***Landslide – Alta Verapaz, Guatemala (Jan. 2009)***
- ***Earthquake – San Jose metropolitan area, Costa Rica (Jan. 2009)***
- ***Forest fire – Volcan Santo Tomas, Quetzaltenango, Guatemala (Feb. 2009)***
- ***Flooding – Lago Enriquillo, Dominican Republic (Feb. 2009)***
- ***Forest fire – Clayton, Panama (March 2009)***
- ***Earthquake – San Pedro Sula, Honduras (May 2009)***

COMMAND CENTER

In 1959, ITT Defense Communications was working on Earth stations for the first active SATCOM carrier as well as for many of the early satellite programs. And *David Hershberg* started his career by working for this company and then, in 1968, he founded ITT Space Communications, Inc. In 1972, David founded Comtech, Inc., Systems Division, and Satellite Transmission Systems, Inc., in 1976 — a wealth of experience, to be certain.

For 18 years, **Satellite Transmission Systems** became the global leader and premier company in SATCOM ground station systems. Under *David's* leadership, STS was a 1992 winner of the *New York State Exporter of the Year Award* and STS became the first company in its field to achieve the coveted **ISO 9001** certification. In addition to his duties at STS, Mr. *Hershberg* also served as the President of the *Satellite Communications Group* of **California Microwave Inc.**, which included responsibility for **EF DATA, Inc**. and **CMI Mobile Products**.

Mr. *Hershberg* founded **Globecomm Systems Inc**. in 1994 as an integrator of SATCOM systems and networks. In a short time, the Company became a leading provider of end-to-end solutions, including systems, connections, and services. In 1996, he founded **NetSat Express, Inc**. as a subsidiary of GSI, to provide Internet service to developing countries, and it is now a leading provider of Internet-via-satellite services for international ISPs and end-to-end Enterprise Solutions, with content delivery offerings such as ***Skyborne***[SM].

Considered an industry leader by many of his peers, Mr. *Hershberg* has championed many new technical and management innovations, and was recently honored as the recipient of ***The Ernst & Young "Entrepreneur of the Year Award*** for the Long Island region in the *Emerging Technology* category.

Mr. *Hershberg* was inducted into **The Society of Satellite Professionals International Hall of Fame** in 2003. Satellite professionals are inducted into the Hall of Fame in recognition of career accomplishments in satellite communications or other space applications over a period of at least 20 years.

Working to improve United States industry competitiveness, Mr. *Hershberg* was invited to testify before the United States Congress, and met with President Clinton on competitive trade issues. In addition, he has worked on trade issues with the **Department of Commerce**, the U.S. Trade representative, **AEA**, **TIA**, and the **Council on Competitiveness**.

An accomplished expert on quality issues, Mr. *Hershberg* has lectured to companies, government agencies, and industry groups on Continuous Improvement and Total Quality Management.

Mr. *Hershberg* allowed time from his busy schedule to offer ***MilsatMagazine*** some insights into his career and his company.

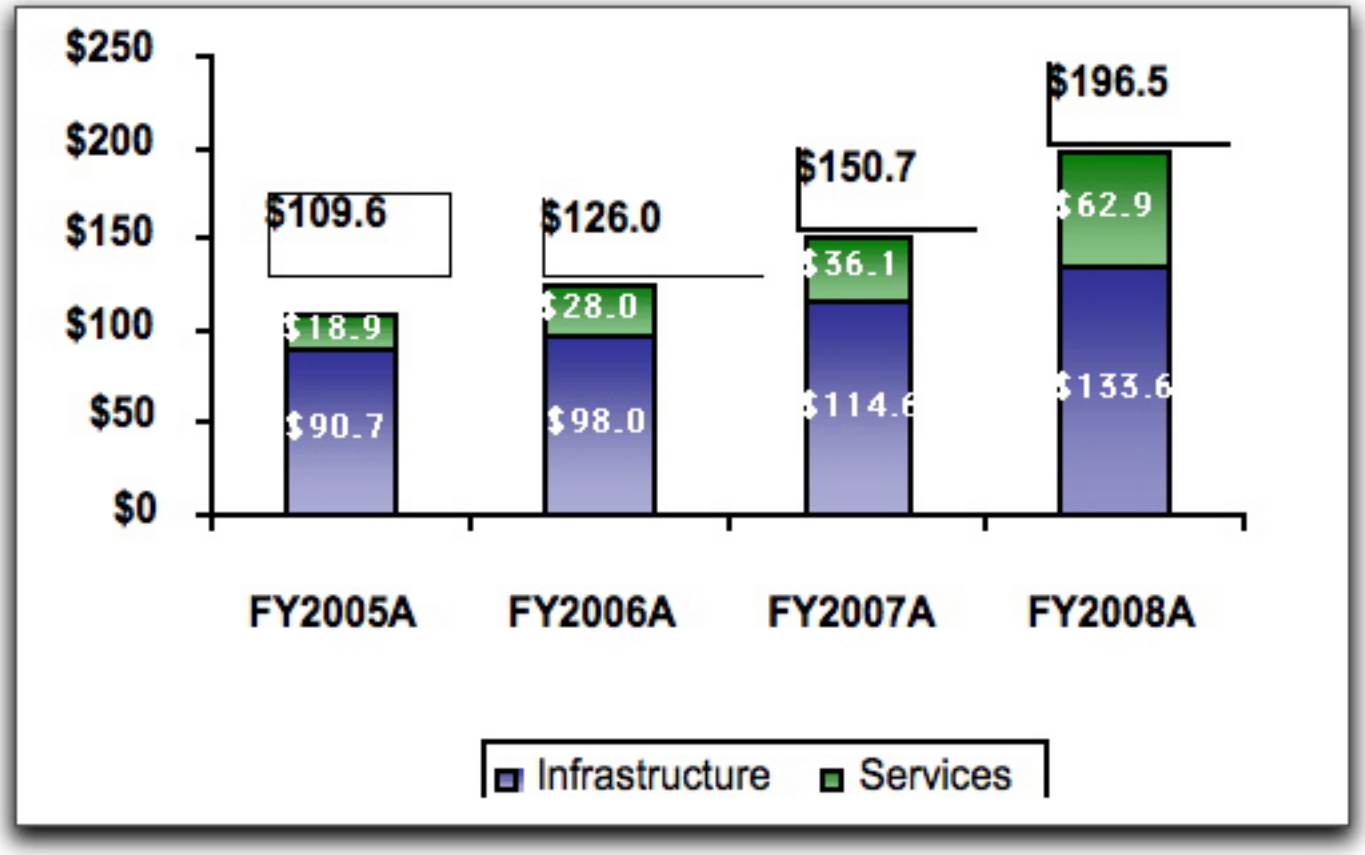
MilsatMagazine (MSM)

