SatCom For Net-Centric Warfare **May 2012**

MilsatMagazine

U.S.A.F.'s AEHF-2 Launch via ULA (*cover photo*)
Competing For Space—AIAA
Space Weather For Emergency Managers
The Importance Of The Space Fence
COMMAND CENTER
General Thomas S. Moorman [Ret]
Diego Paldao, NewSat
Space Weather
WGS + How The DoD's MILSATCOM Vision Has Veered Off Track
XipLink Discusses Optimization
Space: Distruptive Challenges
Industry Expansion, Exploration, Enthusiasm

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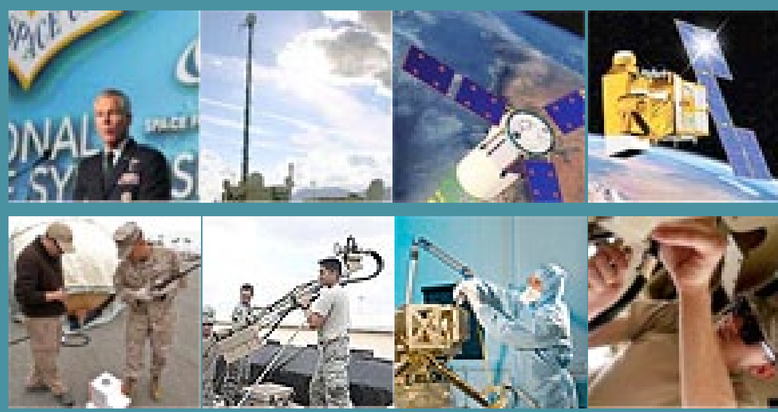

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All Fired Up! Perfect Launch For ULA's AEHF-2

There was only one day's delay, and then GO! to mark the fourth Evolved Expendable Launch Vehicle (EELV) mission this year...

A United Launch Alliance Atlas V rocket blasted off from Space Launch Complex-41 at 2:42 p.m. EDT on May 4th, 2012, with the U.S. Air Force's ***Advanced Extremely High Frequency-2*** (**AEHF-2**) satellite. This was ULA's 4th launch of an aggressive 11 mission schedule for the year and marks the 30th Atlas V mission and the 60th launch for ULA in just over five years. The AEHF constellation is a joint-service satellite communications system that will provide survivable, global, secure, protected and jam-resistant communications for high-priority military ground, sea and air assets. (*Photo below by Pat Corkery, United Launch Alliance*)

Rob Gannon gave the play-by-play for ULA's successful launch. All systems ran perfectly, and once launched, all the exercises ran, and continue to run, as planned.

"We are proud of our entire launch team." said Col. Michael Sarchet, AEHF Government Program Manager, U.S.A.F. "Each AEHF spacecraft will provide warfighters' much improved protected communications capabilities."

AEHF-2 was procured from procured Martin Space Systems Company by the MILSATCOM Systems Directorate, part of the Air Force Space Command's Space and Missile Systems Center. The MILSATCOM Systems Directorate plans, acquires and sustains space-based global communications in support of the president, secretary of defense and combat forces. The MILSATCOM enterprise consists of satellites, terminals and control stations and provides communications for more than 16,000 air, land and sea platforms.

"ULA is proud to serve alongside our mission partners and privileged that the Air Force entrusts the ULA team to deliver critical national security capability to orbit for our soldiers, sailors, airman and Marines around the world," said Jim Sponnick, ULA vice president, Mission Operations. "Through our focus on attaining Perfect Product Delivery, ULA remains dedicated to providing reliable, cost-effective launch services while continuing our unwavering commitment to 100 percent mission success. Today's successful launch was the 60th since ULA was formed just over five years ago and we congratulate the AEHF team on this important step toward delivering these critical protected communications capabilities."

Developed by the United States Air Force to provide assured access to space for Department of Defense and other government payloads, the EELV Program supports the full range of government mission requirements, while delivering on schedule and providing significant cost savings over the heritage launch systems.

ULA's next launch is the Atlas V NROL-38 mission for the National Reconnaissance Office scheduled June 18 from Space Launch Complex-41 at Cape Canaveral AFS.

ULA program management, engineering, test, and mission support functions are headquartered in Denver, Colorado. Manufacturing, assembly and integration operations are located at Decatur, Alabama, and Harlingen, Texas. Launch operations are located at Cape Canaveral AFS, Florida, and Vandenberg AFB, California.

AEHF satellites are the follow-on to the Department of Defense's current five-satellite Milstar communications constellation. When fully operational, the Advanced EHF constellation will consist of four crosslinked satellites providing 10 times the throughput of the Milstar system with a substantial increase in coverage to users.

The Air Force's Military Satellite Communications Systems Directorate (SMC/MC) is the lead agency responsible for managing the AEHF contract. SMC/MC ensures that the secure communications capabilities of this system are made available to military personnel around the globe.

The AEHF system is a joint service satellite communications system that provides survivable, global, secure, protected, and jam-resistant communications for high-priority military ground, sea and air assets. Advanced EHF allows the National Security Council and Unified Combatant Commanders to control tactical and strategic forces at all levels of conflict through general nuclear war and supports the attainment of information superiority.

The AEHF system augments and improves on the capabilities of Milstar and expands the SMC/MC architecture. It provides connectivity across the spectrum of mission areas, including land, air and naval warfare; special operations; strategic nuclear operations; strategic defense; theater missile defense; and space operations and intelligence.

The AEHF system is composed of three segments: space (the satellites), ground (mission control and associated communications links), and terminals (the users). The segments provide communications in a specified set of data rates from 75 bps to approximately 8 Mbps. The space segment consists of a cross-linked constellation of four satellites in geosynchronous Earth orbit. The mission control segment controls satellites on orbit, monitors satellite health, and provides communications system planning and monitoring. This segment is highly survivable, with both fixed and mobile control stations. System uplinks and crosslinks operate in the extremely high frequency (EHF) range and downlinks in the super high frequency (SHF) range. The terminal segment includes fixed and ground mobile terminals, ship and submarine terminals and airborne terminals used by all of the services and international partners (Canada, Netherlands, and U.K.).

Weighing in at approximately 13,600-lb., fully fueled, the satellite is based on the Lockheed Martin A2100 commercial satellite that includes hall current thruster electric propulsion, which is 10 times more efficient than conventional bipropellant systems. The thrusters remove orbit eccentricity during transfer orbit operations, orbit maintenance and satellite repositioning.

The payload features onboard signal processing and crossbanded EHF/SHF communications. Increased coverage is provided by antennas consisting of two SHF downlink phased arrays, two crosslinks, two uplink/downlink theater anti-jam nulling antennas, one uplink EHF phased array, six uplink/downlink gimbaled dish antenna, one each uplink/downlink earth coverage horns.

The Atlas V booster is 12.5 ft. in diameter and 106.5 ft. in length. The booster's tanks are structurally rigid and constructed of isogrid aluminum barrels, spun-formed aluminum domes, and intertank skirts. Atlas booster propulsion is provided by the RD-180 engine system (a single engine with two thrust chambers). The RD-180 burns RP-1 (Rocket Propellant-1 or highly purified kerosene) and liquid oxygen, and it delivers 860,200 lb. of thrust at sea level. The Atlas V booster is controlled by the Centaur avionics system, which provides guidance, flight control, and vehicle sequencing functions during the booster and Centaur phases of flight.

The SRBs are approximately 61 in. in diameter, 67 ft. in length, and constructed of a graphite epoxy composite with the throttle profile designed into the propellant grain. The SRBs are jettisoned by structural thrusters following a 92-second burn.

The Centaur upper stage is 10 ft. in diameter and 41.5 ft. in length. Its propellant tanks are constructed of pressure-stabilized, corrosion resistant stainless steel. Centaur is a liquid hydrogen/liquid oxygen- (cryogenic-) fueled vehicle. It uses a single RL10A-4-2 engine producing 22,300 lb. of thrust. The cryogenic tanks are insulated with a combination of helium-purged insulation blankets, radiation shields, and closed-cell polyvinyl chloride (PVC) insulation. The Centaur forward adapter (CFA) provides the structural mountings for vehicle electronics and the structural and electronic interfaces with the spacecraft.

Shelton Highlights Air Force Space Command's 30 Year History

In his April 17th remarks before a capacity audience at the 28th National Space Symposium, Gen. William L. Shelton, USAF, commander, Air Force Space Command (AFSPC), highlighted accomplishments of AFSPC's 30-year history.

"Moving from a time when space was a 'nice-to-have' with a strategic-user emphasis, to being a vital force multiplier across the entire joint force, space capabilities are now indispensable not only to our nation's defense, but to our national economy as well," Shelton said.

Among the highlights Shelton mentioned were:

- *The 49th successful launch of the Evolved Expendable Launch Vehicle*
- *AFSPC's industry partnership to rescue the first Advanced Extremely High Frequency (AEHF) satellite from a useless orbit*
- *Completed on-orbit checks to provide imagery to U.S. Central Command less than a month after launch of the Operationally Responsive Space-1 satellite*
- *Completion of the largest GPS constellation realignment in history, allowing satellites to provide better coverage in urban canyons and mountainous regions*
- *Success of the X-37 orbital test vehicle, which has been on orbit for 409 days -much longer than the 270-day design specifications*
- *Positive outcomes from the Joint Space Operations Center, which provides resources to process over 155 million sensor observations and track over 22 thousand orbiting objects*

Speaking about the budget, Shelton said the future of AFSPC is heavily dependent on budgetary considerations. "After we look at all the puts and takes... the real decrease in the FY13 Air Force space budget portfolio was only 1.5 percent," he said, demonstrating "commitment to foundational space capabilities as a critical aspect of the nation's defense." He then outlined additional AFSPC missions supported in the new budget:

- *Wideband Global Satellites (WGS)*
- *AEHF satellites*
- *New nuclear command and control system ground terminals and an aircrew terminal*
- *Space-Based Infrared System (SBIRS) satellites*
- *GPS-III*

Looking to the future, Shelton said smaller satellites, simpler designs and fewer on-board systems will increase constellation resiliency and decrease program costs, improving the launch cost-per-pound equation. He also said space-based situational awareness capability is critical.

Shelton said the future vision for AFSPC is focused more on information than platforms. "We now take for granted that we'll have speed-of-light access to data wherever we are for warfighting purposes," said Shelton. "But it's just spam if you can't act on the data provided and turn it into decision-quality information."

Operational Test Of Army's Tactical Comms Backbone

Warfighter Information Network-Tactical (WIN-T) Increment 2 is nearing the finish line as it heads into its largest operational test this month.

WIN-T Increment 2 is a major upgrade to the Army's tactical communications backbone and provides an on-the-move network that reaches down to the company level for the first time.

"This mobile network is a transformational step forward in Army modernization," said Lt. Col. Robert Collins, product manager for WIN-T Increments 2 and 3. "It will dramatically increase the pace at which the Army can prosecute combat operations and speed the overall military decision making cycle."

Using a division slice worth of WIN-T Increment 2 configuration items, the WIN-T Increment 2 Initial Operational Test and Evaluation (IOT&E) is held at White Sands Missile Range (WSMR), New Mexico, as part of the Network Integration Evaluation (NIE) 12.2. To truly stress and test the system, WIN-T Increment 2 nodes will also be spread across 2,000 miles of the United States and involve more than 4,000 soldiers and civilians for the test.

The three-week IOT&E is the Army's record test to fully assess the suitability, survivability and effectiveness of the WIN-T Increment 2 equipment with an operational unit. It will provide the Army with valuable feedback to make any needed doctrine, organization, material or training improvements. The analysis and test results from the IOT&E will be used to support the Full Rate Production Decision scheduled for the fourth quarter of fiscal year (FY) 2012. A successful decision would allow for the fielding of WIN-T Increment 2 to maneuver units across the Army.

"WIN-T Increment 2 is the foundation for the Army's tactical network and a critical component for Capability Set 13 and beyond, providing network mobility and additional communications capacity to what is fielded today," said Col. Edward Swanson, project manager for WIN-T, which is assigned to the Program Executive Office for Command, Control and Communications-Tactical (PEO C3T).

"Increment 2, along with Increment 1b [an upgraded version of Increment 1], will be fielded to tactical formations across the force to enable full spectrum operations, supporting both maneuver and support units."

Similar to a home Internet connection, WIN-T Increment 1 provides soldiers with high-speed, high-capacity voice, data and video communications to battalion level units at-the-halt. WIN-T Increment 2 introduces numerous additional capabilities and is a vital piece of Capability Set 13 - the first integrated group of network technologies out of the NIE Agile Process that will be fielded to Army brigade combat teams starting in FY 2013.

Since the WIN-T Increment 2 network is self-forming and self-healing, it provides a new level of flexibility to support changing mission requirements. It allows combat net radio and data networks to be extended beyond-line-of-sight. An initial network operations capability will also be fielded to facilitate the planning, initialization, monitoring, management and response of the network. Additionally, WIN-T Increment 2's "colorless core" will provide an enhanced level of communications security.

Warfighter Information Network-Tactical (WIN-T) equipment is pictured in preparation for the Army's Network Integration Evaluation 12.1 in November 2011. Second from left is a WIN-T Increment 2 Tactical Communications Node (TCN). (Photo courtesy: Claire Schwerin, U.S. Army)

The construct for the WIN-T Increment 2 IOT&E will create a robust, full-scale division and brigade network for testing. The 2nd Brigade, 1st Armored Division (2/1 AD) at WSMR will serve as the maneuver element, while the 101st Airborne Division at Fort Campbell, Kentucky, serves as the division headquarters element.

Another component of the IOT&E, the 1st Sustainment Brigade in Fort Riley, Kansas, will utilize Increment 1b and connect into the Increment 2 network to demonstrate and test the interoperability between the current and next-generation network. All three units will reach back to the Network Services Center—Training at Fort Gordon, Georgia, which will simulate the Regional Hub Node (RHN) function in the network. There are five RHNs strategically located around the world that use baseband and satellite communications capabilities to enable reach-back from Army units to the Department of Defense Global Information Grid.

"The WIN-T program's readiness to proceed into the IOT&E is reflective of incredible efforts, by many team members, on vehicle integration, testing, logistical planning and Soldier training," Collins said. "I am proud to be part of such a fine organization."

Story by Kyle Bond
PEO C3T

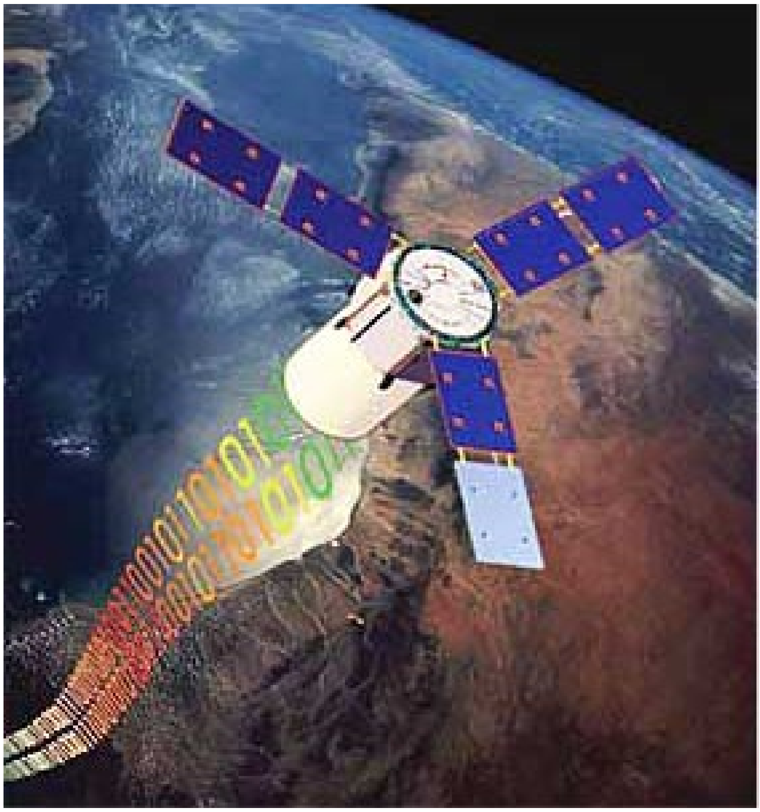
TacSat-3 Retires

ATK has announced the conclusion of the Tactical Satellite-3 (TacSat-3) mission.

The Air Force announced on April 30, 2012, that the satellite deorbited into and burned up in the Earth's atmosphere nearly three years after its May 2009 launch. TacSat-3 was designed for six months of operation, with a goal of one year. Not only did it outlive its design life, it also surpassed its original mission requirements and goals as an experimental spacecraft, and was successfully transitioned to operational status in 2010.

The satellite was removed from operational status and transferred to the Space and Missile Systems Center in February 2012. Once transitioned, ATK provided the Air Force Research Laboratory with updated flight software, that allowed the vehicle to conduct on-orbit collection testing.

TacSat-3's mission revealed the capability to conduct hyperspectral imaging to support the needs of U.S. warfighters.



Artistic rendition of the TacSat-3 satellite.

"Tac-Sat-3 served America well. We were proud to be part of the team that provided reconnaissance data from space to warfighters in the field and to intelligence analysts at home," said Tom Wilson, vice president and general manager, Space Systems Division, ATK Aerospace Group. "Our innovative bus technology was a key factor in successfully extending the TacSat-3 demonstration to a longer-term operational mission. The mission enabled us to apply and enhance our flexible, modular bus platforms for future small satellite missions that included the ORS-1 spacecraft."

The spacecraft is a pioneer of the emerging Operationally Responsive Space program, which was designed to meet the growing need of U.S. forces for flexible, affordable and responsive satellite systems.

ATK, as the spacecraft bus prime contractor, provided the complete bus system, which included the onboard command and data handling system, electrical power system, spacecraft bus primary structure, and interfaces to the launch vehicle and payload. Built and designed in just 15 months, ATK's spacecraft bus met the TacSat-3 program goals of being operationally responsive, low-cost and with expected performance. The spacecraft also featured first-generation modular bus technology designed to provide flexibility for future small satellite missions. As a rapid, affordable experimental mission, the specification did not include a propulsion system to sustain long-term low-Earth orbit.

The TacSat-3 program was managed by the Air Force Space Command with collaboration from the Air Force Research Laboratory Space Vehicles Directorate and the Army Space and Missile Defense Command.

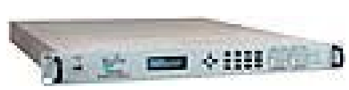
DoubleTalk Is What Is Wanted

Comtech Telecommunications Corp. has announced that its Tempe, Arizona-based subsidiary, Comtech EF Data Corp. received a $1.8 million order from a government systems integrator for modems with DoubleTalk® Carrier-in-Carrier® bandwidth compression.

The U.S. military will use the modems in deployable terminals to support a satellite-based network expansion for battlefield communications.

The order specified the DMD2050 MIL-STD-188-165A Compliant Universal Satellite Modem. The DMD2050 supports the widest possible range of U.S. government and commercial standards. It provides highly advanced and bandwidth-efficient forward error correction and a complete range of modulation types. Given the U.S. government's IP-centric focus, advanced options for the DMD2050 were included in the order, including DoubleTalk Carrier-in-Carrier bandwidth compression and Low Density Parity Check ("LDPC") forward error correction.

DoubleTalk Carrier-in-Carrier, based on Raytheon Applied Signal Technology's patented "Adaptive Cancellation" circuitry, allows transmit and receive carriers of a duplex link to share the same transponder space. DoubleTalk Carrier-in-Carrier is complementary to all advances in modem technology, including advanced forward error correction and modulation techniques. As these technologies approach theoretical limits of power and bandwidth efficiencies, DoubleTalk Carrier-in-Carrier, uses advanced signal processing techniques, provides a new dimension in bandwidth efficiency. When combined with LDPC, it will provide unprecedented savings in transponder bandwidth and power use for the U.S. military. This will enable successful deployments in both bandwidth-limited and power-limited environments.



The DMD2050 Modem

Spy Sat Support

Astrium has signed a through life support contract with the French Defence Procurement Agency (DGA Délégation Générale de l'Armement) to continue to be responsible for the ground segment maintenance (MCO) of the Helios 2 military optical reconnaissance system.

The contract will run from this year through to 2018, continuing a support service that started in 2005 after the Helios 2A satellite initiated operations. The contract will also cover the successors to the Helios program: The satellites that make up the optical space component (CSO) of the MUSIS multinational space-based imaging system and the associated ground component (SSU-CSO).

Ground segment maintenance is essential for a space observation system—

Artistic rendition of the Helios-2 satellite.

alongside the satellites in orbit, the ground segment is at the heart of the system as it is essential for programming, receiving, processing and distributing the images. The MCO agreement covers the maintenance, including all necessary updates, of the hardware and software resources spread across in six countries (Germany, Belgium, Spain, France, Italy and Greece) as well as support for operations.

Helios is a high-resolution military optical reconnaissance system that currently comprises two operational satellites (Helios 2A and Helios 2B), developed under Astrium prime contractorship. Helios provides the programme's partner countries with an autonomous situational awareness capability. The space-based system can acquire images of any point on the globe at any time, and even make repeated passes over the same target area without risk of detection.

Helios 2 is a military optical reconnaissance programme developed by France in cooperation with four other European Union member states (Belgium, Spain, Italy and Greece). The images it captures provide valuable information for high-level state authorities and forces deployed in operational theatre. The most recent Helios satellite, Helios 2B, was launched in December 2009 via an Ariane 5, was also developed under Astrium prime contractorship.

End-To-End Commercial Satellite Solutions

As part of the Future Commercial Satellite Communications (COMSATCOM) Services Acquisition (FCSA), on February 17, 2012, the U.S. General Services Administration (GSA) and Defense Information Systems Agency (DISA) announced the award of the Custom Satellite Communications Solutions' Small Business (CS2-SB) contract to four small businesses.

CS2-SB is the first of two sets of Indefinite Delivery/ Indefinite Quantity (ID/ IQ) contracts for customized end-to-end satellite solutions. The CS2-SB contract holders can compete for task orders that consist solely of satellite professional support services such as analysis and testing. CS2-SB, along with the future award of CS2, also provides access to customer defined end-to-end solutions that include satellite bandwidth, teleport access, network management, the equipment needed for satellite communications, and engineering support such as integration, operations, and maintenance. These awards expand the common marketplace for commercial satellite communications services under FCSA, adding custom end-to-end solutions to the currently available offerings in transponded capacity (bandwidth), and pre-defined subscription services.