Globecomm was founded in 1994 by you, has managed a number of crucial acquisitions over the years, and today finds itself involved in a number of major SATCOM market segments. Would you please tell our readers about your history prior to Globecomm and how you acquired the knowledge necessary to turn your company into the success it is today?

David Hershberg

I personally started my career in the satellite business in1959. I have focused mainly on the ground segment side of the business and what an amazing adventure it's been. I was extremely fortunate, having had a number of good people to work for and to learn from. Mentors in this business are very important and I had several. I also like business, and have an engineering and a Masters of Business degree.

I got into the satellite business when it was absolutely new. This was a big advantage. The first satellite was launched in 1957 and I went to work in 1959. So I was lucky enough to have been given a lot of responsibility as a young guy building the first ground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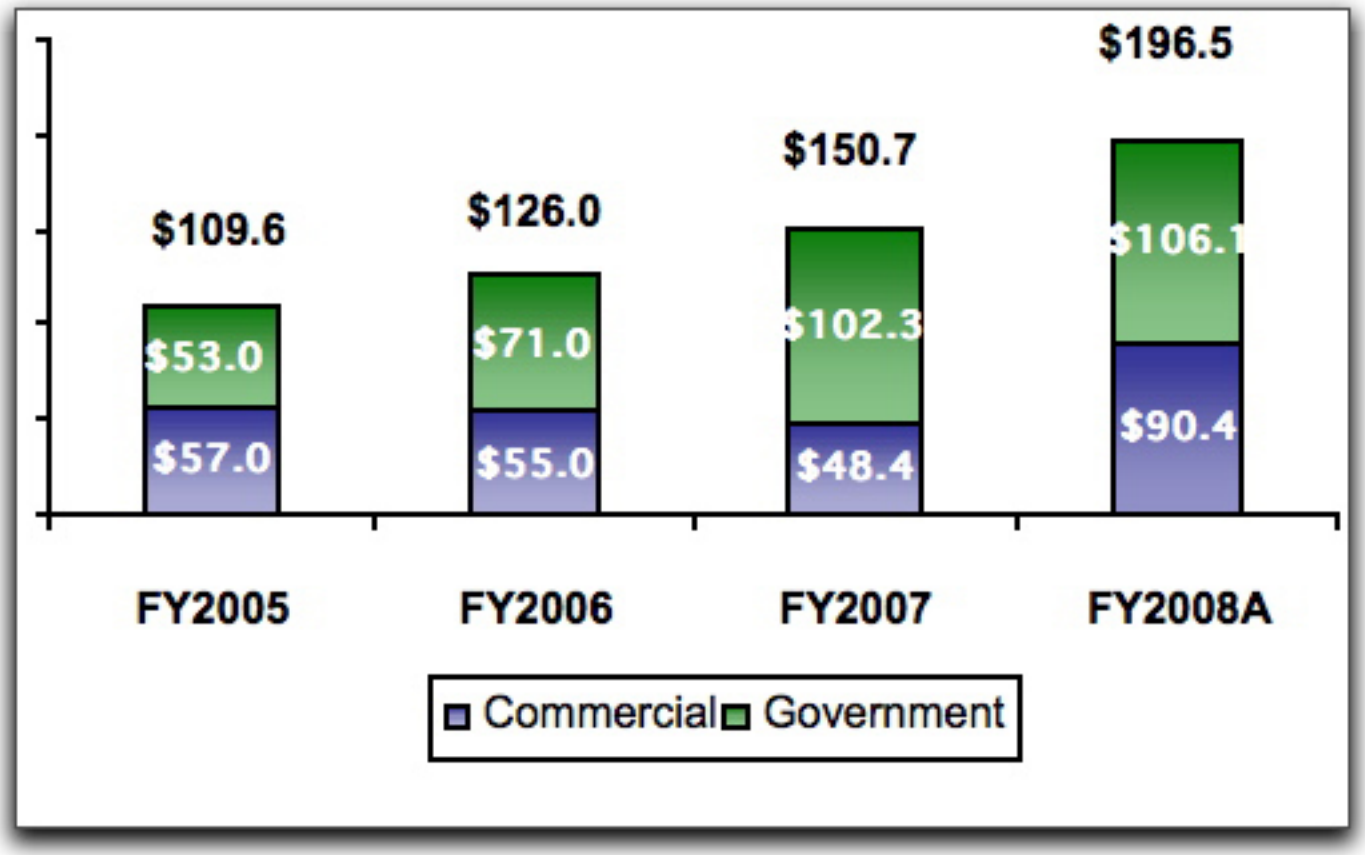
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infrastructure for an active satellite. This would not have happened in a more mature industry, probably. I initially worked for ITT and then Comtech. In 1976 I became an entrepreneur. I started my own company, Satellite Transmission Systems, which I later sold to California Microwave.

I left STS in 1994 and founded Globecomm Systems. I have been involved in both the technical, business and management sides of the business. I learned what was important to customers and employees and studied business and quality issues from the tech side.

I have always thought of myself as one of the team. It's a management style that has suited me well. It enables me to keep learning – and I have learned more in the past 5-6 years, in many ways, because of the rapid shifts in technology. It's never dull.

MSM

Could you tell us about the Globecomm umbrella of products and services and how the Company decided to enter each vertical segment?

David Hershberg

We define ourselves as a provider of end-to-end value-added satellite-based communication products, services and solutions. Our products flow from our ability to leverage our core satellite ground segment systems and network capabilities with satellite communication services capabilities.

We have broken our offerings into key product and service areas. This means we offers pre-engineered systems, systems design and integration services, managed network services and life cycle support services. Overall, this covers most of the major demands of our customer base.

Our global portfolio of customers includes communications service providers, commercial enterprises, broadcast and other media and content providers and

government and government-related entities. Our clients range in diversity from the FAA to Showtime to Bharti Airtel.

I should add that it hasn't always been a "straight line" of success for us. Globecomm grew very fast, to about $100 million revenues in six years. However there was a period when our revenues shrunk to $55 million! Why? We fell into a commodity trap. It was evident that our base business with common carriers and ISPs had become a commodity business.

So we did not sit still. We tried to understand where the business was headed. This was a turning point. Our team grasped the fact very early on that there was going to be a convergence using Internet Protocol. We knew that we could not offer the many services we wanted to offer without being able to make this convergence central to our engineering. So a decision was made to expand our Internet service business to video, cellular, data, voice and network management, as well as logistics support.

After the attacks of September 11th, we also made an important determination regarding the hardware and infrastructure business. We assessed correctly that the American government would expand its use of satellite and related communications systems as part of its global response to terrorists. Since then, we have gone from 10 percent of our business being government-related to about 50 percent.

We have expanded our service business from $15 million to $75 million.

We also began to acquire capabilities in a few areas. Recently we assessed a new area of expansion. As your publication reported, we recently entered the maritime business through two acquisitions. It fits our model of finding industries that can leverage satellite technology and out unique abilities. Maritime is perfect. Here satellite is the only viable means of providing broadband to vessels. Our two acquisitions in this area will help us compete.

MSM

Mr. Hershberg, the requirement for sophisticated military communications continues to increase, demanding more and more satellite capacity and bandwidth. Would you assess the current need among the military for more sophisticated communications technologies?

David Hershberg

From our perspective, the need revolves around trends that are similar and familiar to the commercial world: broadband access and applications to empower the individual with more sophisticated and smaller devices for communications. You can also add that the requirements are coupled with the need to provide all of this while on the "go."

The need for broadband capabilities for the modern war fighter is becoming evident. Modern war depends on "the network" and the network must be fast, reliable and ubiquitous. Broadband is the new infrastructure. The newest requirements are for broadband satellite access on the move, with the ability to function with all necessary devices in increasingly smaller packs to ensure faster movement.

We are also seeing new satellites that are shaping our offering to governments and organizations. The new WGS satellites have significantly more capacity than existing satellites. Most military infrastructure today operates on commercial satellites in C and Ku- band. The military infrastructure is now being upgraded to work with WGS. That is yet another change that we need to aware of.

MSM

As a Company with global interests, how do you and your executive team(s) decide which particular avenues to take in the various countries when offering product and services? How do you interface with the various military organizations around the world? In addition, due to the nature of some of your business, how do you separate and maintain confidentialities when dealing with various government agencies and governments?

David Hershberg

When dealing with military outside of the United States' DoD most of the equipment requirements are covered by ITAR regulations. So it is very important that during the proposal stage we determine if a TAA is required and if the systems require export licens-

es. This is true dealing with foreign FMS sales and also with NATO.

MSM

In your opinion, which technologies are the two most critical? And why?

David Hershberg

The best way to answer that is to identify the two most critical customer needs of the military. The two main ones are in the areas of bandwidth efficiency and those that enable mobile, rapid deployment of essential and increasingly standard communications.