CS2-SB awardees are: AIS Engineering, Inc.; By Light, Professional IT Services, Inc.; Knight Sky Consulting and Associates, LLC; and UltiSat, Inc.

The CS2-SB contracts have a five-year contract period (three-year base with two one-year options) and a ceiling of $900 million. Awards for the companion CS2 full and open contracts for large scale custom end-to-end solutions are planned for later this quarter. More information, including links to the new CS2-SB contracts, is available at the GSA Satellite Services website: ***http://www.gsa.gov/satellite***

Combat SkySat

Marines strained their necks as they looked up toward the sky at what could only be described as a giant balloon flying above Camp Delmar, March 29th.

Marines from the 15th Marine Expeditionary Unit trained with a new communications system that expands the capabilities of the Marine Air Ground Task Force.

The system is called Combat SkySat and is used to retransmit information to extend the range of ultra high frequency communications. The SkySat uses a helium balloon with a hanging antenna to relay UHF signals. Flying at an altitude between 55,000 and 85,000 feet in the Earth's stratosphere, the balloon increases the range of communication to 600 miles in diameter.

The system is built by Space Data Corporation and is billed as a 'float and forget' retransmission system. The balloon has a communications payload attached to it containing a global positioning system, radios and antennas. Two separate radios, one that controls the height and one that allows communication between personnel, are the lifeline of this high-tech equipment.

The main benefit of using the SkySat is that it uses UHF line of sight instead of UHF satellite communications, which the military helicopters cannot receive. This allows Marines on the ground to speak directly with pilots during operations and exercises without having to retransmit through a middle man.

The launch control station allows the operator to 'drive' the balloon. Using helium

Pyisone Win, project manager, Space Data Corporation, and Sgt. Emmanuel T. Martinez, radio supervisor, Command Element, 15th Marine Expeditionary Unit, prepare the Combat SkySat communication system at Camp Pendleton, California, March 29, before allowing the helium balloon to float to Earth's stratosphere. The SkySat system is used to retransmit UHF signals to increases the range of communication up to 600 miles in diameter and expands the capabilities of the Marine Air Ground Task Force.

Communications Marines from the 15th Marine Expeditionary Unit, release the Combat SkySat communication system at Camp Pendleton, California. Photo by Lance Cpl. Timothy Childers.

or hydrogen to inflate the balloon and an internal ballast system (about five pounds of sand), the operator can make elevation adjustments as necessary. If the balloon needs to be higher, the operator can unload some of the sand to make the system lighter. If elevation needs to be lower, the operator can release some of the gas through the venting system, which drops the balloon. There are no fans to assist in directional change, that's up to the wind currents.

"The 15th MEU is adopting the system in response to the 26th MEU's successful use of it in Libya, Afghanistan and Pakistan," said Capt. Michael E. Ginn, assistant communications officer, Command Element, 15th MEU. The battery life for the system is about eight to 10 hours and the system can be launched in winds up to 45 knots, said Ginn. Depending on wind speed, the system can easily cover hundreds of miles before it dies.

"The communications used by Marines have launched three balloons this week," said Ginn. "One landed at Twentynine Palms.

Without the use of the SkySat, the MEU uses a tactical satellite system that requires a middleman on solid ground to deploy an antenna and relay UHF signals via satellite. Because of the unit's expeditionary nature, the new SkySat system will match the capabilities required to communicate between all elements of the MAGTF and eliminate the need for a middleman," explained Ginn.

With the SkySat, Bullrush will be more capable than ever as it continues training for its upcoming deployment.

Story by Gunnery Sgt. Jennifer Antoine

Constant Communications Are Ensured

Far from Camp Lemonnier, Djibouti, U.S. service members stationed in austere conditions in forward operating areas around Africa have regular access to communications, thanks to the Tactical Networking team of the Combined Joint Task Force—Horn of Africa's communications directorate.

CJTF-HOA's TACNET allows troops the ability to exchange messages in a protected medium that enables them to carry out missions all over East Africa.

TACNET technicians maintain two types of satellite global communications routers, secure and unsecured Internet protocol types called "SIPR" and "NIPR," both a necessity that service members rely on to meet their daily mission requirements.

"TACNET's mission here is to create down-range communications for U.S. troops in the Horn of Africa," said TACNET technician Senior Airman Robert Morrison of Middletown, Connecticut. "The SIPR/NIPR Access Point Satellite, or SNAP terminal, allows for mobile use for computers and phones by U.S. personnel in their area of operation, anywhere in the world" Morrison said.

"Without SNAP terminals, personnel cannot access their computer accounts and would need to rely on radio communications instead of phones. Wherever the troops are, they have access to the systems they need," he added, as SNAP terminals are at all forward operating bases from Africa to Afghanistan.

TACNET client U.S. Navy Lt. Jason Schechter, Naval Mobile Construction Battalion 3 assistant officer in charge, said SNAP is a valuable asset for maintaining communications with outlying Seabee detachments. "It allows for secure data and voice communications over long distances, allowing us to communicate with them as if they were in an office next door," Schechter said. "The ability to instantly contact someone on the network when they are in the middle of a remote area is extremely convenient."

"Our detachments typically deploy to an area for several months to work on construction projects," Schechter added. "Constant communication is key to supporting their mission."

U.S. Air Force Master Sgt. Pete Thomann, TACNET non-commissioned officer in charge and a St. Louis, Missouri, native, said most technicians arrive from multiple career fields, yet are highly capable. "They have never seen a SNAP terminal before and within two weeks of boots-on-ground here they are ready to go downrange," he said.

"When downrange, the technicians spend an average of four months in different countries in CJTF-HOA's area of operation, facilitating communications for civil affairs teams as well as U.S.

Tactical Networking technicians from the Combined Joint Task Force - Horn of Africa's communications directorate assemble an access point satellite terminal here April 19. These terminals, operated by the TACNET section, provides U.S. troops a secure medium for communications in support of CJTF-HOA missions. Photo by Staff Sgt. Andrew Caya

Navy construction battalions," said Thomann.

"Within 30 minutes we can set up phone and Internet access at any forward operating location," said TACNET technician U.S. Air Force Senior Airman Christopher Wood of Indianapolis, Indiana.

U.S. Army Civil Affairs Team 4905, another TACNET client supporting CJTF-HOA, operates in Ethiopia and is in constant contact with command leadership. "Communication is a challenge for us but is very important," said U.S. Army Capt. Charles Varner, CAT 4905 team leader. "East Africa is a dynamic region and we need to be able to send and receive important updates in a secure manner."

Communication is essential for any organization to function, said Thomann. "Nobody realizes the importance of communication until it is gone."

Story by Staff Sgt. Andrew Caya

Senior Airman Robert Morrison of Middletown, Connecticut, constructs a SIPR NIPR Access Point Terminal Satellite during training on Camp Lemonnier, Djibouti, April 19. Morrison, a Tactical Network specialist in the communications squadron, is one of a few Airmen who maintains SNAP Terminals which ensures communication between different units around the Horn of Africa. Photo by Staff Sgt. Andrew Caya

MIRI Instrument Finished After Ten+ Years Of Work

After more than 10 years of work by more than 200 engineers, the Mid InfraRed Instrument (MIRI), a camera so sensitive it could see a candle on one of Jupiter's moons, has been declared ready for delivery by the European Space Agency and NASA.

The MIRI Optical System, an instrument for the James Webb Space Telescope (JWST), will eventually take up a position four times further away from the Earth than the Moon. It will now be shipped to NASA's Goddard Space Flight Center where it will be integrated with the other three instruments and the telescope.

MIRI is the first of the four instruments on board of the JWST to be completed. The handover ceremony between the European Space Agency (ESA) and NASA at the Institute of Engineering and Technology in London is the culmination of a long term collaboration effort from teams across both continents. The U.K. guided the development work by these teams, in addition to employing U.K. technologies in the construction of key components and carrying out the assembly, integration, testing and ground calibration at the Science and Technology Facility Council's (STFC) RAL Space. The instrument has been subjected to exhaustive mechanical and thermal testing at the same facility to make sure it can not only survive the rigors of a journey into space, but also remain operational for the life of the mission.

MIRI will allow astronomers to explore the formation of planets around distant stars and could even pave the way for investigations into the habitability of other planetary systems. MIRI offers a sensitivity and resolution many times greater than any other mid-IR instrument in existence today or for the foreseeable future. It will be able to penetrate the dust obscuring distant objects, allowing for smaller and fainter objects than have ever been detected to be mapped in unprecedented detail. Its wavelength of 5 to 28 microns brings a unique scientific capability among the other instruments on the James Webb Space Telescope. These wavelengths bring additional technical challenges due to the extremely low operating temperatures necessary (-266.5ºc). Unlike the other JWST instruments, MIRI will be cooled by a dedicated cooler provided by JPL.

Facilities at STFC's Rutherford Appleton Laboratory had to be specially designed to simulate the environment the instrument will experience in space and account for it's extremely low operating

MIRI during ambient temperature alignment testing at the Science and Technology Facilities Council's Rutherford Appleton Laboratory, in the U.K. Image credits: STFC / Stephen Kill temperatures. The instrument was assembled from major sub-systems that had already been built-up and thoroughly tested in the partner institutes.

The RAL test chamber was then used to test the performance of all the scientific operating modes of the instrument and obtain critical calibration observations. Such rigorous testing promotes confidence in the science it will do when the mission is launched, which is scheduled for 2018.

All About Actuator Accuracy

Moog Space and Defense Group, part of Moog Inc. has engineered a new, noise-free potentiometer called QuieSense™ to enhance the reliability of actuators used with satellites.

The newly designed Moog potentiometers provide feedback on the position of solar array drives and antenna-pointing mechanisms. Moog hopes satellite design engineers will replace traditional potentiometers with Moog's QuieSense technology to extend the reliability and performance of actuators used on satellites. If a satellite is trying to determine the position of, say, its solar array and there is drop-out noise, then technicians may think the solar array is pointing in a direction that it is not. Moog has solved this problem by engineering its new potentiometer to include a rolling motion between the conductor and resistor. Using membrane potentiometer technology, not unlike the kind used with iPod controls, Moog's engineers sourced materials that could compensate for conditions such as ambient pressure and vacuum. Through rigorous testing, Moog qualified that the materials for its new potentiometer met the requirements of spaceflight.

A satellite manufacturer has already opted to use Moog's new potentiometer and actuators on a communications satellite scheduled for launch in early 2014. Moog is also developing a range of sizes for its QuieSense potentiometer to enable satellite makers to easily replace traditional potentiometers found on an array of actuators now used for spaceflight.

Liberty Is At Hand

ATK has developed Liberty into a complete commercial crew transportation system, including the spacecraft, abort system, launch vehicle, and ground and mission operations, designed from inception to meet NASA's human-rating requirements with a potential for the first test flight in 2014 and Liberty crewed flight in 2015.

The company also announced Lockheed Martin will provide support to the ATK and Astrium Liberty team as a major subcontractor on the project.

Liberty's test flights are expected to begin in 2014, with a crewed mission anticipated in late 2015. The current schedule will support crewed missions for NASA and other potential customers by 2016, with a price-per-seat that is projected to be lower than the cost on the Russian Soyuz rocket. Liberty's approach is to bring together flight-proven elements designed from inception to meet NASA's human-rating requirement, reducing development time and costs, and providing known, reliable and safe systems. The simple configuration of a solid first stage and liquid second stage lowers the likelihood of failure and enables a flight path with total abort coverage, maximizing survival for the crew in the unlikely event of an anomaly requiring an abort.

Liberty has a robust and sustainable business case that will create and sustain thousands of jobs across the United States including Alabama, California, Colorado, Florida, Maryland, New York, Ohio, Texas, Utah, and Virginia. Its low remaining development cost accelerates the time to market, filling NASA's requirements, and provides a quicker return on investment to outside entities. Liberty's performance of 44,500 pounds to low-Earth orbit enables the system to launch both crew and cargo and also serve non-crewed markets including ISS cargo up and down mass, commercial space station servicing, U.S. government satellite launch, and future endeavors.

The Liberty spacecraft includes a composite crew module, which ATK built at its Iuka, Mississippi, facility as part of a NASA risk-reduction program at Langley between 2007 and 2010. As prime contractor, ATK is responsible for the composite crew module, Max Launch Abort System (MLAS), first stage, system integration and ground and mission operations, while Astrium provides the second stage powered by the Vulcain 2 engine and Lockheed Martin provides subsystems and other support.

Lockheed Martin is providing crew interface systems design, subsystem selection, assembly, integration and mission operations support for the Liberty spacecraft.

Liberty has been developed under a CCDEV-2 unfunded Space Act Agreement (SAA) with the NASA Commercial program office. The next major milestone is a structural test of the second stage tank, to be conducted at Astrium in June. Additional subcontractors for Liberty include Safran/Snecma, which provides the Vulcain 2 engine; Safran/Labinal out of Salisbury, Maryland, which provides second stage wiring; L-3 Communications Cincinnati Electronics (L3-CE), which provides first stage, abort and telemetry system avionics, as well as second stage telemetry and abort system integration prior to launch at KSC; and Moog Inc., which provides thrust vector control and propulsion control.

The new Liberty launch vehicle will use existing infrastructure at Kennedy Space Center. Illustration is courtesy of ATK

The Space Fence Is Vital For Military Communications

by Ben Ryan, President, Tourmaline Properties, former U.S. Navy Seal Officer

The president's budget proposal for 2013 includes steep cuts in federal military spending. Requested military appropriations are about $32 billion less than this year's total. Meanwhile, defense officials recently unveiled a plan to cut projected department spending by $260 billion over the next five years.

There's certainly a need for federal fiscal reform. However, amid this belt-tightening, genuinely vital military programs shouldn't get the axe. There are important new weapons and intelligence systems in development that hold the promise of radically improving our fighting capabilities and that will assist in making the world a safer place.

Chief among these programs is the **Air Force Space Fence Program**. This program ***must*** stay funded and on schedule for development.

The Space Fence uses a system of radars to detect and track space debris in, primarily, low Earth orbit (LEO)—around 700 to 3,000 kilometers above the planet's surface, where the majority of space debris is located. Space Fence also provides capability beyond LEO to support the cataloging of satellites and debris with other space-based sensors. This information is used by the military and commercial satellites to adjust their orbits in the event they're headed for a collision.

Space debris might sound like a worry better suited for science fiction—it's not.

Official estimates place the number of objects in Earth's orbit in the millions, with at least 500,000 pieces that are more than half-an-inch in length. Defunct satellites, spent rocket boosters, as well as nuts and bolts from old spacecraft now orbit the Earth. As the number of countries with space programs has increased, so has the amount of debris.

Back in 2009, a satellite owned by communications firm **Iridium** collided with a Russian satellite. Both satellites splintered into thousands of pieces of new space junk.

This debris is whipping around the Earth at up to 17,500 miles per hour. At that speed, even a small object can do serious damage to satellites or space stations. NASA predicts that space vehicles now face a roughly a 1-in-250 chance of a catastrophic collision with debris.

That might not sound like much, but when extended to more than 100 missions, the risk of disaster hits a disturbingly high 33 percent.

Earth's orbit has become so crowded that NASA projects space debris collisions will occur at least once every four to five years. Recently there have been some very close calls.

Over the span of just a couple weeks last summer, orbital junk headed for the International Space Station (ISS) and was expected to pass so close that the six astronauts aboard had to take emergency shelter in Russian space capsules. In one instance, the debris zoomed past the ISS less than 900 feet away.

If a commercial satellite gets destroyed or compromised by colliding with space debris, the daily lives of tens of millions of Americans could certainly become disrupted. Think of all the devices used that depend on signals from satellites in orbit around the Earth—the GPS systems, iPhones, even car radios. These devices will cease to function if their associated satellites are seriously damaged.

More importantly, American military operations routinely rely on satellite technology to gain the upper hand in combat. Soldiers use satellite radios to communicate information that is critical to the success of missions and to their safety and survival. In today's world, in which we rely increasingly on special operations forces working in smaller numbers and at greater distances from supporting forces, dependable communications are paramount. If a satellite goes down from an unintended (or intended) space collision, service members can get killed.

The United States does have a space surveillance system in operation. But it has limited capacity and capability, with several systems nearing their end-of-life. Starting in 2009, defense officials have been working with private contractors to build a replacement system. Development has gone smoothly. The new Space Fence is set to achieve initial operating capability no later than 2017.

This project is expected to increase the number of objects tracked every day from 20,000 currently to around 200,000. The system will be powerful enough to detect objects that are just four inches long, peer even deeper into space, and employ state-of-the-art algorithms to better project the paths of potentially dangerous debris.

Federal budget officials have targeted the military for deep cuts over the next few years. It's vital that during this push, the Space Fence program remains unscathed. The Space Fence needs to be well-funded and remain on schedule. This technology represents a major upgrade over existing programs and will help to ensure the safety of our soldiers on the battlefield.

About the author

Ben Ryan is a former U.S. Navy SEAL officer who earned his BA in Biology from Yale and an MBA from Harvard Business School. As head of Strategic Initiatives at Triple Canopy, a private security firm with extensive operations in Iraq and the Middle East, he planned and developed a large secure housing compound in Baghdad. Today, he is President of Tourmaline Properties and Tourmaline Construction in San Diego, California.

About The Space Fence

The **U.S. Air Force Materiel Command**'s Electronic Systems Center at **Hanscom Air Force Base** in Massachusetts leads the procurement for the USA's Space Fence, which is intended to improve space situational awareness as legacy systems in the ***Space Surveillance Network*** (**SSN**) are retired. With a total anticipated value of around $6.1 billion over its lifetime, Space Fence will deliver a system of 2-3 geographically dispersed ground-based radars to provide timely assessment of space objects, events, and debris. ***Failure is not an option...***

The Space Fence procurement is broken down into the following phases:

- Phase A
- Preliminary Design Review
- System Development
- Deployment
- Follow-on support

System development is scheduled to begin in June of 2012, with the first Space Fence radar site providing initial operational capability by the end of fiscal year 2015, and the final site providing full capability by 2020.

To fit this program into its larger context, the U.S. **GAO** characterized four facets of *space situational awareness* (**SSA**), an umbrella term that includes, but is not limited to, tracking space debris:

- Detect, Track, and Identify. The ability to discover, track, and differentiate among space objects. Space Fence will anchor this facet, but it won't be the only asset used for this purpose

- Threat Warning and Assessment. The ability to predict and differentiate among potential or actual attacks, space weather environment effects, and space system anomalies. Space Fence may be able to help with this task, but in a secondary way

- Intelligence Characterization. The ability to determine performance and characteristics of current and future foreign space and counterspace system capabilities, as well as foreign adversary intentions. Better monitoring of space may help with intelligence collection, but in a tertiary way

- Data Integration. The ability to correlate and integrate multisource data into a single common operational picture and enable dynamic decision making.

- Out of Scope for Space Fence. The USA's pending Joint Space Operations Center Mission System (JMS) will play a large role here, and must be ready, or the amount of data generated by the new radars will exceed the system's capacity

The Pentagon expects about 66 percent of their $3.3 billion SSA investment to buy new sensors, about 21 percent on JMS for data integration, and the other 13 percent on extending the lives of current sensors, and other SSA-related programs.

At an estimated program cost of $6.1 billion over its lifetime, Space Fence will be the USAF's largest single investment in SSA sensors. It will serve alongside new systems like the ***SSBS*** satellite, the pending ground-based ***RAIDRS*** electromagnetic interference detection system, and **DARPA**'s pending ground-based ***Space Surveillance Telescope***.

All are designed to boost the existing ***Space Surveillance Network***, which includes 29 ground-based **Department**

of Defense (**DoD**) and privately/foreign owned radar and optical sensors, at 17 worldwide locations; plus a communications network, and primary and alternate operations centers for data processing. Most of the sensors are mechanical tracking, phased-array, and continuous-wave radars, but optical telescopes are also used.