Several new technologies are being introduces to provide more robust bandwidth and efficiencies, especially the areas of "carrier-in- carrier" and adaptive coding. This allows reliable communications to minimize the fade conditions that persist with Ka-band.

Satellite communications from aircraft and UAV's, as well as satcom on the move are really advancing in a big way too.

I should add that a project we did for NATO, which enables tracking individual troop locations by providing a WiMAX connection from a vehicle equipped for Blue Force tracking is also important because mobility and stealth have become important tactical elements.

The newer, smaller tactical terminals we have at Globecomm allow automatic pointing of the antenna and configuration into the network, which again supports an individual warfighter whose support "weapons" are bandwidth and the ability to quickly deploy his or her communication system in order to be effective. We have a branded product called Auto Explorer which has become popular in this area.

MSM

How can the ground segment industry and technology solutions and services providers such as Globecomm "tackle" the need for increasing bandwidth and bandwidth speeds? Reliance upon third parties can occasionally leave one wishing for more control. How is such adjudicated?

Globecomm's AUTO-EXPLORER 1.2m X--band SATCOM terminal

David Hershberg

To some degree, and especially in wartime or periods of conflict like the present one, there is usually a partnership between those tasked with military missions and those who support the mission in the private sector.

They way to offset the military's concern about control is simply to continue to build systems and technologies that offer the user or peacekeeping group more autonomy of use. By introducing better technology and making it appear "seamless," we can strike the right balance between a commercial provider's systems and the military's reliance on those systems.

MSM

Everyone wants "faster, cheaper and better." It is a cliché. However, military departments that have responsibility for space segment, warfighting, and peacekeeping feel pressure to find smaller, more easily implemented systems that are completely viable. What are some of Globecomm's projects in this area?

David Hershberg

That phrase may have become a cliché, but it is also the customer saying to us, 'This is what we need to be effective.' So it is a serious demand. We read into that a requirement to accommodate the rapid rise of mobility as a driver for most communications.

As a result, we did our R&D and produced a suite of terminals and auto explorers that are very easy to use and affordable. In the Fall we will also make available a small and lightweight "manpack" system. These products are what we called militarized COTS (commercial off the shelf). What is appealing about these products is that when tested to a MIL 810F environment and related requirements, they are equal in capability to more expensive MilSpec products.

MSM

We are nearly 8 year beyond September 11, 2001. That disaster clearly brought changes and new technologies to satellite and military segments. What would you say were the major changes brought about due to 9/11, and where do you think we will find ourselves come 9/11/2011?

David Hershberg

September 11, 2001, represented a sea change in our industry as it did in most nearly every aspect of government security. 9/11 was the reason we made a decision to pursue military and government lines of business. The Iraq and Afghanistan conflicts took place in response to the threats from 9/11. There was — and there remains — a tremendous need for intelligence from many locations.

Those locations change with strategic shifts. Many of them can only be identified via satellite. The use of satellite in the military toolkit may well be one of the truly big stories when this period of history is written and assessed.

As with most traumatic events of this kind, 9/11 changed the nature of the modern battlefield. Because of the dispersed nature of terrorism and changing tactics even among traditional militia, we have witnessed an-ever increasing need for bandwidth to pursue objectives.

We envision growth in tactical and mobile terminals. Again, all of this will be in support of a warfighter who will come to rely more and more on networks and information systems; the same stuff that we see in the commercial world, but of course for other, more serious purposes.

From the perspective of morale, we will also see the military furthering its efforts to keep its people connected to their loved ones. Especially during periods of long deployments. The military already supplies Internet and phone services for soldiers to call home or connect with their Web 2.0 tools. (Remember, this is the web generation keeping the peace!). I do not see this decreasing. Quite the opposite.

September 11, 2011 is not so far away. I would say that the enemy will increase its use of technology further by then, which will put more pressure on us to continue to innovate.

MSM

Is Globecomm able to make any new announcements related to its technology services or pre-engineered systems for the military?

David Hershberg

We will shortly announce a line of X-band and Ka-band products, including a vehicle mounted, flyaway using both bands, as well as a new X-band "manpack," to which I have referred during our discussion.

MSM

Where do you see Globecomm in five years? Ten years? What do you foresee as the most important advances for our industry this year and next?

David Hershberg

I don't know if I can see out 10 years. Things really change fast. However, I think you will see high definition surveillance by UAV's via satellite to keep the peace, fight wars and in support of drug intervention and related surveillance. Here again, com-

mercial applications will be used to the advantage of those attempting to make the world safer. This will require bandwidth.