In March of this year, the GAO report "*DoD Faces Challenges in Fully Realizing Benefits of Satellite Acquisition Improvements*" includes a discussion of the Space Fence acquisition strategy—and its potential pitfalls. The agency doesn't believe Space Fence will be ready before 2017, and sees a strong technical risk if the accompanying JMS ground system isn't ready at the same time:

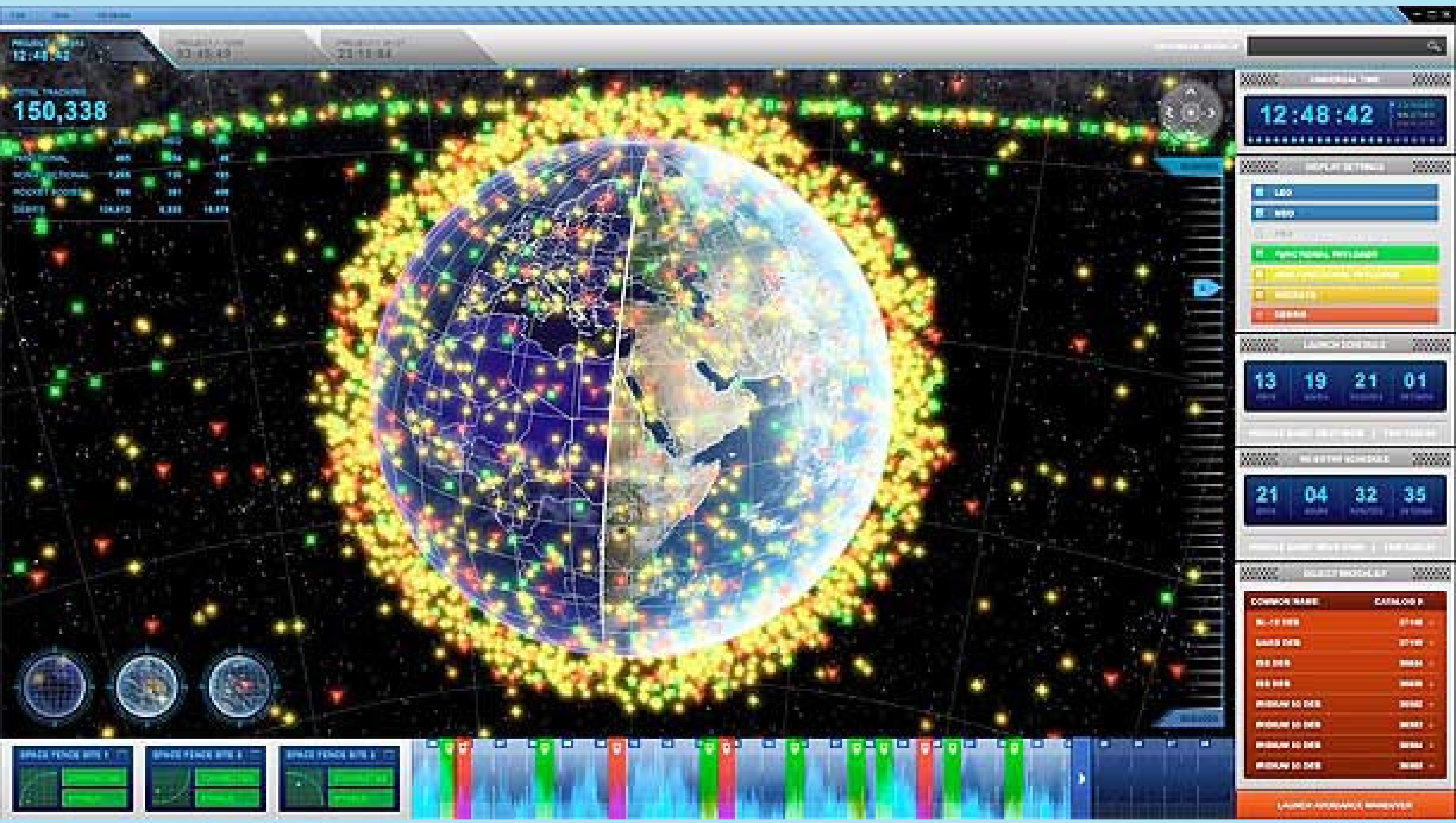
"Space Fence program officials have stated that Space Fence will be one of the largest phased array radars ever built. The size of the radar is expected to provide significant power… but may also pose increased risk…. To mitigate this risk, the Space Fence acquisition strategy includes maintaining competition through technology development and having two firms under contract doing parallel prototype development. This process allows program officials to evaluate contractors' designs and associated costs while moving Space Fence's four critical technologies and backup technologies toward maturity, before the program enters system development which is scheduled for later this year with the award of a single contract. Though earlier plans called for the first Space Fence site to achieve initial operational capability in 2015, estimates show that at current funding levels, this capability will not occur before 2017.

"...Another area where synchronization in system development may pose problems is the Air Force's Joint Space Operations Center Mission System (JMS) and Space Fence programs. JMS is to process data about space assets gathered by the Space Fence and other Space Situational Awareness (SSA) programs, and will increase DOD's ability to track objects in space from about 10,000 objects with the current system to over 100,000 objects. According to the Space Fence program office, JMS needs to be available when the Space Fence is fielded because the amount of data Space Fence will generate exceeds existing command and control system performance limits. JMS recently underwent a change to its acquisition strategy, dividing the program's development into two increments to reduce risk and more rapidly deliver needed capabilities. The first Space Fence radar site is scheduled to provide initial operational capability by the end of fiscal year 2017, and… JMS needs to be operational by this time."

Lockheed Martin's Space Fence Solution

A prototype of a new radar system developed by a **Lockheed Martin**-led team is now tracking orbiting space objects, bringing the U.S. Air Force's Space Fence program one step closer to revolutionizing our nation's space situational awareness.

Using powerful, new, ground-based radars, Space Fence will enhance the way the U.S. detects, tracks, measures and catalogs orbiting objects and space debris with improved accuracy, better timeliness and increased surveillance coverage. Lockheed Martin's prototype radar recently met a key contract requirement during a series of demonstration events by proving it could detect these resident space objects, as they are referred to by the Air Force.



On February 29th, the U.S.A.F. granted its final approval of Lockheed Martin's preliminary design for the system.

"The successful detection and tracking of resident space objects are important steps in demonstrating technology maturity, cost certainty and low program risk," said *Steve Bruce*, vice president of the Space Fence program at Lockheed Martin's *Mission Systems & Sensors* business. "Our final system design incorporates a scalable, solid-state S-band radar, with a higher wavelength frequency capable of detecting much smaller objects than the Air Force's current system."

Space Fence will enable the decommissioning of the aging U.S.-based ***Air Force Space Surveillance System*** (**AFSSS**), originally installed in 1961. With more than 60 nations operating in space today, the final frontier is much more complex than when the AFSSS first started tracking a few hundred orbiting objects. Today, with hundreds of thousands of objects orbiting the Earth, space debris and risk of potential collisions now threaten national space assets providing critical services, including the ***Global Positioning System***, banking and telecommunications.

Bruce added, "Space Fence will detect, track and catalog over 200,000 orbiting objects and help transform space situational awareness from being reactive to predictive. The Air Force will have more time to anticipate events potentially impacting space assets and missions. Our net-centric design approach allows Space Fence to be easily integrated into the broader U.S. Space Surveillance Network of sensors already operated by the Air Force."

Lockheed Martin's Space Fence prototype was developed under an 18-month, $107 million contract awarded by the U.S.A.F; in January 2011. The Air Force has said it plans to award a Space Fence production contract later in 2012. The first of several Space Fence sites is expected to reach initial operational capability in 2017.

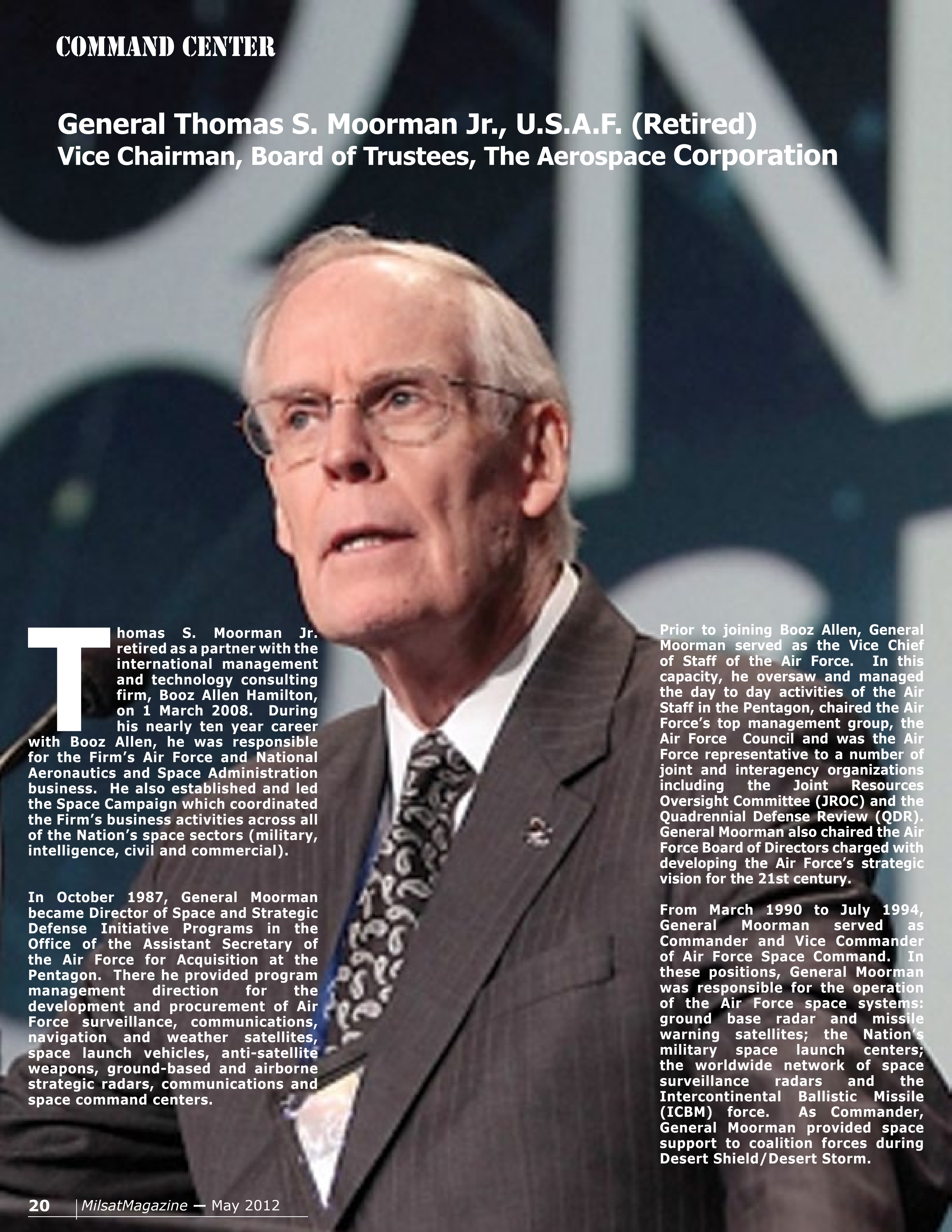
With more than 400 operational S-band arrays deployed worldwide, Lockheed Martin is a leader in S-band radar development, production, operation and sustainment.

The Lockheed Martin-led team, which includes **General Dynamics**, **AMEC** and **AT&T**, has decades of collective experience in space-related programs, including sensors, mission processing, cataloging, orbital mechanics, net-centric communications and facilities.

Headquartered in Bethesda, Maryland, Lockheed Martin is a global security and aerospace company that employs about 123,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services. The Corporation's net sales for 2011 were $46.5 billion.

(Space Fence images are courtesy of Lockheed Martin)

General Thomas S. Moorman Jr., U.S.A.F. (Retired)
Vice Chairman, Board of Trustees, The Aerospace Corporation



Thomas S. Moorman Jr. retired as a partner with the international management and technology consulting firm, Booz Allen Hamilton, on 1 March 2008. During his nearly ten year career with Booz Allen, he was responsible for the Firm's Air Force and National Aeronautics and Space Administration business. He also established and led the Space Campaign which coordinated the Firm's business activities across all of the Nation's space sectors (military, intelligence, civil and commercial).

In October 1987, General Moorman became Director of Space and Strategic Defense Initiative Programs in the Office of the Assistant Secretary of the Air Force for Acquisition at the Pentagon. There he provided program management direction for the development and procurement of Air Force surveillance, communications, navigation and weather satellites, space launch vehicles, anti-satellite weapons, ground-based and airborne strategic radars, communications and space command centers.

Prior to joining Booz Allen, General Moorman served as the Vice Chief of Staff of the Air Force. In this capacity, he oversaw and managed the day to day activities of the Air Staff in the Pentagon, chaired the Air Force's top management group, the Air Force Council and was the Air Force representative to a number of joint and interagency organizations including the Joint Resources Oversight Committee (JROC) and the Quadrennial Defense Review (QDR). General Moorman also chaired the Air Force Board of Directors charged with developing the Air Force's strategic vision for the 21st century.

From March 1990 to July 1994, General Moorman served as Commander and Vice Commander of Air Force Space Command. In these positions, General Moorman was responsible for the operation of the Air Force space systems: ground base radar and missile warning satellites; the Nation's military space launch centers; the worldwide network of space surveillance radars and the Intercontinental Ballistic Missile (ICBM) force. As Commander, General Moorman provided space support to coalition forces during Desert Shield/Desert Storm.

Gen. Thomas S. Moorman at the Space Foundation's Hill award luncheon at NSS. (See sidebar for more info.)

Other assignments during General Moorman's career include service as the Director of the National Reconnaissance Office staff, positions in aircraft reconnaissance and intelligence units, and at Air Force Space Command where he was deeply involved in the planning for the creation and initial standup of the Command.

General Moorman's military awards include the Defense Distinguished Service Medal, the Air Force Distinguished Service Medal with one oak leaf cluster and the Legion of Merit with one oak leaf cluster. He has also been recognized by the Intelligence Community with the award of the National Intelligence Distinguished Service Medal with one oak leaf cluster, the Defense Intelligence Agency's Director's Award and two awards of the National Reconnaissance Office Gold Medal.

General Moorman has received numerous awards for contributions to the Nation's and Air Force space programs including the Dr. Robert H. Goddard Memorial Trophy, the General Thomas D. White Space Trophy, the American Astronautical Society's Astronautics Award and the United States Space Foundation Space Achievement Award. In 2004, he was selected by Space News as one of the top ten contributors to the Nation's space program over the past fifteen years.

He has served on numerous Government advisory boards and studies to include the Congressionally- directed Space Commission to examine the organization and management of national security space activities. Additionally, he has served on a number of space related studies and task forces on behalf of the Defense Department, the Intelligence Community and the National Oceanographic and Atmospheric Administration.

General Moorman is Director Emeritus of the Board of the Space Foundation, a Trustee of the Falcon Foundation, a member of the Air Force Association's Forces Capability Committee, a member of the U.S. Strategic Command, Strategic Advisory Group, a member of the Council on Foreign Relations and a member of the Cosmos Club. He is also the Vice Chairman of the Board of Trustees of Aerospace Corporation, is an Outside Director of the Board of Smith's Detection and Smith's Interconnect, an Outside Director of Elbit Systems of America, a former Director of the Board of Directors of Integral Systems, Incorporated and a Senior Executive Advisor to Booz Allen Hamilton.

General Moorman received a Bachelor of Arts from Dartmouth College, a Masters in Business Administration from Western New England College and a Masters in Political Science from Auburn University. He has also been awarded two honorary degrees—a Doctorate in Management from Colorado Tech and a Doctor of Laws from Clemson University.

MilsatMagazine (MSM)
General Moorman, given your outstanding career in both the military and civilian worlds, how do you see the USAF dealing with the severe budget cuts that are being proposed in the new budget? How will these reductions affect command and control functions of crucial structures of Air Force Space Command?

Thomas Moorman, Jr.
As you pointed out, these are difficult budgetary times requiring tough decisions and tradeoffs. In response to the Nation's ever increasing debt, the Congress passed the Budget Control Act which directed a reduction of $487B in defense spending over the next 10 years. Accordingly, the Air Force's budget submission for FY 13 is $110 B which represents a decrease of 4.4 percent over FY 12.

From what I have read in official Air Force statements and from following the USAF leadership's testimony on the Hill to date, the FY 13 budget submission is aligned with the President's new Strategic Defense Guidance and with cuts mandated by the Budget Control Act. As always, the Air Force seeks to balance force structure, readiness and modernization. I understand the approach for FY 13 is to trade size for quality. Thus, the Air Force will continue to modernize and grow more capable. Modernization like the long range bomber, the tanker, and new/upgraded space capabilities is protected. The Air Force will continue to buy the F-35 fighter in FY 13, but in fewer numbers.

Going into any more details on the background of the budget submission runs the risk of taking all the time you have for this interview. Suffice to say, aircraft numbers are cut, about 10,000 people from across the force are reduced and the USAF identified several billion in efficiencies.

As for space, there is a reduction from last year's space budget. This cut is enabled by several factors. The Air Force's unprecedented space modernization has largely transitioned from development to production; the budget does not include a buy of Wideband Global SATCOM (WGS) satellite in FY 13; the Congress terminated the Defense Weather Satellite System (DWSS) and there were some hard decisions made such as the cancellation of the Operationally Responsive Space (ORS) program.

Let me say a few more words about the on-going and unprecedented Air Force space modernization program. Over the last 15 years or so, the Air Force has modernized virtually the entire inventory of satellite and launch systems. The result is a tremendous increase in quality and quantity. For example, the Air Force is now flying a new warning satellite (the Space Based Infrared System); two new communications satellites (the Advanced EHF satellite and the WGS) and have significantly upgraded GPS-with the GPS II F. Incidentally, to give you an example of increased capability inherent in these new satellites is the fact that one WGS satellite provides as much bandwidth as the entire Defense Communications Satellite System (DCSS) constellation. The only space mission area that is not being modernized is weather and environmental monitoring. As mentioned, the DWSS was cancelled by the Congress.

You asked about space command and control. Of course, the Air Force's space modernization includes upgrades to satellite ground stations. However, I want to highlight a space

Artistic rendition of the Space Based Infrared System

C2 program. The Joint Space Operations Center (JSPOC), at Vandenberg AFB is the military's command and control center for space. It is also the place where the status of space systems are monitored. Additionally, the JSPOC maintains the space catalogue (all objects in space). While the JSPOC has been operational since the early 1990s, to a great extent, it has been a manpower-intensive operation. The JSPOC Modernization System

JSPOC: U.S. Air Force photo by Airman 1st Class Andrew Lee

(JMS) is the replacement program. Last year, the program was restructured to lower costs and to incrementally deliver upgrades. The IOC for the first increment is later this year. JMS is sorely needed to better deal with challenges of a more crowded space environment, a greater variety of threats and the compressed decision timelines. From my perspective, this program is one of the most crucial modernization efforts in the Air Force budget.

MSM
Could you tell us how satellites and MILSATCOM aided our forces during Desert Shield and Desert Storm?

Thomas Moorman, Jr.
As many of your readers know, Desert Shield/Desert Storm were a watershed events in the evolution of space in support of military operations. Although space systems have supported our warfighters in conflicts dating back to the Vietnam war — where first generation MILSATCOM and weather data from early DMSP satellites were used—Desert Storm was the first time that the full range of national security space systems were brought to bear in support of our warfighters.

For example, the Defense Support Program, missile warning system, provided warning of Scud missile launches to our troops in the field to include Patriot batteries. The DMSP weather satellites provided synoptic weather coverage of the theater for air, ground and naval operations. These satellites also provided accurate data regarding the moisture content of the soil to our mechanized ground forces to enable trafficability analysis. GPS really came into its own during Desert Storm. Despite the fact that the GPS on-orbit operational constellation was not fully populated, the system supported the initial strikes against Iraqi early warning radars that kicked off the war. With regard to supporting ground forces, GPS was one of the enablers of the "left hook" offensive over the barren terrain of western Iraq which totally caught the Iraqi forces off guard.

Your question specifically asked about COMSATs. Military and commercial satellites did yeoman's work in Desert Shield in providing warning of Scud launches. The raw DSP data traveled

Artistic rendition of a DMSP satellite.

over communications satellites to ground sites and command centers and then the warning data was sent back to the theater over COMSATs in time to alert our forces and specifically to give Patriot batteries critical azimuthal and timing data to engage the Scuds. The overwhelming majority of intra-theater communications traveled over COMSATS. We were heavily dependent on commercial COMSATs- in fact it is estimated that 80 percent of the war's communications traveled on commercial COMSATs.

To a very real extent, our warfighters discovered space in the course of Desert Storm. They saw the force multiplying and enabling effects of space in support of modern warfare. A very real and longer term consequence of Desert Storm was that subsequently the warfighter began to demand a greater say in the requirements process for evolving and new space capabilities.

In many respects, Desert Shield/Storm was a time of learning on the fly. This learning has continued at an accelerated pace due, in no small part, to the fact that the Nation's military has been at war for most of the last twenty years and, as such, our forces today understand space, and as a consequence, our space capabilities are integrated into all military operations. We still have a ways to go in the integration of data and in responding to ever diminishing timelines, but the progress since Desert Storm has been dramatic.

MSM
Your thoughts, please, on how the military can take advantage of hosted payloads to save both time and costs. With your experience in space launch vehicles, while you were director of Space and Strategic Defense Initiative Programs in the Office of the Assistant Secretary of the Air Force, how do you see such working out for both sides of the equation, and what hurdles need to be overcome for such to succeed?

Thomas Moorman, Jr.
I am very bullish on hosted payloads as I think it is a concept and capability whose time has come. When I was growing up in the space business, hosted payloads (with some exceptions) were generally not in favor because of real estate, power, weight and interference issues. Those that did fly were niche capabilities. However, with the march of technology, potential hosted payloads are now smaller, fairly capable, and generally can be made to be more easily integratable with a host satellite.

I think that the launch of CHIRP (which stands for Commercially Hosted Infrared Payload) on a commercial COMSAT SES 2, was a breakthrough. It is currently on orbit providing useful infrared data. I hasten to add that is a pathfinder or proof of concept, but it is providing a lot of lessons learned. Today the mindset on hosting payloads is changing. The Government is now looking at "hostability technologies" which will allow hosted payloads to be more agile and compatible. These payloads can be designed to be integrated more smoothly thus, taking advantage of available rides without disrupting the launch schedule of the host.

Turning to space launch. On the operational side, the Air Force's stewardship of this mission has been outstanding. At this writing, I think the Air Force has had 75 successful launches and 24 have been the new generation, evolved expendable launch vehicles. This is a really extraordinary record—knock on wood.

Having said that, launching satellites continues to be a very expensive proposition. Accordingly, the Air Force is seeking to draw down the cost by a variety of ways. The objective is to achieve a balance of achieving a less expensive launch while at the same time not jeopardizing mission success. One of ways the Air Force is reducing cost is buying launches in blocks at a fixed cost. This has the advantage of introducing predictability and stability to the launch process. It also allows the Government to achieve economies of scale. The Air Force also is trying to stimulate competition in the launch market. There are several new entrants (such as Space X, Orbital Systems, and ATK) seeking to break into the government launch business. These new players are proposing less expensive launch systems based upon commercial acquisition launch practices. This last Fall, the Air Force, NASA and the NRO collaborated to develop a New Entrants Strategy and a New Entrants Certification Guide. These two documents provide guidance to the new entrants on how to get into the Government launch business and define how the Government will certify these new systems. In essence, the documents provide a roadmap on how these new entrants can compete in the Government market. Because this is a "one strike and you're out" business, the Government is very risk adverse. Hence, initially the opportunity for the entrants at first will be to compete for lower risk payloads. I think the cost reduction steps through fixed price block buys and the outreach to new entrants are very positive steps towards achieving lower cost rides to space while at the same time not taking our eyes off of mission assurance and success.

MSM
Will we see the military becoming more and more involved in the use of small satellites to assist in ISR and other intelligence functions?

Thomas Moorman, Jr.
As many of your readers undoubtedly know, the Defense Department has been looking at the utility of small satellites to help address a number of very real issues. These issues range from improving the responsiveness of space systems, to lowering cost of satellites and launches to increasing space system's resiliency, and, thus enhancing survivability.

There are a number of small satellite programs of all sizes—let me highlight one program. A few years ago, the Congress directed the Air Force to establish an Operationally Responsive Space (ORS) office, which they did. Last June, ORS-1 was launched from Wallops Island, a NASA facility, aboard a Minotaur rocket. U.S. Central Command, the sponsor of ORS-1, began using the imagery in a month or so after launch. As mentioned, I understand that the Air Force FY 13 budget submission cancels the ORS program. While on the surface that might imply that the Air Force is walking away from small satellites, frankly, I don't see it quite that way.

Artistic rendition of the ORS-1 satellite.

I think the Air Force learned a great deal about how to achieve responsiveness from the ORS program and also did some fine work on essential technologies such common interfaces for satellites and satellite buses. This knowledge won't be lost as I think the people and technologies are intended to transferred to the development planning shop at the Space and Missiles Systems Center in LA.

Earlier, we discussed hosted payloads. To my way of thinking, hosted payloads are small satellites, only they are not free flyers. Hosted payloads are another way of dealing with responsiveness, cost and resilience issues.

MSM
With various foreign entities developing weapons designed for satellite destruction are we moving into better technologies to both prevent our satellites from being attacked?

Thomas Moorman, Jr.
Last year, the Secretary of Defense and the Director of National Intelligence signed a National Security Space Strategy. The purpose of this document was to provide the strategic guidance to the Defense Department and Intelligence Community in implementing the President's National Space Policy. The new strategy describes a space environment that is congested, contested and competitive.

There are about 22,000 objects in space most of which are debris. Of that number, about 1,100 are active systems. So space is clearly increasingly congested.

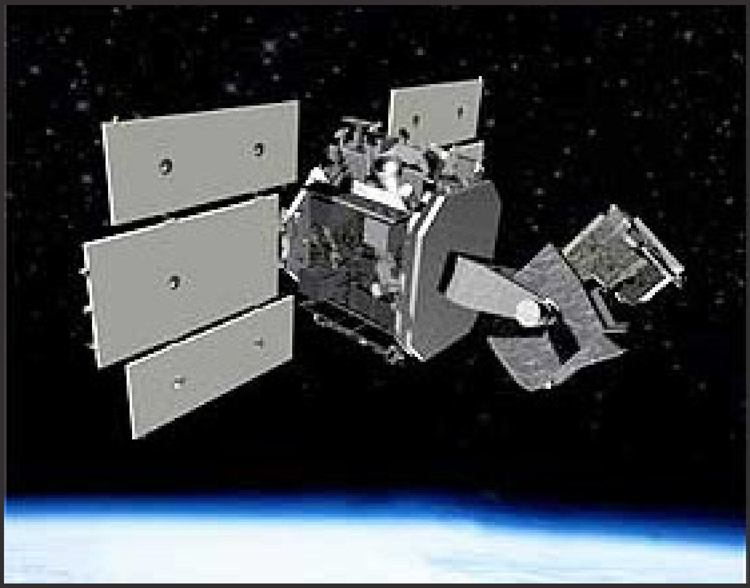
China launched a direct ascent ASAT in 2007 and Iran has demonstrated the capability to jam satellites. These are two examples which underscore that space is increasingly contested.

Space is also competitive, as there are more than 60 nations and consortia operating satellites. Moreover, the US share of the space market has declined markedly over the last 10-15 years.

Dealing with the first two Cs—congested and competitive—begins with a need to understand what's in space and what's going on in space. Those tasks basically describe what has come to be known as Space Situational Awareness (SSA). SSA is the foundation for space operations. The United States has long operated and maintained space surveillance capabilities, but there is no doubt that we need to improve our SSA. This need has been recognized for some time. In fact, because of our country's dependency on space and our vulnerability, the Space Commission, in 2000, identified SSA as a top priority for space modernization.

Accordingly, the Air Force is funding a number of SSA modernization programs which will dramatically improve SSA. One of which is the Space Based Surveillance System (SBSS) which is designed to provide high accuracy surveillance of the geosynchronous belt as well as surveilling objects in lower orbits. The first SBSS has been launched and is undergoing check out. When operational, it will provide enormous increases in volume and accuracy.

The Ground-based Electro Optical Deep Space Surveillance System (GEODSS) that has been deployed for around 30+ years is being upgraded. The Air Force budget submission also includes funds for the development and deployment of a Space Fence which initially will consist of one site with an expectation of another in the Pacific in the out years. Using S-band radars, the Fence will be used primarily to detect, track and measure objects, primarily in low orbit.



Artistic rendition of the Space Based Space Surveillance (SBSS) vehicle. Graphic by Boeing Co.

Another capability which will contribute to SSA are the upgraded early warning radars that provide missile warning and missile defense against ballistic missile threats, but will also provide improvements in space object tracking.

As pointed out in an earlier question, all these system improvements will result in tremendous increases in data which has profound implications for the design of the joint space C2 capability. The design of the JMS program ultimately has to be able to fuse and correlate these disparate and high capacity data sources.

All the above examples deal basically with technology/ equipment upgrades. There is also a need to work the resiliency of our space systems. Fortunately, there is a lot of work underway regarding more distributed architectures. The hosted payload initiatives are an important component of achieving resiliency through proliferated architectures.

MSM
Noting your successes in the commercial world with Booz Allen Hamilton and their Air Force and National Aeronautics and Space Administration business, how did you manage your transition from being a general officer and directing military operations and staffs to that of becoming an important Partner in the business world? What were the most challenging changes for you?

The Ground-Based Electro-Optical Deep Space Surveillance facility at Detachment 2, in Diego Garcia, British Indian Ocean Territory is one of three operational sites worldwide. The facility tracks known manmade deep space objects in orbit around Earth. (U.S. Air Force photo)

Thomas Moorman, Jr.
Let me lead into the question on challenges by saying a few words on transitioning from the public to the private sector. After I retired from the Air Force in the summer of 1997, I spent several months in deciding what I wanted to do for my second career, and in developing an idea of the attributes of a company that would match my goals. Incidentally, I also sought counsel from those who I thought had managed the transition from the Government to industry well. Ultimately, I chose Booz Allen and it turned out to be a good choice for me as I had an enjoyable and rewarding time there.

As for challenges on making the transition to industry, let me highlight three.

I guess first was learning how to handle the frustration that comes with going from being highly knowledgeable in an organization, the Air Force, to being the new guy. As I grew up in an Air Force family and then spent 35 years on active duty, over time, I felt I instinctively understood the culture, values, and organizational dynamics of the Air Force. I think I had a good feel for why things happened and how things got done. This allowed me the comfort of being able to anticipate things. Over the course of the first year at Booz Allen, a great many things were new and I was impatient with my learning curve. Fortunately, I had superb mentors and bosses who were tolerant of my incessant questioning about the business processes and relationships.

The second challenge was getting used to all the implications of profit and loss and managing the bottom line. You see, in my view, and this is probably a gross oversimplification, but the military operates to a budget while industry is cost oriented. The military, by and large, and understandably, is effectiveness oriented while the industry is efficiency oriented. I don't mean to imply that the military is not concerned with efficiencies or that industry is not concerned with effectiveness. Rather, I am talking about organizational orientation and to be sure the metrics are different. I managed a P/L center—the Firm's Air Force and NASA business—and learning the ins-and-outs of the consulting world took some time. Having said that, building a business and developing people to sustain that business was extremely satisfying.

Finally, coming out of the Air Force, one could say that I was administratively challenged. Over the years, I had grown used to the support of fairly large staffs and hence I had grown lazy especially in developing computer skills. At Booz Allen, I had a direct staff of one—that is one person who was dedicated to working my problem—my Administrative Assistant. All others were expected to be on a consulting assignment, or training or developing business. While I was not unaccustomed to long hours, initially I spent more time on certain tasks than necessary. The nature of this challenge probably is generational and certainly is not as big of an issue for those individuals transitioning today.

MSM
Looking back over your successful career, what projects truly bring a sense of accomplishment to you?

Thomas Moorman, Jr.
That is a multi-faceted answer as I have had a long career—coming up on 50 years. If I may, let me begin this answer with some general comments.

First of all, I was privileged to have been part of three very fine organizations—the Air Force, the National Reconnaissance Office (NRO) and Booz Allen Hamilton. With respect to my military career, I feel privileged to have been involved in the evolution of both the military and intelligence space programs and as such, have seen the tremendous progress in terms of technical capabilities as well as the dramatic growth in both the utility of these marvelous systems. Further, I have also seen an extraordinary increase in our Nation's and especially our military's dependency on the data from satellites. It has also been a real pleasure to see the evolution in maturity of the Air Force and the NRO space organizations.

As a Direct Reporting Unit (DRU) of Air Combat Command (ACC), the Air Force Command and Control Integration Center (AFC2IC) mission is to support COMACC initiatives to influence, integrate and improve Air Force command and control (C2) capabilities. The AFC2IC is focused on Joint Force and Joint Force Air Component Commanders' capability to dominate the battlespace and control forces.

The AFC2IC provides direct support to COMACC as the lead integrator for the AF C2 Service Core Function (SCF). A highly refined, integrated and standardized C2 system and structure is essential for the USAF to fly, fight and win in Air, Space, and Cyberspace in the 21st century.

The Center represents warfighters from all the major commands and provides the operational warfighter perspective to Air Force C2 spiral development and systems acquisition commands and processes and leads the planning and execution of continuous experimentation culminating with the Joint Expeditionary Force Experiment (JEFX).

I must also say that I am enormously proud of the people that I worked with in the Air Force and the NRO. Getting a chance to work with such a talented, dedicated and smart workforce has been one of the real highlights of my career. Also I must admit that I am especially proud to see the people that I knew as young officers and civilians ascend to leadership roles in the Air Force and the NRO.

More specifically, I guess one of the highlights of my career would have to be being intimately involved in the early stages of the planning for the establishment of Air Force Space Command in the late 70s and early 80s. Then about a decade later, I returned to command that organization during a formative and eventful period, which included such an historical event as Desert Shield / Desert Storm. That was an exciting and fulfilling time and also a very real learning experience. In some ways, the Air force Space Command's focused support to this war underscored the value proposition of why the command was created.

I also spent about 11 years in the space reconnaissance business, and my time in the NRO was very satisfying. Being a part of that elite organization with an absolutely vital mission was an honor and privilege. The intelligence that the NRO collected was critical to our understanding of the threat, to the maintenance of treaties and was a crucial component of our deterrence posture during the Cold War.

As for my time in Booz Allen, here I would like to get away from using the first person singular. We built a team of high performing professionals who helped our clients deal with tough problems such as strategic planning, high profile programmatic trades, the health of space industrial base, growing a systems engineering and integration capability and developing methodologies and tools to understand why certain acquisition programs falter to name a few.

Space Foundation's Most Prestigious Award Presented to General Moorman at the 28th National Space Symposium

Gen. Thomas S. Moorman, Jr., USAF, Ret., former vice chief of staff of the Air Force was presented with the Space Foundation's highest honor, the General James E. Hill Lifetime Space Achievement Award, at a special luncheon that was sponsored by Raytheon on April 18, 2012, at the 28th National Space Symposium at The Broadmoor Hotel in Colorado Springs, Colorado.

Named for the Space Foundation's former, long-time chairman, the General James E. Hill Lifetime Space Achievement Award is one of the global space community's highest honors; past recipients have included Norman Augustine, Gen. Bernard Schriever, Buzz Aldrin, Peter Teets, Dr. Hans Mark and E.C. "Pete" Aldridge, among others.

The annual Space Foundation National Space Symposium brings together all sectors of space to highlight accomplishments and address opportunities and issues facing the global space community today.

Competing For Space

By Mike Conschafter, Director, Space Systems, Aerospace Industries Association (AIA)

The U.S. space industry currently faces dual threats; major reductions in federal aerospace spending and overly restrictive satellite technology export policies. If we continue on this path, without implementing the right reforms, our nation risks the scenario of a weakened space industrial base that is unable to fully meet U.S. national security needs or sustain our technological edge against foreign competitors.

Competing for Space: Satellite Export Policy and U.S. National Security clearly details the impact that inappropriate export controls and inadequate trade policies have had on the U.S. satellite industry. It also offers recommendations that will make U.S. firms more competitive in the global marketplace while at the same time protecting our national security. The Aerospace Industries Association (AIA) believes that actions to modernize the export control system and enhance space trade among our allies are long overdue and will build a stronger, more robust U.S. satellite industry and supplier base that are able to meet the challenges associated with budget constrained government customers.

We surveyed AIA members this year on the topic of export regulations and the message was clear: outdated export controls are hurting U.S. companies. Data supports this view. The U.S. held 73 percent of the worldwide share of satellite exports in 1995—this fell to a staggering 25 percent by 2005.

Today, U.S. law requires export agencies to still look at a nut, bolt, or screw for a commercial satellite and an anti-tank missile through the same regulatory prism.

Clearly, it's time for a change.

This is an urgent call to our national leaders to bolster opportunities for satellite exports by modernizing the U.S. export control system. AIA's recommendations center on the creation of market conditions that would allow U.S. firms to compete, and win, their fair share of international commercial space business—nothing more, nothing less.

Maintaining a strong industrial and supplier base is, in itself, a major national security issue; enabling this critical sector to compete internationally will become increasingly important as government spending is constrained. Modernizing the nation's export control system will result in a healthier space industrial base —allowing the United States to better focus on sensitive technologies and safeguard national security while creating high wage, high skill jobs.

For our national policymakers, promotion of satellite exports should rank among the most viable options to aid our economy, reinforcing U.S. preeminence in space and ensuring our aerospace industrial base remains second to none.

Marion C. Blakey, **President and Chief Executive Officer, AIA**

The Foundation

More than a dozen years ago, Section 1513(a) of the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 shifted export control jurisdiction of all satellites—including commercial communications satellites and their parts and components—from the Commerce Department, the agency responsible for licensing "dual-use" exports, to the State Department, the agency that monitors the licensing of munitions exports. The Section 1513(a) restrictions for satellite exports were put in place after the 1998 Cox Commission investigation that addressed concerns about Chinese access to U.S. high technology.

The shift, intended to protect sensitive space technologies and preserve U.S. preeminence, has since contributed to the loss of U.S. commercial satellite market share and fostered the competitiveness and capabilities of U.S. competitors abroad. Simply put, we have legislated away our nation's dominance in space.

The companies that comprise the domestic space industrial base developed the capabilities and services that have fueled the nation's economy and ensured U.S. technological dominance for generations. U.S. economic and technological leadership enabled the country to prevail in the Cold War and set the stage for U.S. global leadership in the 21st century. As we enter a new era of budget austerity and the threat of draconian sequestration cuts loom, failure to revise export controls could result in an ongoing loss of critical industrial base suppliers and pose an increasing risk to national security.

The Industry Speaks: 2011 AIA Member Survey

In 2011, AIA conducted a survey of its membership to assess the space industry's most recent concerns with current export regulations. Twenty member companies provided detailed responses to the survey, and this resulting report was reviewed and approved by AIA's Space and International Councils. These AIA member firms that provided detailed survey responses are a very comprehensive group accounting for over 75 percent of total 2010 sales by U.S. satellite and component manufacturers as identified by Space News' "Top 50 Space Industry Manufacturing and Services 2011 Report"—totaling more than $30 billion in 2010 sales. Key results include:

- ***More than 90 percent of respondents indicated a connection between export controls and eroding space industrial base capabilities. Respondents reported that U.S. export controls stand as barriers to domestic companies and create an advantage for foreign competitors***

- ***A significant number of respondents favor a major overhaul of U.S. export controls. Section 1248 of the Fiscal Year 2010 National Defense Authorization Act (NDAA) tasked the Departments of Defense and State with considering the prospect of moving appropriate space components from the United States Munitions List (USML) to the Commerce Control List (CCL). More than 70 percent of AIA survey respondents voiced concern that the Section 1248 report would help their firms only if it resulted in Congress authorizing the President to make substantial revisions to USML Category XV (space vehicles)***

- ***100 percent of respondents said that current export control restrictions have at least some adverse impact on their businesses***

- ***Respondents noted that current policies have created the unintended consequence of fueling foreign competition for U.S.-dominated market share. The result: a dampening of sales opportunities to boost U.S. space technology innovation***

- ***More than 70 percent of respondents blamed ITAR for lost sales, with many small businesses characterizing losses as "significant."***

AIA Recommendation: Modernize Satellite Export Controls

- ***The U.S. government should expeditiously complete and release its review of space systems and components under consideration for removal from the United States Munitions List (USML)***
- ***Congress should return authority to the administration for determining the export control jurisdiction of space system technologies***
- ***The U.S. government should exercise this renewed authority to remove low/no risk technologies from the USML and designate them for inclusion on the CCL, which allows for greater flexibility while preserving the appropriate technology transfer safeguards***

AIA Recommendation: Promote U.S. Space Industry Exports

- ***Selected space systems should receive support under the administration's National Export Initiative, which set the goal of doubling U.S. exports over the next five years***
- ***The Export-Import Bank should develop a greater focus on support for the U.S. satellite manufacturing sector. The use of credit guarantees should be considered for domestic projects if international competitors are backed by government guarantees***
- ***Additional resources should be provided for the Commerce Department to develop and support space export strategies. With adequate funding, the Commerce Department can help level the playing field for U.S. firms trying to compete and win in the global marketplace***
- ***International military sales have for decades strengthened the U.S. aerospace industry and enabled allies to cost-effectively acquire new capabilities. The Defense Department should encourage our allies to acquire U.S.-built spacecraft and systems.*** ***See the Appendix at the close of this article.***

Introduction

The U.S. space industry currently faces major funding reductions from its core customer—the federal government—and at the same time current export policies limit it from conducting effective commercial business abroad. As small businesses and suppliers respond to this scenario by closing their doors, without reform, a weakened U.S. space industrial base may be unable to meet national security needs or sustain its technological edge against international competitors.

The details of the national security risks posed by inappropriate export controls and the absence of export-focused trade policies on the strength and competitiveness of the U.S. space sector will now be offered. It is AIA's position that addressing both areas will enhance space trade among U.S. allies and lead to a stronger U.S. space industry and supplier base that is better equipped to meet the challenges of budget-constrained government customers.

Representing more than 90 percent of the U.S. aerospace industry, AIA works to educate government decision makers regarding issues critical to the country's economic strength, technological competitiveness and defense readiness.

"I remain concerned that our own civil and commercial space enterprise, which is essential to the military space industrial base, may be unnecessarily constrained by export control legislation and regulation."—Gen. Kevin Chilton, former commander of U.S. Strategic Command and former space shuttle commander[1], during a 2009 hearing before the House Armed Services Committee.

Prepared by AIA's ***Space and International Councils***, this report makes recommendations and includes findings from an AIA survey that provides new insight regarding the impact of current export restrictions on space industry manufacturers of all sizes.

A multitude of studies have previously provided findings and recommendations on ways to improve the U.S. space industry's competitiveness. (*A list of relevant studies and a brief summary of each can be found later in this presentation.*)

In particular, a February 2008 study from the **Center for Strategic and International Studies** (**CSIS**) found that current export control policies adversely impact U.S. firms—especially in the second and third tier—and their ability to compete for foreign space business.

Today, the call for reform should be urgent. With federal space budgets under pressure and satellite export policies that remain inappropriate, U.S. industry—including many small to medium-sized businesses—may be forced to reduce or eliminate involvement in the space sector. This scenario, described in the AIA's 2010 report "Tipping Point", could lead to a devastating loss of space capabilities essential to national security. While some commercial satellite prime contractors have found ways to mitigate the impact of current policies, lower tier suppliers remain threatened, along with the overall competitiveness of the U.S. space industry.

An August 2011 **Futron** analysis of the space industry in 10 countries stated: "*Only the United States has shown four straight years of competitiveness declines… By contrast, Russia, China and Japan have improved their own space competitiveness by 12 percent, 27 percent and 45 percent, respectively.*"[2]

Stable domestic federal budgets are critical to the U.S. space industry—the export market is simply not large enough to assure its health. Without stabilizing government space budgets, developing effective export promotion strategies and modernizing the U.S. export control system, the United States faces the real and daunting possibility of losing its preeminence in space. The goal of this report is to convey the urgency to policymakers about the need for updated export policies that we believe will strengthen the U.S. space industrial base and enhance national security.

Outdated Export Controls: Dulling Our Security Edge

U.S. defense technology can be a force multiplier on the battlefield–providing our troops with an edge over their opponents. Effective export controls can sharpen that edge. Export controls keep our most advanced technologies, weapons and equipment out of the hands of our adversaries. Unfortunately, the current U.S. export control system is not optimized to protect sensitive technologies while also maximizing the economic and national security benefits of international trade.

International technology trade helps U.S. aerospace and defense companies create jobs and fuel economic growth. The industry supports more than one million American jobs and according to AIA estimates, created a $51.2 billion aerospace trade surplus in 2010.

Global trade also strengthens U.S. alliances and improves our security posture by providing allies and friendly nations with the capabilities they need to work jointly or unilaterally in support of shared security goals.

The current U.S. export control system was designed decades ago to meet the demands of a Cold War-era, bipolar security environment. According to a 2009 report, Beyond Fortress America, prepared by the National Research Council of the National Academies, the U.S. export control system has not been updated to reflect post-Cold War conditions. The current system closes off business opportunities with foreign customers and increases costs for U.S. industry and small businesses. This ultimately weakens the industrial base and its ability to support the nation's security and economic interests.

Worldwide Share of Satellite Exports 1995 2005

These challenges are particularly acute in the space sector. Numerous studies have highlighted the negative impact of excessive export controls on the American space industrial base. These studies focus on the impact of Section 1513(a) of the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999. This legislation shifted export control jurisdiction of all satellites–including commercial communications satellites and their parts and components–from the Commerce Department, the agency responsible for licensing "dual-use" exports, to the State Department, the agency that monitors the licensing of munitions exports through the *U.S. Munitions List* (**USML**).[4] This move placed satellites under the *International Traffic in Arms Regulations* (**ITAR**), government regulations that control the export of defense-related articles. The *Section 1513(a)* restrictions for satellites export were put in place after the **1998 Cox Commission** investigation of Chinese access to high technology.