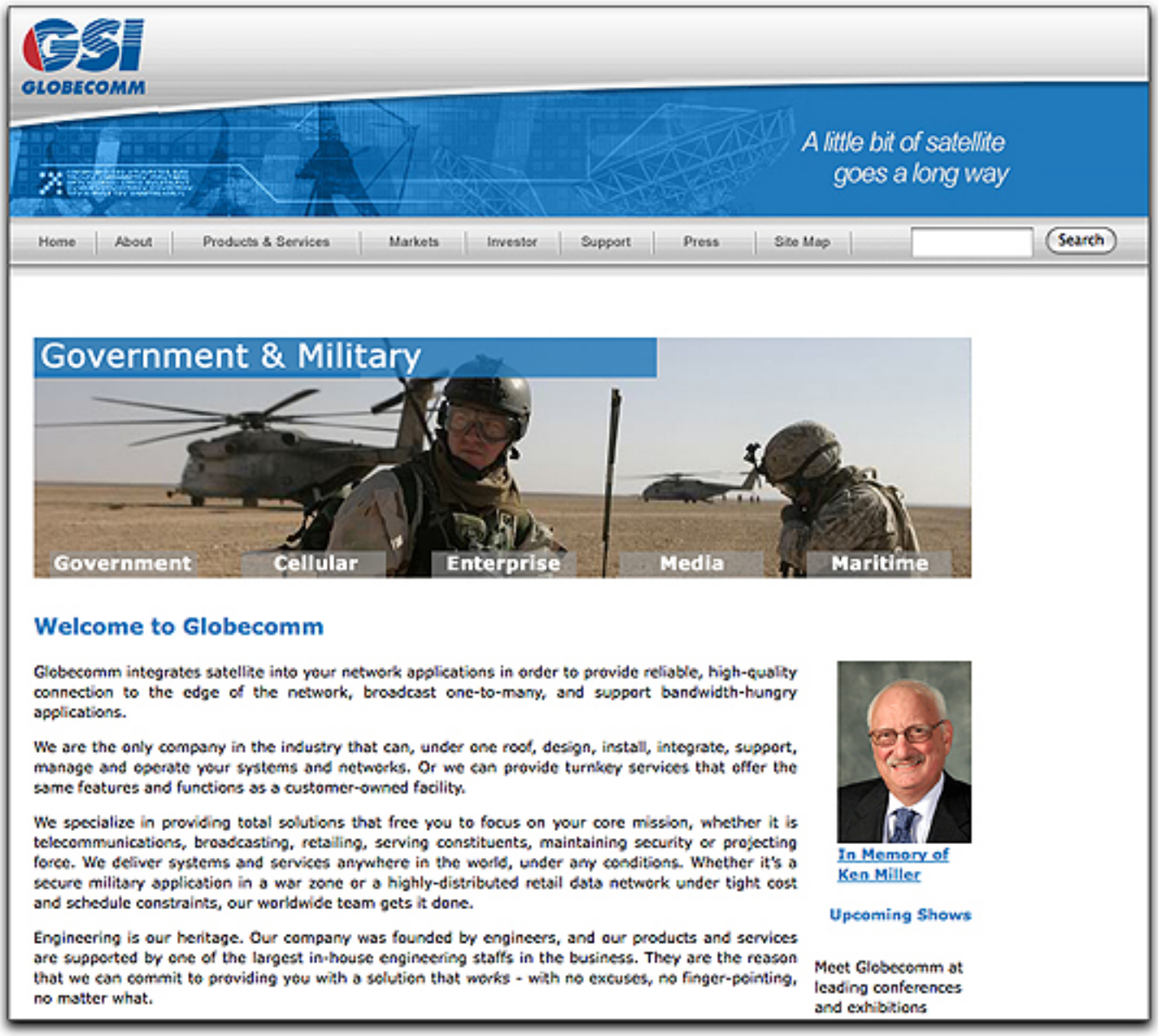
The use of an Internet-like network and the Internet with high level of encryption will be the seamless communication choice for the military and governments.

Cellular type systems coupled with broadband satellite tactical terminals will allow the war fighter to have real time access to wide area communications and information systems. Hopefully this will provide an edge.

Speaking on behalf of my industry, we will need to upgrade a lot of equipment to Ka- and X-band over the next 48 months. We will also need to upgrade the modems and demand access systems to keep pace with an ever-increasing flow of data, voice and video. Sound familiar?

MSM

Thank you for your time, Mr. Hershberg.



Development of U.S. Navigational Satellites

by Jos Heyman, ***Tiros Space Information***

Location of military equipment in the field is an essential requirement for the 'warfighter'. In *The Brick Moon*, a book published in 1873, E.E. Hale, the author, described four 600m diameter satellites which were in polar orbits of about 6500 km altitude. Two of the satellites passed regularly over Greenwich in the United Kingdom, while the other passed regularly over New Orleans, USA. The purpose of these satellites, which were apparently manned, was to be used by navigators to determine longitude.

Today unmanned satellites, substantially smaller that those suggested by *E.E. Hale*, provide navigators with such a facility.

Navigation is the technique of determining one's position through the intersection of two or more lines from reference points of which the positions are already known. To assist in this, the globe is divided in latitudes, which are reference lines running parallel to the equator, and longitudes, which run from the North to the South pole. Latitudes are up to 90° north and south of the equator and longitudes are 180° east and west of the 0° longitude which runs through Greenwich (U.K.).

Latitude can be measured either from the angle of the Pole Star above the horizon or by the angle of the noon-day Sun in relation to the navigator's position. Longitude determination makes use of the fact that the Earth rotates on its axis once every 24 hours, *i.e.* in one hour 15° of longitude passes beneath the Sun.

It is also possible to navigate by stars of which the position in the sky is known at a specific point of time or by means of dedicated radio transmissions from ground stations of which the position is known.

Navigational satellites are essentially radio transmitters of which the orbital positions are known. Through analysing the signals from three satellites, a navigator is not only able to determine his longitude and latitude but also, where appropriate, his altitude.

Transit/NNSS Series

The early navigational satellites of the United States were of an experimental nature. They were sponsored by the U.S. Navy and were built by **RCA**. The early ***Transit*** satellites used a radio-Doppler navigation method in which the ship's position was calculated from the observed change in the received frequency of the satellite radio transmission as the satellite passes across the sky.

This technique is based on the principle that the orbit of a satellite can be accurately computed by the analysis of the Doppler shift of the radio transmissions by the satellites.

This shift is like the changing frequency, or pitch, of the a train's whistle as it approaches and passes a listener. As the train approaches, the sound waves pile up in the direction of the listener. They stretch out from the listener's stand point as the train speeds away and an apparent change in frequency occurs. In a similar manner, the frequency of radiowaves reaching the ground from a moving satellite undergoes an apparent change, although the satellite continues to transmit on the same frequency.

The accuracy is limited by the frequency stability of the satellite transmissions and the ability to predict the satellite's orbit between the time it is measured by a ground tracking station and the time the user observed the satellite.

Orbital elements are transmitted by satellite and stored in the memory. Orbital elements are updated by ground stations every 12 hours.

Another method is based on time ranging. Here the user calculates his distance from a satellite by a measurement of the time that the radio signal of the satellite takes to cover the distance to the receiver. To achieve a reasonable accuracy, this method requires three separate satellites are needed and a very accurate clock.

Name	Int.Des.	Launch	Notes
Transit-1A	----------	17-Sep-1959	Failed to orbit
Transit-1B	1960 _ 2	13-Apr-1960	
Transit-2A	1960 _ 1	22-Jun-1960	
Transit-3A	----------	30-Nov-1960	Failed to orbit
Transit-3B	1961 _ 1	21-Feb-1961	Failed to separate from Lofti-1
Transit-4A	1961 _ 1	29-Jun-1961	
Transit-4B	1961 _ 1	15-Nov-1961	
Transit-5A1	1962 _ 1	19-Dec-1962	
Transit-5A2	----------	5-Apr-1963	Also known as Ops-0804; failed to orbit
Transit-5A3	1963 022A	16-Jun-1963	
Transit-5BN1	1963 038B	28-Sep-1963	
Transit-5BN2	1963 049B	5-Dec-1963	
Transit-5BN3	----------	21-Apr-1964	Also known as Ops-4368; failed to orbit
Transit-5C1	1964 026A	4-Jun-1964	Also known as Ops-4412

Table 1 — Launch dates of the Transit series

The ***Transit-1A*** and ***-2*** series carried two ultrastable oscillators, an electronic clock, and four frequency transmitters which operated in the 162/216 MHz and 53/324 MHz bands. ***Transit-3*** carried, in addition, a small magnetic memory. The ***Transit-4*** series, which was of a different design, was unique in that they carried a *Supplementary Nuclear Power* (**SNAP**) source to generate the satellite's power requirements. Transmitters operated at 150/400 MHz.

The ***Transit-5*** series satellites were of an octagonal shape and carried dual frequency transmitters as well as a 30 m gravity gradient stabilisation boom. The ***5A*** sub-series were powered by solar cells whilst the ***5B*** sub-series carried a **SNAP-9A** nuclear power source. The ***5C*** sub-series reverted again to solar cells.

The ***Navy Navigational Satellite System*** (**NNSS**), also called ***Oscar*** or ***Transit***, was the first operational system based on satellites built by **RCA**. The principal objective was to provide positioning facilities with an accuracy of 150m to submarines carrying ***Polaris*** missiles. At a later stage the system was also made available to civilian users. The satellites transmitted at 150 MHz and 400 MHz. While six satellites provided useful coverage, additional satellites were launched as in-orbit spares. The satellites launched in the 1985/88 period are sometimes referred to as ***Stacked Oscar On Scout*** (**SOOS**). See *Table 2* on the next page for launch specifics.

Timation/NTS series

The ***Timation*** or ***Navigation Technology Satellites*** (**NTS**) series tested new equipment to be used in the ***Global Positioning System*** (**GPS**). ***Timation-1*** carried two high-precision quartz clocks for accurate measurements based on a three dimensional navigation technique. ***Timation-2*** carried improved equipment and a dual frequency transmitter operating at 150/400 MHz. In addition, ***Timation-3*** (or ***NTS-1***) carried two rubidium vapor atomic clocks and operated at the 335 MHz and 1580 MHz frequencies, while ***NTS-2*** tested a ceasium clock. The satellite also carried an experimental solar array. ***NTS-3***, which was not launched, was to carry a hydrogen-masar clock.