While the move was intended to protect sensitive space technologies and preserve American preeminence, what resulted was a widespread loss of commercial satellite market share among U.S. manufacturers as illustrated by a 2008 report by CSIS (*see the chart on this page*). During a 2009 hearing before the House Armed Services Committee, General Kevin Chilton, former commander of U.S. Strategic Command and NASA astronaut stated, "I remain concerned that our own civil and commercial space enterprise, which is essential to the military space industrial base, may be unnecessarily constrained by export control legislation and regulation."[5]

In addition, an unclassified 2010 study by the **National Reconnaissance Office** (**NRO**), the U.S. agency that operates many of America's most sensitive satellites, found that smaller second and third-tier satellite vendors have "*insufficiently diverse business"–likely due in part to current export restrictions. The NRO study found that such a limited market impacts the supplier base most severely, ultimately with a negative impact on U.S. security programs. Specifically, the study pointed out that, "The limited supplier base may compromise long-term availability of some critical components and can negatively affect current program schedules."*[6]

Other cases of a weakening space industrial base can be found by reviewing the *Defense Production Act* (**DPA**) *Title III Program* (**Title III**), a program that provides funding streams in order to preserve domestic military supply chain capability. It is worrisome to note that at least 13 out of 20 current DPA Title III projects are aimed at supply chain materials necessary for the U.S. space program.[7] Current Title III programs related to the space sector include: readout integrated circuits that support sensitive U.S. surveillance satellites; radiation hardened electronics that are used for missile defense and space applications; and Lithium Ion batteries required for satellite power.[8]

"The (current export control) system has the effect of discouraging exporters from approaching the process as intended. Multinational companies can move production offshore, eroding our defense industrial base, undermining our control regimes in the process, not to mention losing American jobs. Some European satellite manufacturers even market their products as being not subject to U.S. export controls, thus drawing overseas not only potential customers, but some of the best scientists and engineers as well."

—Former U.S. Secretary of Defense Robert Gates. Speech on Export Control Reform before Business Executives for National Security. April 20, 2010.[9]

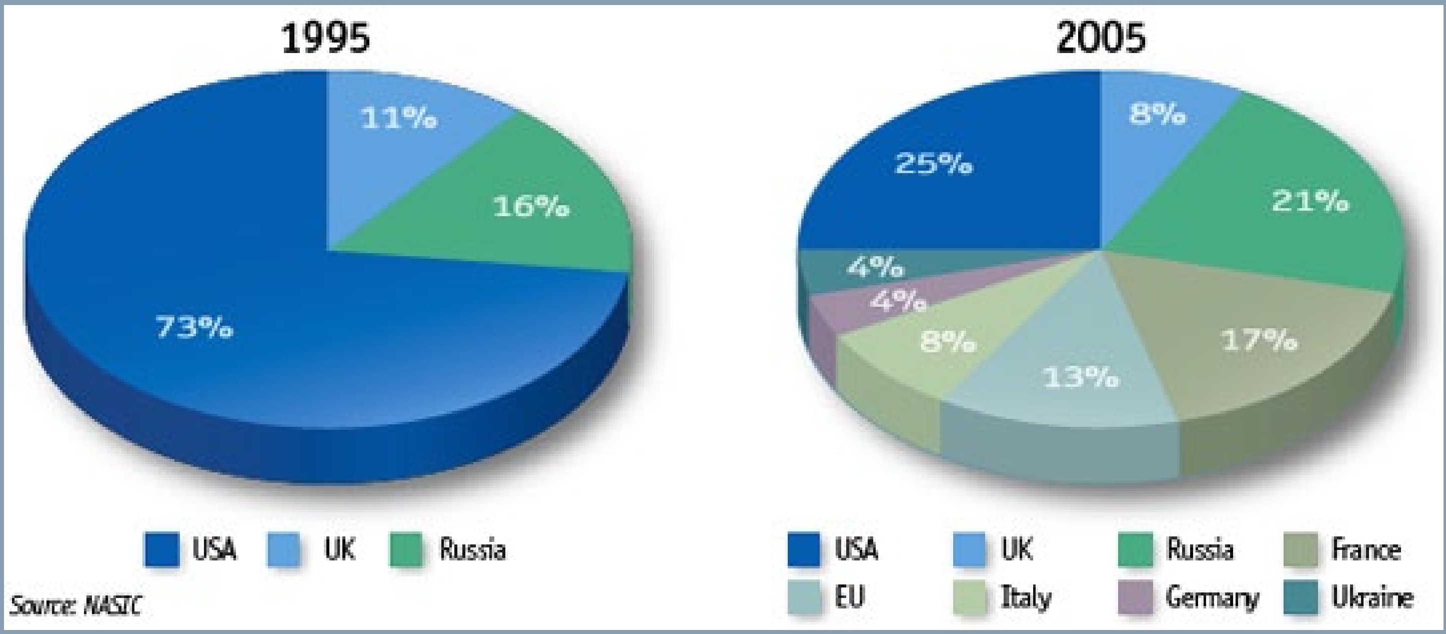


Figure 1. Worldwide Share Of Satellite Exports

Supporting The Industrial Base

The U.S. space and defense industrial base—a collection of specialized manufacturing firms and innovative small businesses—is responsible for the design and development of space systems and components for commercial customers and the U.S. government. These companies are unique: their major customers are agencies of the U.S. government such as NASA, the Defense Department and those in the intelligence community. With relatively few opportunities to compete on contracts that can take years to complete, the industry's high-stakes business development paradigm has been referred to as "betting the ranch on winning in Vegas."[10]

But as government spending on space and security programs decreases, contraction within industry is inevitable. The result will mean less competition and innovation, and reduced capabilities to produce systems needed by the government. Ultimately, some firms may fail outright. U.S. policymakers can counteract this trend by removing existing barriers to new commercial opportunities for American space and defense manufacturers. "*In the process of protecting technology, the United States has created an incentive for foreign suppliers of space systems hardware to develop competing technology. In addition, other space agencies are motivated to develop their own technologies, rather than buying U.S. technology, when their source for technology in the United States is not always available due to ITAR licensing issues.*"

One major barrier to U.S. export competitiveness is the presence of all satellites and related components (however innocuous) on the USML, which forces industry and its suppliers to rely more and more on diminishing domestic federal programs in order to remain alive. Foreign competitors have used our own policies against us by marketing their satellites as devoid of U.S. parts and components – "*ITAR Free*." Meanwhile, efforts to promote exports within the Obama administration, such as the *National Export Initiative*, are not adequately optimized to support exports of commercial U.S. satellite technology.

AIA Survey Results

The 2011 AIA member survey referenced in the Executive Summary offers new insights about the challenges associated with the current export regime. The survey provides a valuable snapshot regarding the cost of the status quo for the industry, U.S. jobs and our security and economic interests.

Do you see a connection between export controls and space industrial base capabilities?

More than 90 percent of respondents saw some connection between export controls and eroding space industrial base capabilities. Respondents reported that export controls present barriers to U.S. companies, which our foreign competitors do not face.

One small U.S. space business stated that due to ITAR barriers, their "market share and profitability has been reduced significantly." Another firm cited that "ITAR controls are hurting the competitiveness of U.S. suppliers in areas where there is similar technology available in other parts of the world." One business cited ITAR controls as restricting firms from selling to international satellite builders and also added that foreign market protection exacerbates the challenge.

Their statements reflect a threat to the profitability and investment environment that encourages U.S. companies to research and develop new capabilities.

"...there is a danger here that export controls, if not reviewed and refined, can in fact create the opposite kind of a situation here, where our industry is no longer competitive; therefore our industry is declining; therefore their ability to provide for us is also declining."

– General C. Robert "Bob" Kehler, Commander, United States Strategic Command[11]

How would the U.S. government's interim report on NDAA Section 1248 help your business?

The *Fiscal Year 2010 National Defense Authorization Act* (**NDAA**)—signed into law in 2009—included *Section 1248*, which tasked the State Department and the Defense Department to evaluate the national security risks of removing space components from the USML. An interim report was released in 2011.

More than 70 percent of respondents voiced concern that the 1248 report would only help if it results in Congress authorizing the President to make substantial revisions with the *USML Category XV* (*space vehicles*). Among space system suppliers, the predominant interest was to address inappropriate restrictions on "*specifically designed or modified systems, or subsystems, components, parts, and accessories.*"

"In the process of protecting technology, the United States has created an incentive for foreign suppliers of space systems hardware to develop competing technology. In addition, other space agencies are motivated to develop their own technologies, rather than buying U.S. technology, when their source for technology in the United States is not always available due to ITAR licensing issues."

– AIA Member

The current export regime results in firms treating small components with the same level of scrutiny as the completed full assembly of a space system. For example, the full extent of export control scrutiny must be applied to items such as special fasteners, sheet metal brackets, composite molds and other components. Although unique for space, these items are not critical technologies and their export does not warrant USML level pre-and post-shipment compliance measures.

Do current ITAR regulations adversely impact your business?

All respondents mentioned that current export control restrictions had some adverse impact on their businesses.

One AIA member noted, "The impact of the ITAR upon business operations is ever-present. Nearly all program data provided to nearly any country requires some ITAR authorization. Accordingly, nearly all of the literally thousands of exchanges/exports necessary in the course of an average satellite program must be conducted under a license or agreement. Even routine, non-sensitive low level exchanges with the closest allies, because they relate to what is considered a 'defense article,' become defined as 'technical data.'"

ITAR licenses, record keeping requirements, and increased potential for delays magnify the risk and cost of competition for U.S. businesses. Ultimately, these circumstances damage the reputation of U.S. industry, and reduce predictability and profitability for the U.S. exporter, thus threatening the health of the domestic space industrial base.

Another firm stated, "The transfer of commercial communications satellite components to the CCL would provide welcome relief to the U.S. commercial satellite sector and increase our firm's competitiveness. Such a shift would reduce our European competitors' significant marketing advantage of being able to offer 'ITAR-Free' *satellites free of U.S. components*."

A variety of firms cited instances where, due to ITAR satellite, component restrictions and the cost of compliance, they made the decision to avoid certain non-U.S. markets.

Do you see a connection between foreign competition and the current state of U.S. space industrial base capabilities?

Respondents noted that current policy clearly had the unintended consequence of fueling the development of foreign competition for what had previously been U.S.-dominated market share.

One respondent firm noted that in the past 10 years, the European Space Agency (ESA) has attempted to develop a European unfurlable mesh antenna reflector. While the effort has yet to be successful, the motivation for ESA still exists as long as the United States restricts exports of its own mesh antenna technology.

Has your company lost sales due to ITAR-free marketing by foreign competitors? Could you quantify the value of the lost sale?

More than 70 percent of respondents described lost sales due to ITAR. Specific sales opportunities in Europe, Canada, Asia and other parts of the world were described. Many small businesses cited a "significant" loss of sales.

One small firm attributed annual sales losses of $5 million annually to the current export control regime. While other companies found the losses difficult to quantify, most agreed that the current export regime was hurting their competitive posture. They also stated that they are forced to dedicate significant resources to managing ITAR compliance that would otherwise go toward reinvestment.

Another mid-size firm remarked that the ITAR-free positioning of potential customers in Europe and Israel for their components results in lost revenue of between $500,000 and $2 million for every ITAR-free satellite manufactured. Their customers are also beginning to identify ITAR control in writing as a negative consideration in the bid and proposal process.

One respondent specifically referenced a lost sale opportunity of satellite components—non-sensitive components available on the global market – where ITAR delays and restrictions resulted in a foreign firm deciding to do business with a non-U.S. competitor.

Recommendations

Revise Satellite Export Controls

Instead of preventing other countries from developing space capabilities, barriers to export for U.S. satellite products have prompted numerous countries to create indigenous space capabilities and leverage their growing market share to support research, development and innovation. As U.S. global market share declines, many domestic companies – particularly second and third-tier suppliers – are increasingly reliant on sales to the U.S. government, or are considering abandoning their space business altogether. In the absence of a healthy, cutting-edge, space industrial base in the United States, our government may be forced to rely on non-U.S. suppliers for key space system components.

Without meaningful steps to stabilize government space budgets, modernize the export control system generally and enhance space trade among our allies, the United States faces a real and daunting possibility of losing its preeminence in space, along with its ability to compete in the global space industry. In order to prevent the loss of space industrial capabilities needed for U.S. security, AIA urges the Departments of Defense and State to complete expeditiously a final response to the National Defense Authorization Act's Section 1248 that directs a review of moving satellite and space-related items off the USML.

AIA strongly urges Congress to pass legislation that would return discretion to the President for the removal of satellites and related components from the USML—subject to restrictions, Congressional oversight and other measures appropriate for safeguarding U.S. national security.

AIA Recommendations

- ***Promptly complete and release the U.S. government review of the space systems and components considered for removal from the USML.***
- ***Congress should return authority to the President for determining the appropriate***
- ***U.S. agency for export control jurisdiction over satellite and space technologies.***
- ***The U.S. government should use this renewed authority to review and approve the movement of low/no-risk technologies from the USML to the Commerce Control List (CCL). The CCL, maintained by the U.S. Commerce Department's Bureau of Industry and Security, is the more appropriate regulator for low-risk commercial technology exports.***

Support the U.S. Space Industry By Promoting Exports

While the Obama administration's 2010 National Space Policy recognizes the importance of international space collaboration, it lacks a focus on the space and satellite industries that contribute to an "increased transparency and stability among nations and provide a vital communications path for avoiding potential conflicts."[13]

Opportunites Lost To Non-U.S. Competitors:

• Germany currently operates TerraSAR-X, a commercial Earth observation radar satellite for which there is no U.S. equivalent. According to a 2009 Space News report, the U.S. National Geospatial-Intelligence Agency (NGA) awarded contracts to three companies to provide commercial radar satellite data, each of which will rely on foreign-owned satellites because no U.S. firm operates spacecraft collecting the imagery sought by the NGA.

• U.S. policy currently limits commercial Earth imagery sales to those offering a resolution of no less than 0.5m Ground Sample Distance, while foreign competitors are developing the commercial capability to exceed that resolution for systems that will be offered to the global marketplace.

AIA believes that a stronger partnership between the industry and government would create new opportunities for U.S. exporters. During an AIA-sponsored government and industry forum in 2011, one of the most repeated requests from industry was for reform of the U.S. export control system. There were also calls from industry for the U.S. government to advocate more aggressively in support of American space industry exports, toward the goal of a level playing field in the global marketplace.

International competitors today can count on government resources and advocacy for critical business pursuits. In 2010, the French-Italian firm Thales Alenia Space won a $2 billion contract to build more than 60 satellites for U.S.-based Iridium after aggressive action from the French export credit agency, COFACE. COFACE agreed to cover 95 percent of a $1.8 billion facility that would ensure most of the financing for the project.[14] It was reported that because the U.S. manufacturer competing against Thales was technically making a domestic sale, it was ineligible for U.S. Export-Import Bank credit guarantees.

According to the Kyodo news agency, in early 2011 the Japanese government was considering the purchase of a U.S. missile warning satellite. This capability would be useful to monitor missile launches from North Korea as well as for disaster monitoring purposes. With the right export reforms and U.S. government backing, such a move would bolster both U.S. and Japanese security while also supporting a healthy U.S. industrial base.

– Associated Press, "Japan mulling purchase of defense satellite from U.S.," July 9, 2011.[12]

As a bulwark against foreign government influence, some in industry have advocated the development of a U.S. government-wide strategic plan for federal export promotion and export financing programs for space systems. This type of plan would encourage international space cooperation in a way that sustains U.S. market leadership while giving international customers access to the best technology at the best available price.

The ***Wideband Global SATCOM*** (**WGS**) is a useful model for understanding how this type of cooperation can work. The WGS is a satellite communications system planned for use in partnership by the U.S. Defense Department and the Australian Department of Defence. The Australian government is currently funding a sixth WGS satellite in return for a portion of the satellite's bandwidth. The U.S. Air Force is also seeking a ninth WGS satellite to be financed in part through international agreements.

Additional cooperation of this type can support a robust U.S. space industrial base, strengthen the capacity of our global partners and is ultimately a win-win for both the United States and its allies.

AIA Recommendations

- ***Selected space systems should receive attention under the administration's National Export Initiative, which set the goal of doubling U.S. exports over the next five years.***
- ***The Export-Import Bank should be activated to support more effectively the***
- ***U.S. space manufacturing sector. The use of credit guarantees should be considered for domestic projects if international competitors are backed by government guarantees.***
- ***Additional resources should be provided for the Commerce Department. With adequate funding, the Commerce Department can help level the playing field with additional support to U.S. firms trying to compete and win in the global marketplace.***

Boeing technicians prepare a GPS satellite for mass properties testing at the company's facility in El Segundo. Mass properties testing ensures that a satellite meets weight, center of gravity, dynamic balance, and moment of inertia requirements in preparation for launch and operation. Boeing GPS testing uses a robust spin rate of 40 rpm. Two GPS IIF satellites are currently in service, two are complete and await launch, and eight are in various stages of manufacture. Photo courtesy of Boeing.

- ***International military sales have for decades strengthened the U.S. aerospace industry and enabled allies to acquire new capabilities cost-effectively.***
- ***The U.S. Defense Department should encourage our allies to utilize U.S. spacecraft and systems.***

Conclusion

The U.S. space industry and its supplier base, which provides our nation with critical national security capabilities, survive in large part because of U.S. government programs. In light of significant spending constraints faced by the federal government, there is a renewed sense of urgency that the United States should reevaluate its export control system and trade promotion strategies in order to strengthen both our space industrial base and national security.

Numerous government, industry and research institutions have found that current export control policies negatively impact our U.S. businesses and national security.

While many members of Congress remain rightly concerned about ensuring sensitive U.S. satellite technology not fall into the wrong hands, many are also beginning to recognize the flaws in the current system that hamstrings the U.S. space industrial base. Members of Congress including long-time champion of export control modernization Rep. *Howard Berman* (D-Calif.), have become more and more interested in trying to find a new approach that balances technology protection while also allowing U.S. firms to compete abroad.

As Rep. *Michael Turner* (R-Ohio) put it during a 2009 House Armed Services Committee Strategic Forces Subcommittee hearing, "*I hope, in a bipartisan way, our committee can work together on a pragmatic approach that strikes a balance between protecting our unique, advanced space technology and capabilities and promoting a viable defense industry that competes in the global marketplace*."[16]

Other members of Congress have called for changes as well. Rep. *C. A. "Dutch" Ruppersberger* (D-Md.), Ranking Member on the *House Permanent Select Committee on Intelligence*, has been an outspoken advocate for satellite export reform, stating that "*Now our American manufacturers are limited in what they can sell anywhere, and it's really become a huge business in Europe to circumvent ITAR… And consequently we're at a great disadvantage. We can't sell what we need to, and right now Europe is taking advantage of this and it's hurting us.*"[17]

Rep. *Dana Rohrabacher* (R-Calif.), who has backed legislation in support of satellite ITAR reform, has said, "*America needs a vibrant aerospace and space technology industry. Everyone agrees ITAR reform needs to happen. We need to make sure that our high tech exports aren't strangled by regulations.*"[19]

In addition, in an August 2011 op-ed in the *Washington Examiner*, *James Jay Carafano* of the conservative **Heritage Foundation** argued that America was "*forfeiting*" its leadership in space due to excessive export controls. Carafano states that when satellites were moved to the USML, "*In one stroke, Congress had managed to boost both our foreign satellite manufacturing competitors and China's commercial space industry.*"

American satellite manufacturers produce some of the most advanced technologies and highest quality products on the planet. Unfortunately, superior products alone will not enable U.S. industry to be the unquestioned market leader if industry's ability to compete is constrained by inappropriate regulations and is not supported by U.S. trade policies.

It is the recommendation of AIA and many others that removing inappropriate market restrictions and providing critical U.S. government export promotion will position our satellite and space sector manufacturers to once again be second to none.

Appendix

Background and current status of export reform efforts

As former Defense Secretary *Robert Gates* remarked in an April 2010 speech, "*The problem we face is that the current system—which has not been significantly altered since the end of the Cold War—originated and evolved in a very different era, with a very different array of concerns in mind.*"[20]

During his 2011 Senate Armed Services Committee confirmation hearing, current Defense Secretary *Leon Panetta* also expressed similar views on export controls.[21]

To help policymakers more fully understand the current landscape of export control policies, it is important to review what led us to this point.

The current export control system was designed in the Cold War era when the United States was ramping up spending

ATK's ORS-1 satellite

in order to become the global leader in innovation and high technology. During this period, from 1961 to 1989, U.S. spending on national security space alone rose from under $10 billion annually to over $40 billion.[22] For much of this time it was a bi-polar world—the United States and the Soviet Union had the only major space programs, and stringent controls were essential to preventing our adversaries from benefiting from U.S. technological innovation. U.S. industry did not require exports for their survival as government spending provided ample business for both large and small firms.

With the end of the Cold War near, U.S. leaders—representing Republican and Democratic administrations—began to consider changes to the export framework that had dominated the post-war era. Presidents *Ronald Reagan*, *George H.W. Bush* and *Bill Clinton* all took steps to facilitate the export of U.S. commercial satellites, providing growth opportunities for the U.S. space industry.

In 1988, President Ronald Reagan lifted a ban on the use of Chinese launch vehicles for U.S. commercial communications satellites. In 1992, during the administration of George H.W. Bush, the State Department transferred jurisdiction of some commercial communications satellites to the Commerce Department.

From 1989 through 1996 Presidents Bush and Clinton made multiple "national interest" determinations allowing launches of commercial communications satellites on Chinese rockets and, eventually, Russian and Ukrainian launch vehicles.[23]

"It is time we undo the damage this restriction has unintentionally created for U.S. business, U.S. competitiveness, and U.S. national security. It is critical that we resolve this matter and prevent China from overtaking U.S. satellite manufacturers. I'm proud to have worked with my colleagues on both sides of the aisle to develop this common sense solution…"

—Rep. Howard Berman (D-Calif.)[15]

1998 Cox Commission Investigation

After a series of scandals related to allegations of Chinese access to U.S. high technology were uncovered in the mid-1990s, Congress created a committee in 1998 known as the *Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China*, commonly referred to as the "**Cox Commission**" in reference to its chairman, Rep. *Christopher Cox*.

The Cox Commission was responsible for investigating these incidents and ultimately produced a bipartisan report (*a declassified version was released in May of 1999*). The report detailed instances of Chinese espionage and attempts to obtain information on U.S. nuclear weapons.