Name	Int.Des.	Launch	Notes
NNSS-30010	1964 063B	6-Oct-1964	Also known as Ops-5798
NNSS-30020	1964 083D	12-Dec-1964	Also known as Ops-6582
NNSS-30030	1965 017A	11-Mar-1965	Also known as Ops-7087
NNSS-30040	1965 048A	24-Jun-1965	Also known as Ops-8480
NNSS-30050	1965 065F	13-Aug-1965	Also known as Ops-8464
NNSS-30060	1965 109A	21-Dec-1965	Also known as Ops-1509
NNSS-30070	1966 005A	28-Jan-1966	Also known as Ops-1593
NNSS-30080	1966 024A	26-Mar-1966	Also known as Ops-1117
NNSS-30090	1966 041A	19-May-1966	Also known as Ops-0082
NNSS-30100	1966 076A	18-Aug-1966	Also known as Ops-2366
NNSS-30110	---	---	Used as Transat
NNSS-30120	1967 034A	14-Apr-1967	Also known as Ops-0100
NNSS-30130	1967 048A	18-May-1967	Also known as Ops-7218
NNSS-30140	1967 092A	25-Sep-1967	Also known as Ops-4947
NNSS-30150	---	---	Used as P76-5
NNSS-30160	---	---	Used as Hilat-1
NNSS-30170	---	---	Used as Polar Bear
NNSS-30180	1968 012A	2-Mar-1968	Also known as Ops-7034
NNSS-30190	1970 067A	27-Aug-1970	
NNSS-30200	1973 081A	30-Oct-1973	
NNSS-30210	---	---	Not used
NNSS-30220	---	---	Expended in tests, 1992
NNSS-30230	1988 033A	26-Apr-1988	
NNSS-30240	1985 066A	3-Aug-1985	
NNSS-30250	1988 074A	25-Aug-1988	
NNSS-30260	---	---	Not used
NNSS-30270	1987 080A	16-Sep-1987	
NNSS-30280	---	---	Not used
NNSS-30290	1987 080B	16-Sep-1987	
NNSS-30300	1985 066B	3-Aug-1985	
NNSS-30310	1988 074B	25-Aug-1988	
NNSS-30320	1988 033B	26-Apr-1988	

Table 2 — Launch dates of the NNSS series

Name	Int.Des.	Launch	Notes
Timation-1	1967 053E	31-May-1967	
Timation-2	1969 082A	30-Sep-1969	Also known as Ops-7613
Timation-3	1974 054A	14-Jul-1974	Also known as NTS-1 and Ops-7518
NTS-2	1977 053A	23-Jun-1977	

Table 3 — Launch dates of the Timation/NTS series

Name	Int.Des.	Launch	Notes
TIP-1	1972 069A	2-Sep-1972	Also known as Triad
TIP-2	1975 099A	12-Oct-1975	
TIP-3	1976 089A	1-Sep-1976	

Table 4 — Launch dates of the TIP series

Name	Int.Des.	Launch	Notes
Nova-1	1981 044A	15-May-1981	Also known as NNSS 30480
Nova-2	1988 052A	16-Jun-1988	Also known as NNSS 30490
Nova-3	1984 110A	12-Oct-1984	Also known as NNSS 30450

Table 5 — Launch dates of the Nova series

Name	Int.Des.	Launch	Notes
Navstar-1	1978 020A	22-Feb-1978	Also known as Ops-5111
Navstar-2	1978 047A	13-May-1978	Also known as Ops-5112
Navstar-3	1978 093A	7-Oct-1978	Also known as Ops-5113
Navstar-4	1978 112A	11-Dec-1978	Also known as Ops-5114
Navstar-5	1980 011A	9-Feb-1980	Also known as Ops-5117
Navstar-6	1980 032A	26-Apr-1980	Also known as Ops-5118
Navstar-7	----------	18-Dec-1981	Failed to orbit
Navstar-8	1983 072A	14-Jul-1983	Also known as Ops-9794
Navstar-9	1984 059A	13-Jun-1984	Also known as USA-1
Navstar-10	1984 097A	8-Sep-1984	Also known as USA-2
Navstar-11	1985 093A	9-Oct-1985	Also known as USA-10

Table 6 — Launch dates of the Navstar series

Name	Int.Des.	Launch	Notes
Navstar 2-1	1989 013A	14-Feb-1989	Also known as USA-35
Navstar 2-2	1989 044A	10-Jun-1989	Also known as USA-38
Navstar 2-3	1989 064A	18-Aug-1989	Also known as USA-42
Navstar 2-4	1989 085A	21-Oct-1989	Also known as USA-47
Navstar 2-5	1989 097A	11-Dec-1989	Also known as USA-49
Navstar 2-6	1990 025A	26-Mar-1990	Also known as USA-50
Navstar 2-7	1990 025A	26-Mar-1990	Also known as USA-54
Navstar 2-8	1990 068A	2-Agu-1990	Also known as USA-63
Navstar 2-9	1990 088A	1-Oct-1990	Also known as USA-64
Navstar 2A-1	1990 103A	26-Nov-1990	Also known as USA-66
Navstar 2A-2	1991 047A	4-Jul-1991	Also known as USA-71
Navstar 2A-3	1992 009A	23-Feb-1992	Also known as USA-79
Navstar 2A-4	1992 019A	10-Apr-1992	Also known as USA-80
Navstar 2A-5	1992 039A	7-Jul-1992	Also known as USA-83
Navstar 2A-6	1992 058A	9-Sep-1992	Also known as USA-84
Navstar 2A-7	1992 079A	23-Nov-1992	Also known as USA-85
Navstar 2A-8	1992 089A	18-Dec-1992	Also known as USA-87
Navstar 2A-9	1993 007A	3-Feb-1993	Also known as USA-88
Navstar 2A-10	1993 -17A	30-Mar-1993	Also known as USA-90
Navstar 2A-11	1993 032A	13-May-1993	Also known as USA-91
Navstar 2A-12	1993 042A	26-Jun-1993	Also known as USA-92
Navstar 2A-13	1993 054A	30-Aug-1993	Also known as USA-94
Navstar 2A-14	1993 068A	26-Oct-1993	Also known as USA-96
Navstar 2A-15	1994 016A	10-Mar-1994	Also known as USA-100
Navstar 2A-16	1996 019A	26-Mar-1996	Also known as USA-117
Navstar 2A-17	1996 041A	16-Jul-1996	Also known as USA-126
Navstar 2A-18	1996 056A	12-Sep-1996	Also known as USA-128
Navstar 2A-19	1997 067A	5-Nov-1997	Also known as USA-134