The report also examined Chinese launch failures during the Bush and Clinton administrations. In these instances, Chinese rockets carrying U.S. commercial communications satellites failed and the U.S. firms that manufactured the satellites were asked to provide information in support of the Chinese accident investigation. The report explains how the U.S. firms provided information related to the Chinese rocket fairings and inertial control systems that could have been used to strengthen Chinese rocket—and ICBM—design capabilities. The Cox Commission's investigation led to the inclusion of a provision—*Section 1513*—in the *Strom Thurmond National Defense Authorization Act for Fiscal Year 1999*. Section 1513 moved control of all satellites and related technologies to the State Department's *United States Munitions List* (**USML**), thereby making their export subject to more stringent controls as required under *section 38* of the *Arms Export Control Act*.[24]

The report details that after the 1996 Chinese launch failure with the ***Intelsat 708*** satellite on board, the commercial communications satellite's electronic encryption boards were not recovered. It concludes that these boards were mounted close to the satellite's hydrazine propellant tanks and were likely completely destroyed. The Commission specifically noted that, "*…the National Security Agency remains convinced that there is no risk to other satellite systems, now or in the future, resulting from having not recovering the FAC-3R boards from the PRC.382*."[25]

The Strom Thurmond National Defense Authorization Act sought to ensure that U.S. space business activity not harm national security and most of its provisions related to the Cox Commission aimed to restrict the proliferation of missile technology to China. While the intent of those involved in the Cox Commission was to prevent export of missile and militarily sensitive technologies to China, the result was that all satellites—even commercial communications satellites and their component parts—are now part of an outdated system of export controls that hampers export even to close allies…a system that former Defense Secretary Gates has described as failing at the "*critical task of preventing harmful exports while facilitating useful ones.*"[26]

Impact Of The National Defense Authorization Act For FY 1999

Not long after all satellite technologies were placed on the USML, the U.S. global market share of satellite manufacturing revenue dropped precipitously.[27] Many began to argue that changes in the law had gone too far. The Cox Commission was largely concerned about the transfer of sensitive high technology to China. However the resulting legislation ended up severely restricting the transfer of commercial satellite information and technologies abroad – even to U.S. allies.

Like all technologies captured on the USML, commercial satellites and related components are subject to a "one size fits all" control regime. Nuts, bolts, screws, hoses and other components indistinguishable from their commercial counterparts now require a State Department export license that prohibits retransfer to any party not accounted for in the original license and requires ongoing tracking of access to such items, no matter how innocuous. In contrast, foreign competitors are able to ship parts and components under minimal or no scrutiny because their governments treat them as commercial commodities. This lack of a level playing field creates compliance costs and delays that affect the competitiveness of U.S. manufacturers without commensurate benefit to U.S. national security interests.

U.S. satellite communications ground station, courtesy of the DoD

Such drastic measures may have even been unintentional to many in Congress responding to the Cox Commission. In fact, a review of the Congressional Record during the passage of the Strom Thurmond National Defense Authorization Act shows that Congress was mainly concerned about protecting sensitive nuclear, missile and intelligence satellite technology. Yet, by placing commercial satellite technology on the USML, Congress inadvertently put a clamp on the ability of U.S. industry to compete overseas for non-sensitive commercial satellite sales. Today, such outdated restrictions have unintentionally damaged U.S. security by impairing the vitality of the U.S. space industrial base.

In 2008, after years of concern voiced by the space industry that the law required unnecessary regulation of benign technology, the **Center for Strategic and International Studies** (**CSIS**) released a report that laid out how U.S. space firms were struggling under needlessly restrictive export regulations. According to the report, the United States is the only country today that classifies commercial communications satellites as munitions. Further, outdated export controls were cited as the number one barrier to foreign markets by industry. In the report CSIS shows that the United States held 73 percent of the worldwide share of satellite exports in 1995—this fell to a staggering 25 percent by 2005.

One of the most disturbing trends identified by the CSIS study was that export controls are particularly suffocating to the 2nd and 3rd tier of the space industry. The study detailed hundreds of millions of dollars in lost sales attributed to ITAR licensing.

Multiple reports and other public statements on satellite export restrictions paint a clear and comprehensive picture that the National Defense Authorization Act for Fiscal Year 1999 went too far (*for a comprehensive guide to these studies, see the appendix section of this article*).

As U.S. firms became restricted by heavy export control restrictions, their ability to access global markets decreased, thereby limiting available funds to invest in new commercial systems. At the same time, European space investments actually increased to develop new commercial satellite systems. According to the Commerce Department, "*there has been little innovation in satellite busses by U.S. manufacturers after the change in export controls in 1999*."[28] While some of this data may reflect fluctuations in the market for GEO satellites, it is possible to argue a relationship between changes in the law and U.S. satellite market share.

The impact on the industrial base may have not been realized due to a post-9/11 increase in government funding for space programs that sustained much of the industrial base. However, with current federal budgets projected to be flat or declining in many areas, the need to find ways to strengthen our commercial satellite sector while maintaining stable investments in federal space programs could not be greater.

Congress has begun to recognize the necessity of legislative action. In 2010, Rep. Howard Berman (D-Calif.) introduced **H.R. 2410** with the goal of providing flexibility to commercial satellites and related components under the USML. In 2011, Rep. Berman also introduced **H.R. 3288**, *Safeguarding United States Satellite Leadership and Security Act of 2011*, to continue efforts to strengthen and modernize satellite export controls.

Export Reform In The Obama Administration

Calls to reform the export control system are made not just by the space industry, but by a broad range of technology sectors. To help modernize what most regard as an antiquated and largely ineffective system, President Barack Obama, in August 2009, directed an interagency review of the U.S. export control system writ large. This review would take a comprehensive look at weapons and dual-use technologies. The administration's goal was to determine how to strengthen national security and competitiveness of key U.S. manufacturing and technology sectors by focusing on current threats, as well as adapting to the changing economic and technological landscape that provides security, economic and foreign policy benefits from technology trade.

The administration's review determined that the current U.S. export control system—for all technology sectors—is "overly complicated, contains too many redundancies, and, in trying to protect too much, diminishes our ability to focus our efforts on the most critical national security priorities."29 As a result, the administration launched an effort known as the *Export Control Reform Initiative* (**ECR**). This ongoing effort will review the current U.S. export control system and make changes that are "*designed to enhance U.S. national security and strengthen the United States' ability to counter threats such as the proliferation of weapons of mass destruction.*"[30]

The U.S. government currently maintains two different primary control lists, the *Commerce Control List* (**CCL**) and the *United States Munitions List* (**USML**). The lists are administered by two different departments and hold different structures, different levels of specificity and different definitions. The CCL notably offers varying levels of control requirements while the USML has a "*one size fits all*" approach demanding significant pre- and post-shipment compliance activity. The CCL also itemizes technologies on the list while the USML uses broad definitions of what is captured on it.

The administration plans to conduct the ECR Initiative in three phases. *Phase I* seeks to develop the methodology for building new control lists that are "*positive lists*," which describe controlled items using objective criteria (horsepower, speed, accuracy, or other precise descriptions). In *phase II*, the administration will restructure the USML and CCL into lists that apply varying degrees of control depending on the item. A new section of the CCL will be established to hold essentially commercial/dual-use formerly USML items. A "*bright line*" process will end jurisdictional disputes over an item by clearly identifying whether that item should be on the USML or CCL. These initial phases will be conducted by the Executive branch with Congressional consultation.

As part of *phase III*, both the USML and the CCL will be combined into one list falling under the jurisdiction of a *Single Licensing Agency* (**SLA**). An SLA will streamline the review processes and ensure export decisions are predictable, efficient and transparent.

As part of ECR phase I and II, the administration is looking to find ways to focus controls around those technologies that pose the most significant threat to national security. In the words of the administration, the aim is to build "*higher fences around fewer items*."[31] In addition, as part of these reviews, U.S. government departments and agencies are looking at all the categories of the USML to determine which items should be subject to USML or CCL control. Spacecraft systems and associated equipment are part of *USML Category XV*. Adjustments to Category XV, unlike every other category on the USML, will require legislative action to amend the Strom Thurmond National Defense Authorization Act and return discretion to determine the jurisdiction of this technology to the administration.

Largely due to the growing chorus of concern that overly restrictive export controls were impacting U.S. security, the *Fiscal Year 2010 National Defense Authorization Act*—signed into law in 2009—included *Section 1248*, which tasked the Departments of Defense and State to evaluate the national security risks of removing space components from the USML.

The report will better inform Congress regarding the commercial space technologies that would be appropriately controlled under the CCL. The 1248 report will be incorporated into the Obama administration's National Space Policy. The Policy contains a section on export modernization, stating that departments and agencies should "*seek to enhance the competitiveness of the U.S. space industrial base*" consistent with the results of the ECR Initiative.

By taking such a position, the White House and its National Security Council staff were deferring to the ECR Initiative for final word on export control recommendations related to space. Former National Security Council director of space policy, *Peter Marquez*, stated that "*When that export policy gets announced, it will supersede the portions of this space policy dealing with export control.*"[32] When this AIA article went to publication, the results from the ECR Initiative's Category XV review or the 1248 report had not yet been publicly released.

What the interim 1248 report does provide is an initial conservative assessment of satellite systems and components that could be removed from the USML. The interim study did find that commercial communications satellites, along with most of their components, could be appropriately moved from the USML to the CCL without posing an unacceptable national security risk.

In addition, the interim study concluded that the President of the United States should be provided "*with the authority and flexibility to determine the export licensing jurisdiction of satellites and related components*".[33] It is important to note that in the preliminary 1248 report and in proposed rules supporting the ECR Initiative, the administration is not advocating any changes to current technology transfer policies with respect to China.

National Export Initiative

On March 11, 2010, President Obama signed an executive order creating the "*National Export Initiative (NEI)*."[34] This initiative recognizes the loss of jobs incurred by the recent economic and financial crisis and is designed to help stimulate job growth by bolstering the private sector's ability to export, with the goal of doubling exports over five years. In order to accomplish this goal, the administration's initiative seeks to remove trade barriers by helping U.S. firms—especially small businesses—conduct business abroad.

The administration's NEI represents a potential opportunity for many small U.S. space firms to take advantage of trade missions and U.S. government advocacy. Currently, space firms have not been a prominent component of the NEI due largely to the export restrictions that remain in place. However, if the right reforms were made to the current export control system, a variety of small space industry suppliers would be better able to utilize the government resources offered through the NEI.

Some aspects of the NEI may even be appropriate to advance with selected space firms under the current export controls system. For example, if a U.S. firm is able to identify an export opportunity, the NEI has created a task force directed to work with lenders to deliver financing to small business exporters and expand business counseling on export finance programs. The NEI also seeks to educate small business exporters on market access issues, tools that could be used by some small space supplier firms to identify areas for exports.

A Synopsis Of Major Studies Calling For Satellite Export Reform

Numerous officials and reports have documented the impact of export restrictions on the U.S. space industrial base. Since the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 moved satellites to the USML, the following reports and groups have either captured the disastrous consequences of ITAR licensing on commercial satellites or have recommended changes to satellite export control regulations:

- ***2000—Booz Allen & Hamilton Report; U.S. Defense Industry Under Siege—An Agenda for Change: "We estimate that this particular U.S. industry (communications satellite manufacturers) could lose up to $1 billion of sales annually if the export controls issues are not resolved."35***

- ***2007—Institute for Defense Analysis Study; Export Controls and the U.S. Defense Industrial Base: "In interviews with individual firms it is apparent that companies are already being constrained in supply chain choices by export control restrictions. In some cases export control measures are actually encouraging R&D and capital investment overseas, as well as discouraging R&D partnerships with firms and the DOD." The report goes on to cite the case of Canadian TELESAT as an example of a major customer permanently moving away from U.S. manufacturers after the change in export jurisdiction from CCL to ITAR.[36]***

- ***2007—U.S. Air Force and Commerce Department Defense Industrial Base Assessment—U.S. Space Industry: "...the U.S. share of satellite manufacturing has decreased 20 recent for all commercial communication satellites (COMMSATs) sales and 10 percent for geosynchronous orbit (GEO) COMMSATs since 1999." "A Tier 2 company commented, 'ITAR restrictions and limits are a major impediment to be able to respond to proposal requests and subsequently sell products in foreign markets.' A Tier 3 company '...is withdrawing from the space business due to a sustained absence of profitability and a refusal of some foreign customers to procure equipment that requires U.S. ITAR licensing.'"[37]***

- ***2008—National Security Space Office Survey: A survey by the Defense Department's National Security Space Office of nearly 200 small U.S. space companies found that 70 percent of those companies surveyed stated that ITAR restrictions inhibited their ability to compete for foreign business. More than 40 percent of companies cited ITAR restrictions for hiring difficulties. Many of the survey's findings show that our U.S. small space businesses are the most vulnerable to fluctuations in government funding and compliance burdens.[38]***

- ***2008—Report to Congress of the Independent Assessment Panel on the Organization and Management of National Security Space: "A critical factor in the developing threat to U.S. space supremacy is the accelerating proliferation of space technology. The growth in international space design, production, and operations spurred in part by U.S. restrictions on the export of space technology [under the International Traffic in Arms Regulation (ITAR)] is leveling the playing field so that many nations now compete with the United States in space."[39]***

- ***2008—Space Foundation Paper on ITAR and the U.S. Space Industry: "ITAR restricts the ability of U.S. firms to compete because foreign companies do not operate under equal restrictions. Technology remains on the USML, even when it is commercially available in other countries, because lists of critical U.S. military technologies are seldom updated."[40]***

- ***2008—House Permanent Select Committee on Intelligence Report on Overhead Architecture: "Government and industry participants described how ITAR has motivated European companies to establish an international (non-U.S) collaborative R&D environment where ITAR-banned technologies are produced indigenously, thereby defeating the premise of ITAR."[41]***

- ***2008—Center for Strategic and International Studies Study on the Space Industrial Base and Export Controls: "Export controls are adversely affecting U.S. companies' ability to compete for foreign space business, particularly the 2nd and 3rd tier. And it is the second- and third- tier of the industry that is the source of much innovation, and is normally the most engaged in the global market place in the aerospace/defense sector."[42]***

- ***2009—House Committee on Foreign Affairs Subcommittee on Terrorism, Nonproliferation and Trade; Hearing on Export Controls on Satellite Technology: "Now, the space industry has made credible arguments that the International Traffic in Arms Regulations, known as ITAR, has hurt business and the space industrial base. This claim is echoed in private at least by the Intelligence Community who sometimes find it more and more difficult to source satellite-related equipment domestically."[43]***

- ***2009—National Academies' Beyond 'Fortress America' Report: "...the export control system enforced in the United States today has failed to evolve with changing global conditions, and now produces significant harm to U.S. military capability, to homeland security, and to the nation's economic competitiveness."[44]***

- ***2010—Annual DOD Industrial Capabilities Report To Congress: "In the vacuum left by U.S. companies in international markets, foreign firms have been energized to fill the void and even create "ITAR-free" products that have no U.S. components that might prevent exporting to third countries. The cost and difficulty of export licensing becomes a competitive disadvantage to lower-tier U.S. firms with fewer financial resources."[45]***

- ***2010—Aerospace Industries Association Report, Tipping Point: "At a time when the U.S. government should be encouraging growth across all sectors of the economy, export controls are limiting growth in the space sector, especially among component suppliers. In the absence of a healthy, cutting-edge U.S. space industrial base our government may be forced into reliance on foreign suppliers for key components, accelerating the loss of U.S. leadership in space."46***

- ***2011—Joint Defense Department and Director of National Intelligence National Security Space Strategy: "Export controls, however, can also affect the health and welfare of the industrial base, in particular second- and third-tier suppliers. Reforming export controls will facilitate U.S. firms' ability to compete to become providers-of-choice in the international marketplace for capabilities that are, or will soon become, widely available globally, while strengthening our ability to protect the most significant U.S. technology advantages."47***

- ***2011—Heritage Foundation Report "China's Space Program: A Growing Factor in U.S. Security Planning": "(The United States) is seeking to reform export controls and the International Trade in Arms Regulations, which have harmed the international competitiveness of American satellite manufacturers. These efforts, as long as they continue to address specific security concerns and do not slight the continued need to protect key American technology advantages, deserve support from Congress and Secretary of Defense Leon Panetta."48***

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About the Aerospace Industries Association

The Aerospace Industries Association was founded in 1919, only a few years after the birth of flight. The nation's most authoritative and influential voice of the aerospace and defense industry, AIA represents more than 150 leading aerospace and defense manufacturers, along with a supplier base close to 200 associate members. AIA represents the nation's leading designers, manufacturers and providers of:

- Civil, military and business aircraft
- Homeland and cybersecurity systems
- Helicopters
- Materiel and related components
- Unmanned aerial systems
- Equipment services
- Space Systems
- Missiles
- Aircraft engines
- Information technology

About the author

Mike Conschafter is Director, Space Systems at the Aerospace Industries Association (AIA). In this capacity, Mike coordinates space policy issues related to the Department of Defense, U.S. Air Force, Missile Defense Agency and other government organizations.

Before joining AIA, Mike advised U.S. Congressman Doc Hastings (R-WA) on defense, science, and energy affairs. In addition to his role as a policy advisor, he managed security and science appropriations for Mr. Hastings' district in Washington state where he was instrumental in securing funding for critical DOD, Department of Energy, Department of Homeland Security and National Science Foundation programs. Mike also worked on issues related to DOE's Hanford Site, the Pacific Northwest National Laboratory, and organized an annual series of briefings on DOE and National Nuclear Security Administration programs. Prior to his work in the House of Representatives, Mike served in the office of U.S. Senator Lindsey O. Graham (R-SC). He supported the senator's commitment to defense and science issues, specifically related to DOE's Savannah River National Laboratory and other state research organizations. During his tenure Mike led the creation of the Senate Hydrogen and Fuel Cell Caucus.

Mike holds a B.A. in history and political science from the University of North Carolina at Chapel Hill and completed post-graduate coursework at the National Defense University at Ft. McNair.

Poster credit: ULA

Satellite Export Reform: Myths & Facts

***MYTH**: A recent uptick in U.S. satellite manufacturing revenue is a trend that clearly shows that the current export control system does not need to be changed.*

***FACT**: The U.S. space industry—from top tier firms to suppliers—remains competitively disadvantaged by the current satellite export regime. The overall trend is clear—the United States held 73 percent of the worldwide share of satellite exports in 1995—this fell to a staggering 25 percent by 2005. This study and a myriad of others have shown that the current system is not optimized to allow U.S. firms to compete against their international counterparts. A 2011 review of the U.S. space industry by Futron clearly showed that the United States is falling behind in space competitiveness. As the space industry's main customer—the U.S. government—reassesses its spending priorities, many space and defense firms will require stronger international and commercial sales in order to survive. It is more important than ever for national leaders to address export control modernization.*

***MYTH**: Removing satellites and related components from the USML will harm U.S. national security.*

***FACT**: Sensitive satellite and launch technologies will certainly need to remain under strict export control of the USML. However, there are a variety of low/no risk commercial satellite systems and components—many of which are already available on the international market—that should be considered for control under the less restrictive CCL. As the National Defense Authorization Act for Fiscal Year 1999 moved all satellites and components to the USML, even commercial communications satellites and widely available subcomponents remain under munitions list export control. Preventing export of nonsensitive technologies actually results in damage to the U.S. industrial base, making our small businesses less competitive and potentially less able to meet the national security needs of the U.S. government. Clearly, we need a more nuanced export system for today's space technologies.*

***MYTH**: Why modernize export controls for satellites now? The Europeans have developed their own capabilities and would not buy U.S. space products even if export controls were changed.*

***FACT**: There are a variety of U.S. manufacturers that currently do business with European countries. These firms have unequivocally stated that the correct changes to the current export control system would benefit their business in Europe. Other companies are looking elsewhere for business—especially in the Middle East, where many countries' budgets remain stable and interest in technology is increasing. In South America, the Chinese have been reported to be aggressively pursuing satellite sales to Brazil, a country in which U.S. companies lack a substantial presence.*

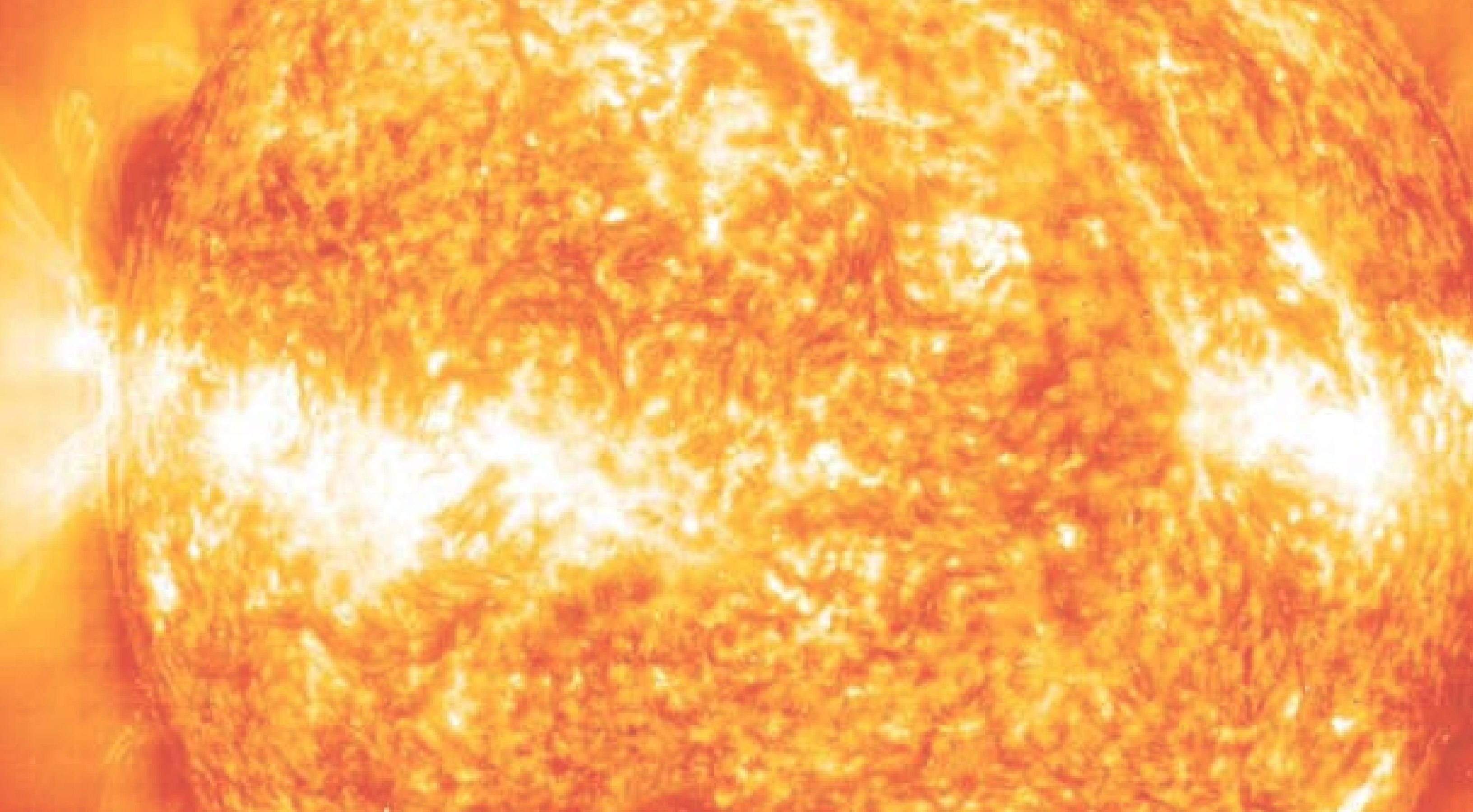
***MYTH**: Why should we be concerned about satellite export control modernization? Won't it just help large companies who win billions of dollars in U.S. government contracts anyway?*

***FACT**: The large and small U.S. companies that comprise our space and defense industrial base are critical to U.S. national and economic security. Without these companies, we would not be able to lead the world in technology and would be unable to produce the systems needed to provide our warfighters with an edge on the battlefield. It is imperative that we protect sensitive technology from export, but it is similarly important for our security that we provide these firms with the tools needed to win export business against their foreign competitors. Export control modernization could arguably help U.S. second- and third-tier suppliers the most. These small businesses often lack the resources to manage the complicated and challenging export control regime. This causes many small firms to make the decision to stay out of the space market entirely or can cause significant sales losses among small firms that remain in space markets. A reinvigorated export control system would have immense benefits for the U.S. space industry, especially second- and third-tier small businesses.*

Space Weather: What Emergency Managers Need To Know

by Elaine Pittman, Associate Editor, Emergency Management Magazine

When FEMA Administrator *Craig Fugate* tweets about space weather warnings, people sometimes reply and ask if they should don aluminum hats. Although the thought of severe weather in space might sound like a plot from a science fiction novel, the threat is real—and could potentially cause widespread blackouts and shut down the electric power grid for an extended period of time.



Experts have said the effects from a major storm would be much worse than Hurricane Katrina—picture hundreds of communities without power, which would mean no water, communications would eventually go down, and commerce would come to a halt.

Extreme space weather is a low-probability but high-impact event. It has come onto emergency managers' radar within the last few years and is now being added into planning efforts at federal and state agencies. And now is the time to work it into preparedness activities. Solar weather works in 11-year cycles, and a solar maximum is expected in May 2013, meaning there's an increased chance for an extreme event.

"It's not going to knock your house down; you're not going to get radiation sickness from it," Fugate said. "But these very complex, large-scale interactions in the upper atmosphere can cause disruption to terrestrial systems—primarily power lines and pipeline systems—that may result in power outages and disruptions in communications that would then affect people."

To understand space weather, it's best to start with a look at the three types of storms:

- Solar flares are violent explosions in the sun's atmosphere. It can take up to eight minutes to feel the flares' effects on Earth, which can include the loss of high-frequency communications and impacts on GPS and radar systems. The effects can last from minutes to about three hours.

- Solar radiation storms are elevated levels of radiation that occur when the numbers of energetic particles increase. The effects are felt on Earth 30 minutes to several hours later, and the duration can last hours to days. This type of storm can impact satellite systems, and there are concerns that it could also disrupt communications systems.

- Geomagnetic storms are the largest of the three types and are caused by coronal mass ejections,

explosions in a region around the sun called the corona. The effects can arrive on Earth 20 to 90 hours later, so warnings can be issued in advance. This type of storm can cause wide-ranging impacts to GPS and the power grid; geomagnetic storms also can cause intense damage to transformers, which could keep electric power from fully recovering for an extended period.

The strongest geomagnetic storm on record took place in 1859. Known as the *Carrington Event*, the storm electrified telegraph lines, which then shocked technicians and ignited telegraph papers, according to **NASA**. Now, 153 years later, power lines and critical infrastructure crisscross the country, and people and industry are dependent on the electricity they provide. In addition, the increase of this infrastructure has made the nation, and the world, significantly more at risk to space weather.

"The biggest geomagnetic storm of modern times occurred in 1989, and that brought the electric grid down in Quebec and Montreal," said *Bill Murtagh*, program coordinator for the **National Oceanic and Atmospheric Administration**'s *Space Weather Prediction Center* (**SWPC**). The storm left six million people without power for about nine hours.

And that's one of the main concerns surrounding space weather. A large geomagnetic storm can potentially short out or destroy transformers, the devices that transfer electrical energy from one circuit to another, and that constitutes the basis for many power distribution systems. A strong storm could knock out hundreds of transformers, therefore leaving a large area in a blackout.

The good news is that the SWPC can provide alerts in advance of these storms—but the bad news is that there isn't a stockpile of transformers on hand in case one or more needs to be replaced. "There aren't 200-ton transformers on spare in the back room somewhere," *Murtagh* said. "In many cases, [transformers] are designed with specifications unique to their location."

Rich Andres, senior research fellow at **National Defense University**'s *Institute for National Strategic Studies*, said that replacing transformers is "very difficult." They must be shipped from overseas, and no one has the capacity to make them very quickly. "If you started talking about hundreds of transformers that need to be replaced, it could be months, and more likely years, before you could replace them," he said.

Although most aspects of planning for these types of storms fall under the all-hazards approach, the potential disruption to the power grid requires partnering with the private sector—to educate it about the threat, sharing how such an event would impact services and operations. Another important aspect, Fugate said, is understanding that some of an agency's response capabilities could be impacted. Satellite-based systems and communication systems are vulnerable to the effects of a space storm.

FEMA began working space weather into its planning efforts in 2009 and is developing a response plan for it. After meeting with officials at the SWPC, FEMA held a tabletop training exercise on the topic in conjunction with the European Union. FEMA receives reports and does routine briefings when space weather occurs, and if there is a warning about a storm that has the potential to impact the Earth, the agency's representative will video conference with the SWPC to get more information about it.

Based in Boulder, Colorado, the SWPC is a 24/7 operation that functions like any other weather office—it tracks and forecasts weather, and issues alerts and warnings—but it's focused on solar and geophysical events. It has a product subscription service that provides email alerts for those who wish to receive them. Fugate said FEMA looks to the center as the "official voice" of space weather threats and capabilities.

By understanding the phenomenon, emergency managers and the public will better understand how to plan for and respond to it, Murtagh said. Since space weather doesn't pose a direct threat to people—they won't be harmed by a storm in the same way that other natural disasters like tornadoes can—some say that's why this topic has been on the back burner of planning efforts. But that's changing in states such as Maryland and Florida.

In late 2010, Maryland became engaged in the topic and within the last six months has gotten aggressive about it, said *Mike Fischer*, director of operations for the state's *Emergency Management Agency*. "What we're looking at is how government responds and reacts when you don't have power or communications," he said.

Maryland is working to educate communities, government agencies and first responders about the threat, and is also interested in developing standard operating procedures around it. In the state, a recently established *Office of Resiliency* is going to focus on public-private partnerships, community resiliency and long-term recovery.

"I think the overarching theme where we're going with this is back, as somebody said, to the old civil defense era where you looked after yourself and your neighbor," *Fischer* said.

With the community-resiliency approach, the state is teaching people how to take care of themselves and their neighbors, because if a catastrophic event were to occur, government would only be able to provide support for so long. In addition, if people can take care of themselves, the government can focus on getting industry back up and running, which will benefit everyone.

Fischer said Maryland also is recommending the use of 20 percent renewable energy. *Chuck Manto*, a consultant and CEO of **Instant Access Networks**, echoed that sentiment: "If we made 20 percent of power, we could hobble along if [the power grid] were to go down indefinitely," he said. One of the benefits of looking at low-frequency, high-impact events, Manto added, is that it makes communities more sustainable, which prepares them for all types of emergencies.

Florida has also incorporated space weather in its emergency preparedness efforts. ***William Booher***, external affairs director for the *Florida Division of Emergency Management*, said via email that space weather is a facet of the *Florida Energy Assurance Plan* training and exercise series. "This year, there will be training courses and workshops offered regionally and a statewide exercise executed, which will use the potential impact of an extreme geomagnetic storm as the simulated event," he said.

The division also works with the *Florida Reliability Coordinating Council* to coordinate with electric utility companies, which can participate in the state's energy assurance exercises and provide technical and situational expertise during the exercise planning process, according to *Booher*.

In addition to sources like the SWPC, other organizations are working to provide space weather information and increase planning in emergency management organizations. InfraGard, a partnership between the FBI and the private sector, is organizing a national conversation between emergency planners and critical infrastructure operators to discuss this issue and the effects from an *electromagnetic pulse* (**EMP**), which is produced when a nuclear device explodes at a high altitude and could have impacts similar to a geomagnetic storm. Manto is leading this effort and said subject-matter experts are being recruited to serve on advisory panels.

"We will also organize leaders among the key critical infrastructure [sectors] across the country," he said, "so that people will actually be able to learn from each other and talk to each other."

Manto cited an *EMP Commission* report finding that said if 10 percent of the nation's most critical infrastructure were protected,

40 percent of the economic damage from an EMP event would be avoided because communities would maintain situational awareness and some of their viability. Manto said his company has received grants to research electromagnetic shielding, and he also is developing a local power protection system.

Editor's note:
This article is courtesy of ***Emergency Management Magazine***

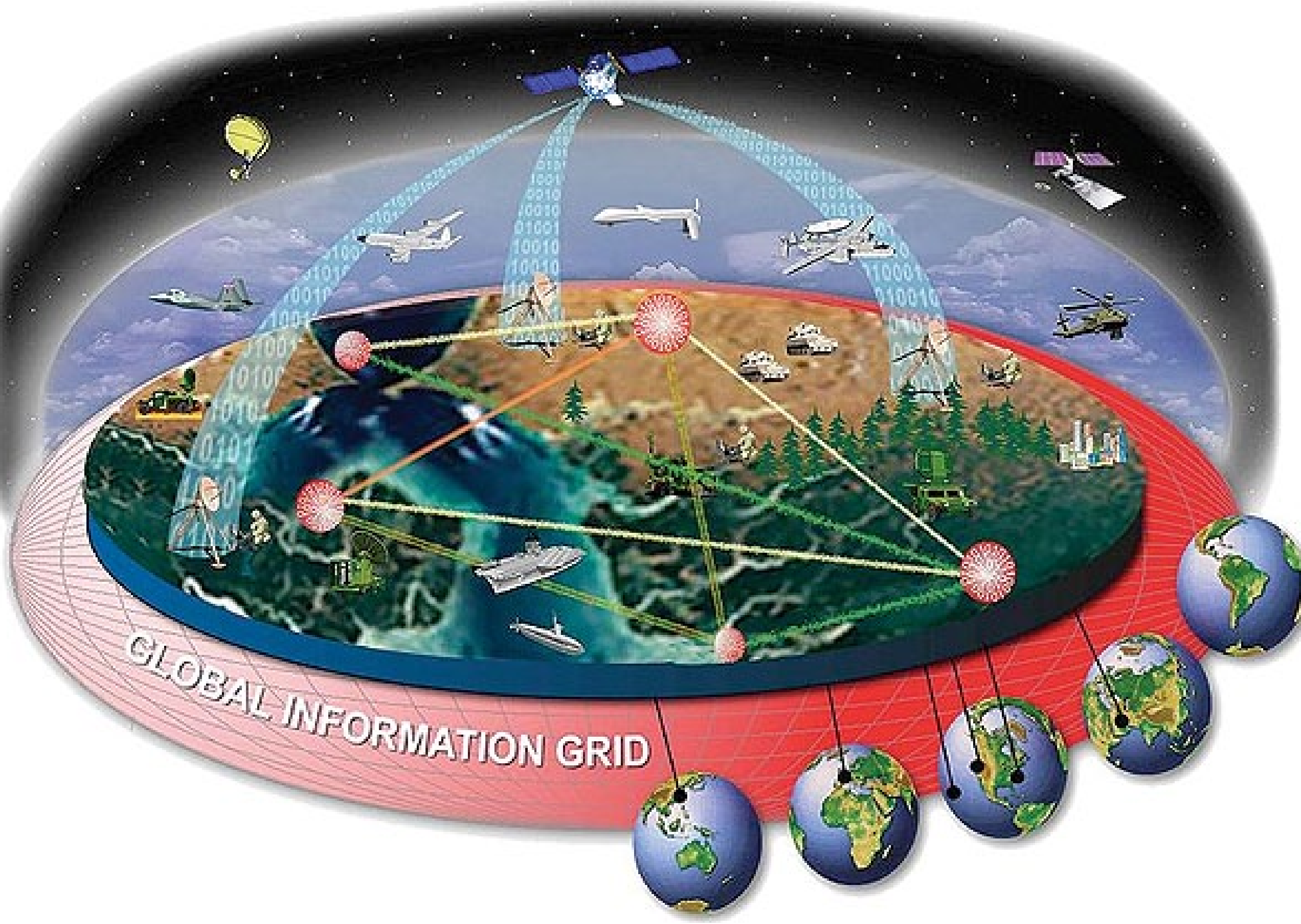
About the author
Elaine Pittman is the associate editor of Emergency Management magazine. She covers topics including public safety, homeland security and lessons learned. Pittman is also an associate editor for *Government Technology* magazine. Email: *epittman@govtech.com*

WGS + Other Examples Of How The DoD's Vision For MILSATCOM Has Veered Off Track

by William J. Donahue, Lieutenant General, U.S.A.F. [Ret.]

The Department of Defense's recently published "Sustaining U.S. Global Leadership: Priorities for 21st Century Defense" calls for decisions on which military investments to continue, which to defer, and which to cancel. The result must maintain a ready and capable force while reducing "the cost of doing business."

How does the current U.S. military satellite communications (MILSATCOM) architecture fit into this 21st century defense strategy? In my opinion, it is not a good fit. That is unfortunate because the MILSATCOM domain can become a model for balancing defense needs with business efficiencies.



The foundations for this balance are rooted in the U.S. Air Force MILSATCOM architecture of 15 years ago—developed when U.S. forces and resources were undergoing unprecedented reductions due to the Cold War "*Peace Dividend*." The MILSATCOM architecture then was divided into three segments:

1. Wideband: Build a three-satellite fleet providing assured capacity for military forces, filling the "gap" between the demise of the Defense Satellite Communications System (DSCS) constellation and the fielding of the next generation of wideband capability. DoD anticipated most of its wideband connectivity needs would be met by the increasingly capable and available commercial SATCOM systems. As these commercial systems came on line, the thinking went, the DoD would use its budget and buying leverage to be the smart buyer of these commercial capabilities, while wideband service from WGS and commercial would to be the source of assured "capacity" for U.S. forces.

2. Protected: Build four satellites that could avoid, negate and mitigate attempts to disrupt, deny, or exploit U.S. operational connectivity. This was viewed as the "hardened, thin-line of connectivity" that would provide the "assured" connectivity needed for operations under the most stressing conditions imaginable.

3. Narrowband: Mitigate the aging of UHF Follow-on (UFO) satellites, assess commercial offerings, and examine the need for a system (military or commercial) in 2007 and beyond to serve the "comms on the move" (COTM) needs of U.S. forces.

The ***Global Information Grid*** (**GIG—***see the illustration on the previous page*)—the "system of systems" concept—was just emerging at the turn of the century, with MILSATCOM viewed as a key component. Commercial SATCOM was central to the GIG, requiring thoughtful integration with powerful solutions that were emerging in terrestrial (global fiber) and wireless (cell phone) domains. "GIG" thinking was also viewed as a path to affordability and mission assurance for U.S. forces undergoing unprecedented reductions as the nation "cashed-in" on the "Cold War Peace Dividend."

The overall Global Information Grid concept was straightforward: assured capacity, assured connectivity, and COTM through a rich mix of terrestrial, maritime, air and space-based connectivity to meet the global connectivity requirements of U.S. forces.

To achieve true efficiencies and provide assured communications, the DoD had to become a smart buyer of the ubiquitous commercial SATCOM that was entering the market. The department began to actively consider its role as public/ private partnerships were taking shape and terminals were becoming smaller and more capable on a global scale.

These developments promised an exciting SATCOM technology landscape for the late '90s. The GIG "system of systems" strategy was poised to deliver on the promise that bandwidth would not be a limiting factor when it was time to apply force, that connectivity would be "like oxygen on the battlefield," always available, always on, and in sufficient quantities required by U.S. and Allied forces. Assured capacity, assured connectivity, COTM and efficiency were all within reach; the DoD would build must-have systems that commercial was unlikely to field, and be the smart buyer in the market for the balance of its required capability.

So Much For Integrating Commercial SATCOM Into The DoD GIG Architecture

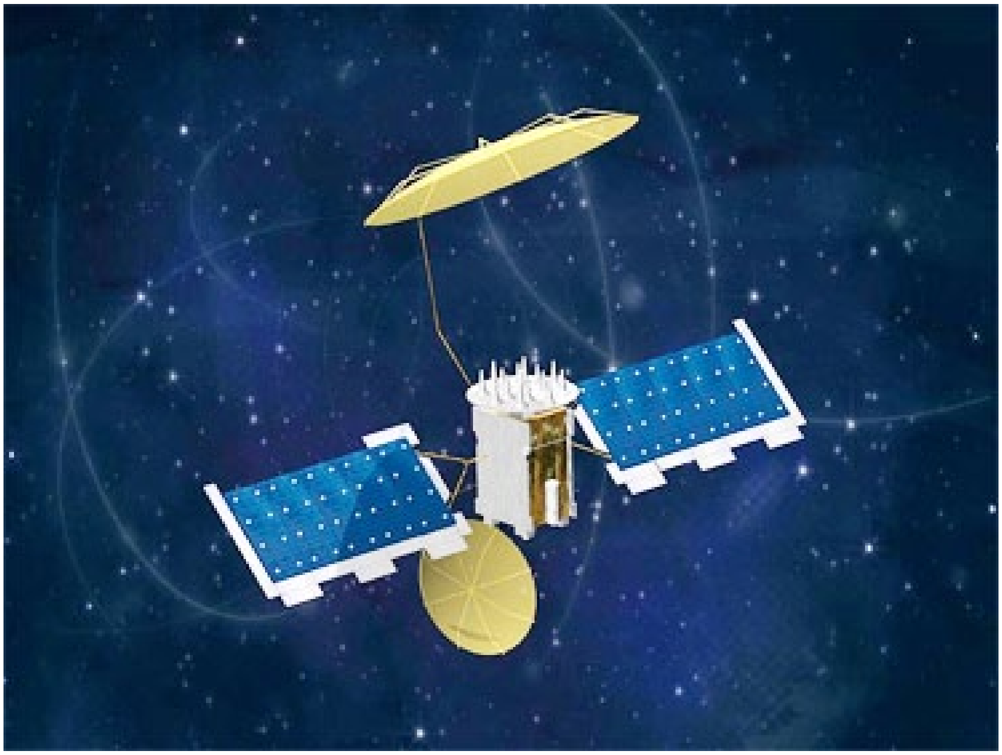
Inexplicably, the DoD now finds itself on a substantially different path, a path almost 180 degrees from that envisioned in the late '90s during the days of the "Peace Dividend." Current DoD policy appears focused on purchasing large systems and capabilities—at enormous taxpayer cost—rather than acquiring those same services from the proven commercial market place.

Case in point: The WGS program morphed from "Gapfiller" to Wideband "Global" Satellite. The acronym remains the same, but the concept has radically changed and expanded. From the original three-satellite system, the DoD is on a path to deliver ten ***WGS*** satellites on orbit and appears to be focused on replacing as much commercial SATCOM as possible in the process. (*In an ironic historical footnote, the highly-touted all-encompassing capabilities of the early 2000's Transformational Satellite Communications System (TSAT) became a casualty of DoD's unwillingness and inability to commit the necessary resources; transformation was not a technical challenge—it was a resource challenge.*)

A further example of DoD's new MILSATCOM architecture is its commitment to acquiring a purpose-built ***Mobile User Objective System*** (**MUOS**). This complex and costly system will provide capability almost identical to the commercially-delivered mobile services we have come to rely on in our daily lives.

The protected ***Advance Extremely High Frequency*** (**AEHF**) system continues to stay the MILSATCOM architecture course, as it rightly should. However, it appears likely that budget pressures will cause upgrades to be deferred.