Table 7 — Launch dates of the Navstar 2 series

TIP Series

The satellites in the ***Transit Improvement Program*** (**TIP**) were considered as a precursor to the ***Nova*** series and incorporated the ***Disturbance Compensating System*** (**Discos**), hence, ***Transit Improved And Discos*** (**Triad**), which was designed to maintain position in orbit by correcting disturbances caused by solar wind and atmospheric resistance. In addition ***TIP-1*** carried a radio-isotope thermal generator. The satellites in this series were built by **RCA**, as was the ***Transat*** satellite, which was launched on 28 October 1977 and tested the ***Satrack*** experimental system.

Nova series

The Nova system was purely military and was a development of the Tip series. The satellites were built by **RCA**.

Navstar Series

The ***Navstar*** or ***Global Positioning System*** (**GPS**) was the navigational satellite system developed by

Name	Int.Des.	Launch	Notes
Navstar 2R-1	----------	17-Jan-1997	Failed to orbit
Navstar 2R-2	1997 035A	23-Jul-1997	Also known as USA-132
Navstar 2R-3	1999 055A	7-Oct-1999	Also known as USA-145
Navstar 2R-4	2000 025A	11-May-2000	Also known as USA-150
Navstar 2R-5	2000 040A	16-Jul-2000	Also known as USA-151
Navstar 2R-6	2000 071A	10-Nov-2000	Also known as USA-154
Navstar 2R-7	2001 004A	30-Jan-2001	Also known as USA-156
Navstar 2R-8	2003 005A	29-Jan-2003	Also known as USA-166
Navstar 2R-9	2003 010A	31-Mar-2003	Also known as USA-168
Navstar 2R-10	2003 058A	21-Dec-2003	Also known as USA-175
Navstar 2R-11	2004 009A	20-Mar-2004	Also known as USA-177
Navstar 2R-12	2004 023A	23-Jun-2004	Also known as USA-178
Navstar 2R-13	2004 045A	6-Nov-2004	Also known as USA-180
Navstar 2R-14	2005 038A	26-Sep-2005	Also known as Navstar 2R-M1 and USA-183
Navstar 2R-15	2006 042A	26-Sep-2006	Also known as Navstar 2R-M2 and USA-190
Navstar 2R-16	2006 052A	17-Nov-2006	Also known as Navstar 2R-M3 and USA-192
Navstar 2R-17	2007 047A	17-Oct-2007	Also known as Navstar 2R-M4 and USA-196
Navstar 2R-18	2007 062A	20-Dec-2007	Also known as Navstar 2R-M5 and USA-199
Navstar 2R-19	2008 012A	15-Mar-2008	Also known as Navstar 2R-M6 and USA-201
Navstar 2R-20	2009 014A	24-Mar-2009	Also known as Navstar 2R-M7 and USA-203

Table 8 — Launch dates of the Navstar 2R series

Rockwell for the US Navy. Although primarily a military system, and originally known as **Program 621B**, its facilities were also available to civilian users. Four satellites fixed the three-dimensional position of an object with a margin or error of 30m. This accuracy could be improved to 5m with the use of 18 satellites.

The ***Navstar*** satellites were equipped with three rubidium clocks and one caesium clock and transmit at 1575.42 MHz for civilian users and at 1227.6 MHz for military users.

Navstar 2

The current operational ***Navstar 2*** system consists of 21 satellites. While the system is in the first instance a military system but the facilities will also be available to civilian users.

The satellites carry an atomic clock with an accuracy of 1 second in every 300,000 years. The complete system, which includes three in-orbit spares, will provide a positioning accuracy of 16m.

Navstar Constellation

The numbering of the ***Navstar*** satellites is confusing, to say the least. While in this article a straight chronological launch sequence numbering has been used, the satellites, being military, also received a **USA** numbering, in a multi-disciplinary series of military satellites. In addition, the satellites are identified by their *pseudo-random* (**PRN**) number or space vehicle identity (**SV ID**) number, which are based on the orbit arrangement of the on-line transmitting satellites.

The ***Navstar 1***, ***Navstar 2*** and ***Navstar 2A*** series were built by **Rockwell** (now **Boeing**), while the ***Navstar 2R*** series was built by ***Lockheed.***

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. Jos is the editor of the **TSI News Bulletin** and is also a regular contributor to the British Interplanetary Society's Spaceflight journal.*

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