With the advantage of hindsight, we can see several consequences of government not giving commercial SATCOM a formal, planned role in supporting the Defense Department's MILSATCOM architecture. First and foremost, the DoD was unable to



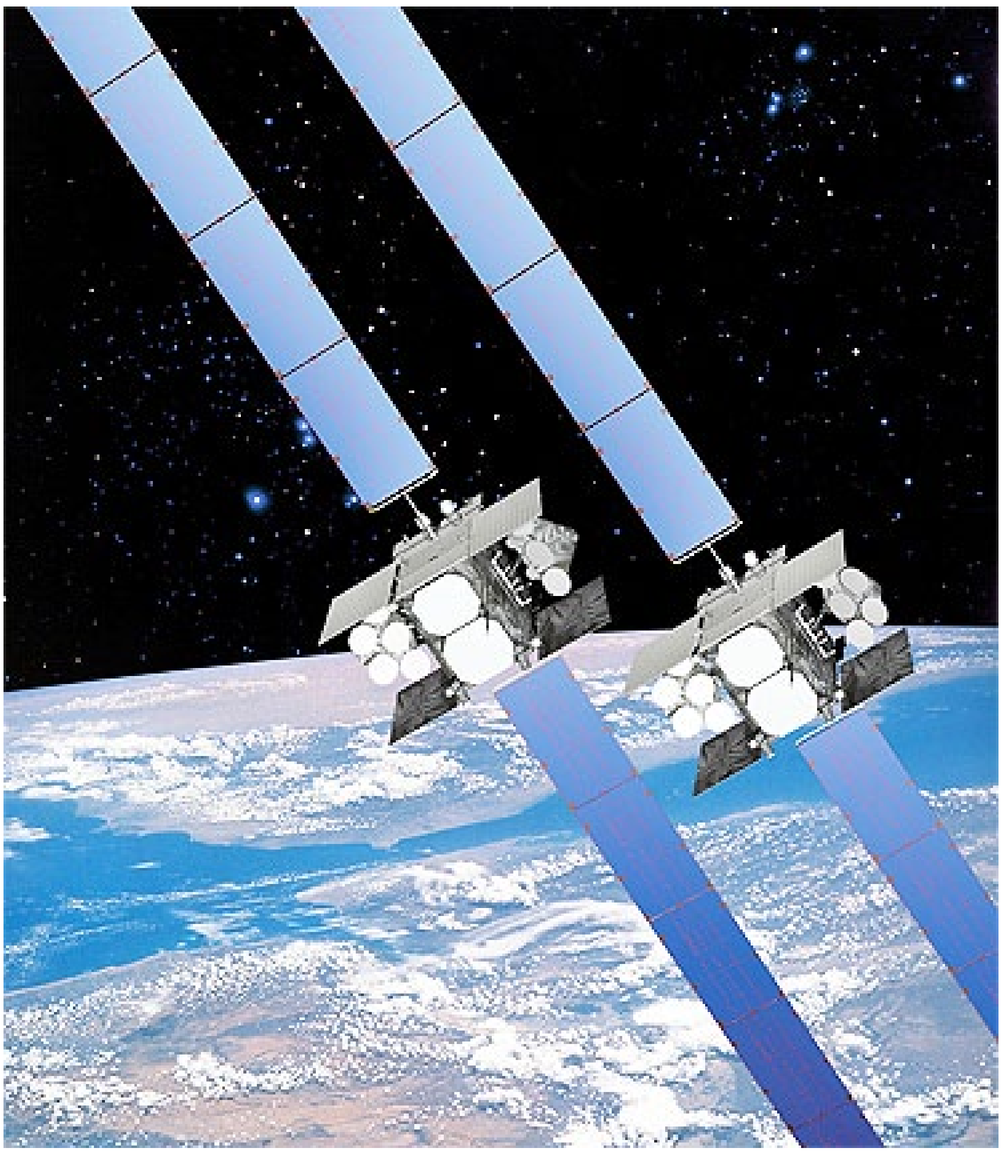
Artistic rendition of the Mobile User Object System (MUOS)

become the commercial SATCOM "smart" buyer envisioned in the "Peace Dividend" manifesto. The DoD continues to pay spot market prices because it lacks program and budget line authorization. This constraint forces the Department to purchase capacity when dollars become available, when needs and international demands are greatest, and more to the point, when market prices are at a premium.

New Acquisition Policies— The Law of Unintended Consequences

The DoD has expanded and altered its WGS program to curb spending on commercial SATCOM. Its efforts embrace two components: "block buying" to drive down acquisition costs, and international participation to "burden share" user costs for the WGS constellation.

One outcome of this strategy is that the DoD's WGS program is now a direct, front-line competitor in the commercial wideband market. This is akin to the government buying a fleet of expensive cars for officials to travel routes well served by reliable public transportation just to get a "volume discount" on the purchase! It reminds me of the old adage about cost avoidance: why tell people you are saving $2 by walking to work rather than taking the bus, when you could brag about saving $10 by walking rather than taking a taxi. The use of scarce DoD dollars on WGS, which is arguably equivalent to or less technically capable than leading edge commercial systems, results in several consequences:



WGS provides essential communications services, allowing Combatant Commanders to exert command and control of their tactical forces, from peace time to military operations. Tactical forces will rely on WGS to provide high-capacity connectivity to the Defense Information Systems Network (DISN). Artistic rendition courtesy of U.S.A.F.

- Undermines United States' protected communications capabilities because it uses scarce resources that could be applied to these critical systems.
- Does not add anything to the industrial base which manufacturers are not already doing in the design and build of commercial systems.
- Perpetuates spot market purchases when operational and warfighter bandwidth needs rise above the capacity of WGS.

Encouraging Signs

The Department is investigating hosted payloads on commercial satellites and is exploring, albeit sporadically, outright purchase of commercial satellites for DoD needs. However, these developments are burdened by bureaucracy and are insufficiently bold to address critical cost and capability requirements. Furthermore, while recent national space policies make encouraging assertions about increased use of commercial satellite bandwidth, these policies appear weighted in favor of the U.S. defense sector at the expense of commercial satellite operators.

The DoD needs a "capabilities based" procurement method that recognizes the maturity of the commercial SATCOM manufacturers and their ability to build and field capacity that is compatible with military needs and requirements. The commercial SATCOM industry's ability to deliver a defined capability on orbit, on a time-definite schedule, at an affordable and set price, should be the envy of every DoD program manager. Clearly the military must, and should, build to its specific military requirements when there is no commercial solution. However, most current and anticipated military SATCOM needs can be met by commercial solutions. Has anyone asked the question: what would a commercial X-band or Ka-band satellite cost compared to a "block bought" WGS satellite?

Demand for efficiencies in DoD purchasing and spending are important, but mission success is an imperative. Our fighting forces in the future may be smaller, but they will depend even more on technology to make them capable, agile, and successful. Bandwidth and connectivity are critical ingredients in that equation. Now is the time to explore every avenue possible to drive down costs and drive in capabilities.

It is time for the DoD to clearly delineate when they will be a SATCOM provider/consumer (AEHF) and when they should be the smart consumer on the commercial market. The current WGS strategy mixes and confuses this important provider/consumer paradigm.

The Way Ahead

From the perspective of three-plus decades in the U.S. Air Force, serving in a variety of communications, information, command and control positions at virtually every level, I humbly offer the following suggestions:

Establish a Commercial SATCOM Budget Line: This may seem like a "blinding flash of the obvious," but it is long overdue. The vast majority of commercial SATCOM spending over the last decade was "off-budget," executed through emergency supplemental funding, or, more currently, *Overseas Contingency Operations* (**OCO**) funds. Absent a budget line, industry has lacked fundamental market predictions and forecasts to support investments that could provide mission capability for the DoD while providing a respectable ROI for the business. The time is overdue to consider a "Commercial SATCOM Industrial Fund." Unless and until there is a commercial SATCOM budget line and a capacity purchasing program that leverages DoD's enormous buying power, the DoD will continue paying premium prices for required bandwidth. Defense has long acquired telecommunications as services; the process is well defined and the contractual instruments are mature. *Why should commercial SATCOM acquisition practices be any different than those for terrestrial communications?*

Consider a SATCOM Civil Reserve Fleet: This concept has surfaced sporadically but there is reasonable doubt it has ever received more than cursory consideration. **U.S. Transportation Command** and **Air Mobility Command** have employed the **Civil Reserve Air Fleet** (CRAF) model for decades, while the U.S. commercial airline industry has superbly served DoD airlift needs. It is time to draw on the lessons learned from the CRAF airlift concept to determine if the concepts can, and should be, applied to a SATCOM Civil Reserve Fleet. Properly executed, a SATCOM CRAF strategy could be a key ingredient in the ***operationally responsive space*** (**ORS**) effort.

Revisit Governance of International SATCOM Sources & Use: Current SATCOM mandates, policies and laws, while well intended, frequently have unintended consequences. In any event, they are doing little to protect U.S. interests in the international arena. Many of these policies are bringing non-market forces into play and thus altering the free market environment that delivers best value to the government customer. WGS, ITAR, public/private partnerships, international cooperation—all demand review in light of current DoD requirements and economic realities.

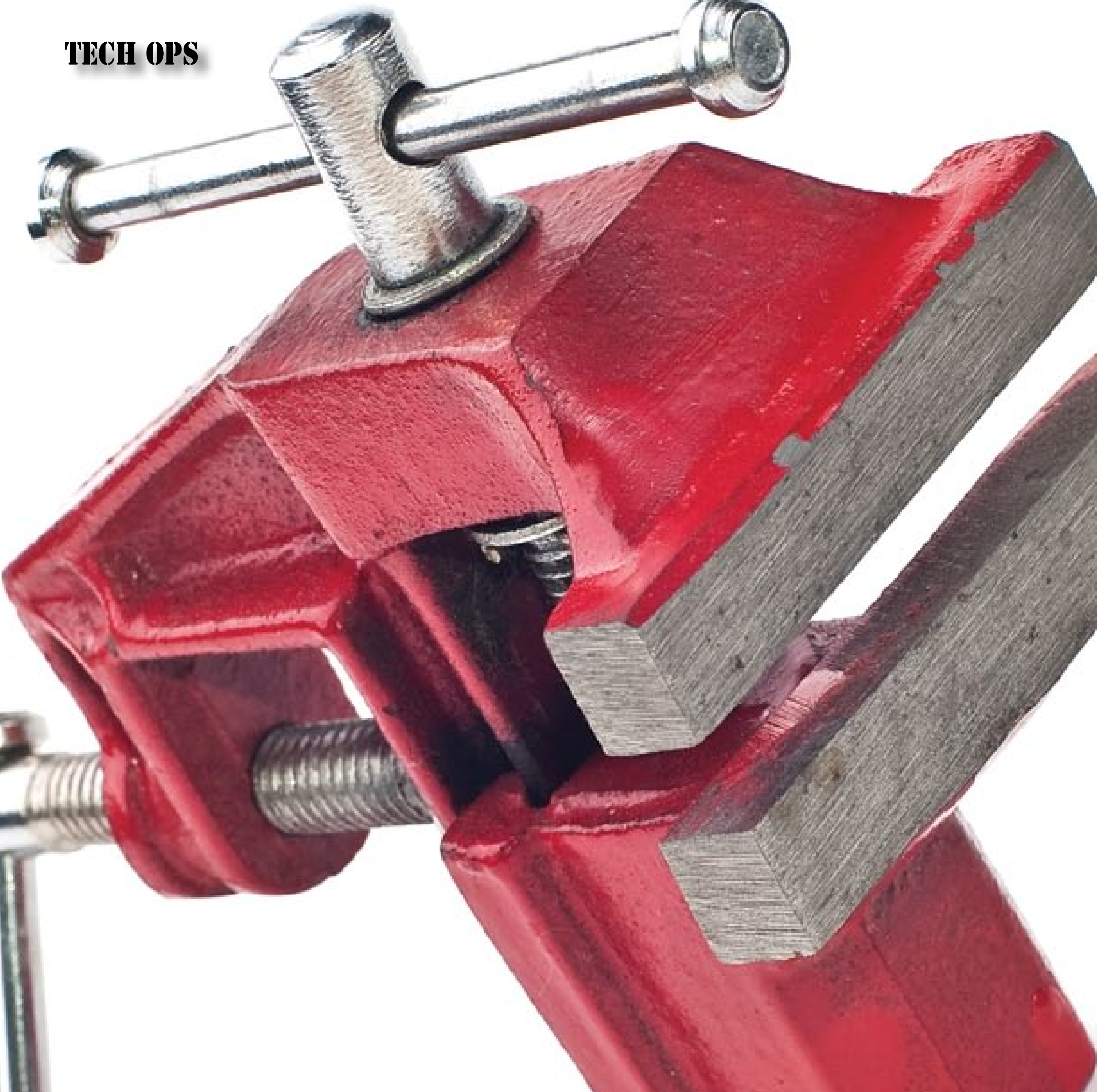
In closing I am reminded of a recent feature in *Aviation Week & Space Technology* discussing manned space flight and the use of commercial capabilities. It was titled "*Commercial Space Day Has Not Come*." In my mind, this aptly sums up the current commercial satellite communications market. DoD needs to rethink its mandates, carefully and intentionally partner with industry, and explore new models for being a smart buyer of commercial SATCOM. Only then will DoD achieve required mission success and the efficiencies demanded by today's economic and strategic realities.

Artistic rendition of an Advanced Extremely High Frequency (AEHF) satellite

About the author

Mr. Donahue retired from the U.S. Air Force as a lieutenant general in May 2000. When he retired he was the Director of Communications and Information at Air Force Headquarters and Commander of the Air Force Communications and Information Center in Washington, D.C.

During his 33-year Air Force career, Mr. Donahue served in a variety of communications, information, command and control positions at virtually every level in the Air Force. He has extensive background in the full range of Air Force information technology, telecommunications and space-based systems. Among a range of clients, he currently advises, XTAR, LLC on satellite communications matters.



XipLink Real-Time Optimizations

by Charlie Younghusband, Founder and
Senior Vice President of Product Management, XipLink

XipLink Real-time (“XRT”) is a new optimization capability that compresses, coalesces and prioritizes VOIP and UDP for significantly more bandwidth and packet efficiency without compromising quality. XRT can provide bandwidth savings up to 50 percent and guarantee quality delivery. This article describes how small packet applications can benefit from optimization, how XRT functions, how XRT can be added to a network to deliver large bandwidth and packets per second reductions, and then specific XRT savings examples.

XipLink Real-time ("**XRT**") is a new optimization capability that compresses, coalesces and prioritizes VOIP and UDP for significantly more bandwidth and packet efficiency without compromising quality. It provides key benefits including dramatic bandwidth reduction, significant reduction in the packets per second carried over a network, and ensures that real-time traffic is properly prioritized for optimum quality.

XRT optimizes small packets, in particular VoIP. However, Skype and other UDP/TCP applications with many small packets can also benefit from XRT. While there are now many highly bandwidth efficient VOIP codecs available, they cannot address the header overhead. XRT removes the high overhead associated with IP packet delivery. XRT is available through XipLink's flexible and scalable line of Appliances (XA).

Background

The amount of voice traffic on satellite links continues to increase at a rapid pace, with significant growth in the use of VoIP, Skype and other voice applications. Real-time traffic such as voice, which is based on small UDP packets, places a tremendous load on network devices due to the high packets per second per voice call. In addition, voice traffic such as H.323 based VoIP or Skype, is highly bandwidth inefficient as the packet headers are often the same size as the payload—an overhead rate of 40 percent.

- Inefficiency applies to all UDP—standard VOIP as well as Skype etc., but in particular small packet applications (e.g. not full frame video streaming).
- These real-time steams need to be prioritized but managed through the network.
- Effective voice codecs are well established and provide excellent options to tune quality versus size. Little need to touch the data stream.
- Jitter and delay are critical in VOIP, but optimization is possible with minimal impact and in many cases will benefit from quality improvement at the same time.

All of these issues and weaknesses are addressed by XRT.

Codec & Bit Rate (Kbps)	Payload Size (Bytes)	Sample period (ms)	PPS	Bandwidth (kbps)
G.729 (8 Kbps)	20	20	50	26.8
G.711 (64 Kbps	160	20	50	82.8
G.723.1 (6.3 Kbps)	24	30	34	18.9
G.728 (16 Kbps)	60	30	34	28.5
Skype (variable)	~67	20-60		100

How can VOIP and UDP traffic benefit from optimization? It's true that they cannot be 'accelerated' in the same way that TCP traffic can be optimized, but there are important other optimizations that help both the quality, timeliness and bandwidth use of these real-time applications.

VOIP and other streaming application can benefit from optimization in many ways:

- Approximately 40 percent of most VOIP packets are headers.
- Most headers do not change much from packet to packet: there is a lot of redundancy between packets—even as they are sent milliseconds apart.
- This redundancy is true even with multiple streams (calls): calls may often have a common destination or source IP address, but there is no sharing of headers between them.

XRT Capabilities

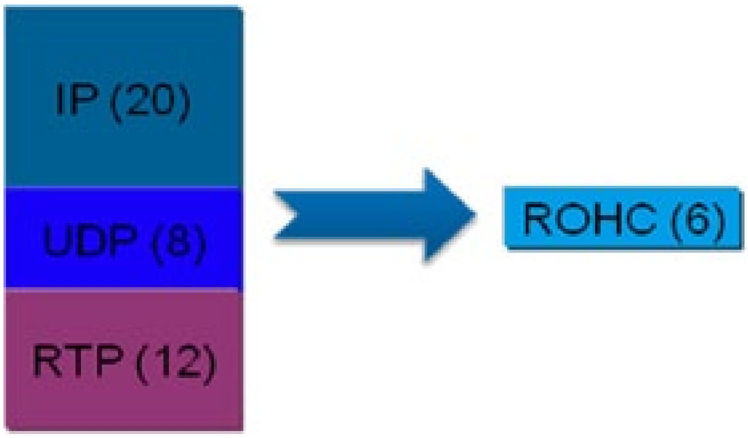
The primary features of the XipLink Real-time include:

- Header Compression—ROHC Header Compression
- Coalescing—Concatenate small packets together while minimizing jitter
- QoS—Shaping and bandwidth control of traffic

Header Compression

The XipLink solution incorporates an implementation of the *Robust Header Compression* (**ROHC**) standard. This is an IETF standard and the most modern and effective technique for header compression. Header compression takes advantage of the streamed nature of the UDP protocol, since most headers stay the same or are similar (*IP address is always the same, etc*.), a small reference token is substituted for the repetitive fields. This typically reduces the packets from 40 bytes to 6 bytes or less. The XRT solution has profiles to compress the IP headers, UDP, UDPlite and then RTP for VOIP. So a UDP based application, like Skype, can have its UDP and IP headers compressed while maintaining it's own proprietary (non-RTP) session header.

While the largest benefits can be seen from VOIP, an IP application can also benefit from XRT if it has streams of small packets, including TCP applications such as Citrix.



ROHC is substantially more effective than older compression techniques such as cRTP, for compression effectiveness, and for resilience against packet loss.

Coalescing

"Coalescing" groups multiple header-compressed packets together into a single packet. This can also be termed as aggregation. Compressed packets are concatenated within the coalesced packet. This allows the IP headers of individual packets to be compressed, yet provides an ultra-lightweight shell that provides route-ability and the correct DSCP mark as the packets it contains.

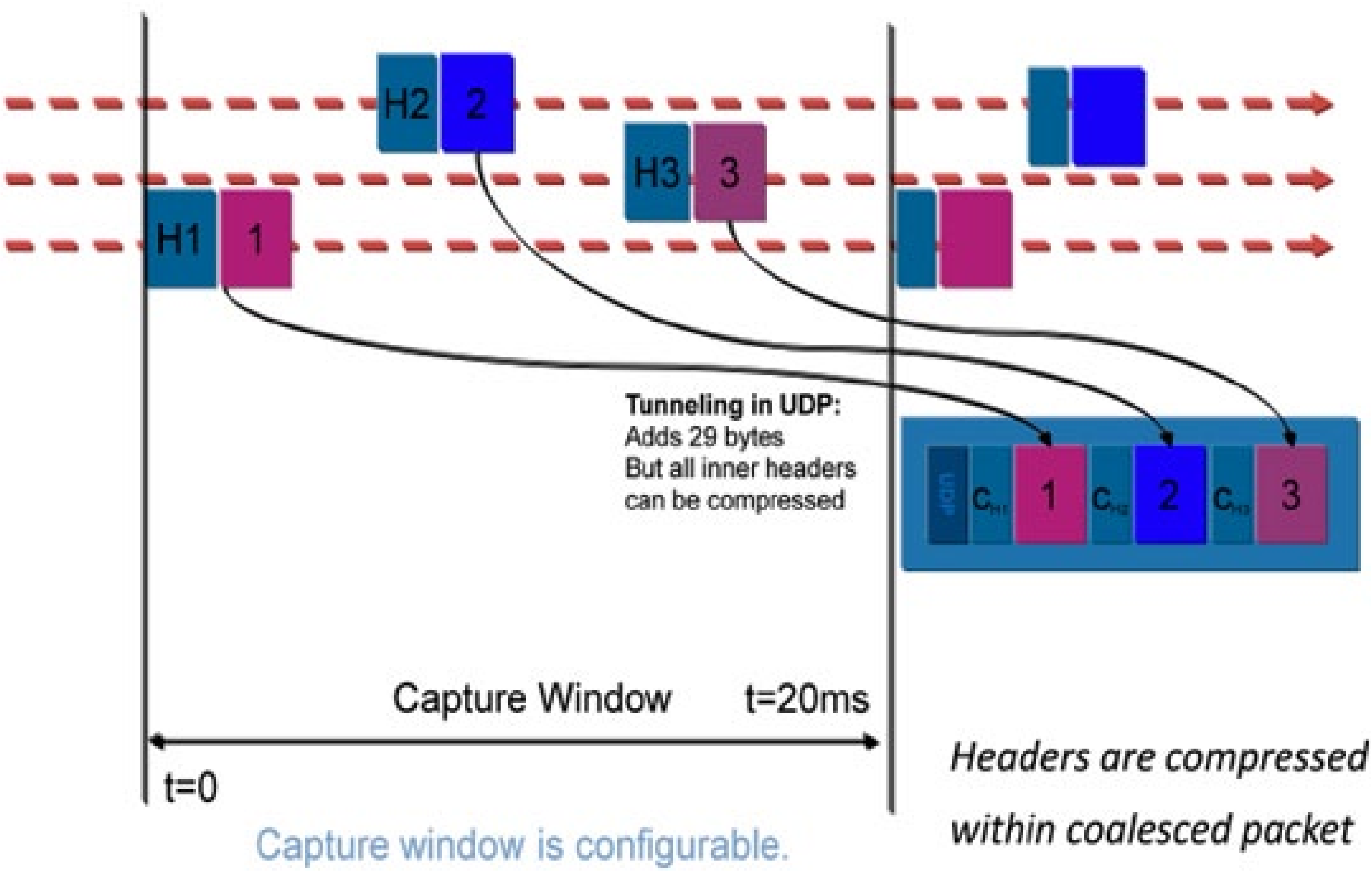
Multiple coalescing queues are used, one for each DSCP class. This ensures that the QoS is maintained throughout the network. At the most basic level, it ensures that high priority traffic is not compromised by coalescing a larger non-priority packet, such as coalescing VOIP together with video. It also allows for multiple priority queues to be active at the same time, for instance it automatically supports *Multi-Layer Protocol Prioritization* (**MLPP**) in U.S. government and military applications.

Once the capture window timer expires or the coalesced maximum size is reached, the coalesced packet is sent immediately. The capture window and maximum size of the coalesced packet can be configured. On a low bandwidth network, a smaller maximum packet size can be configured so the serialization delay does not contribute to jitter. A longer capture window can provide more benefit if there are only a few calls on a network link, but for VOIP, the value must be safely less than the jitter buffers of the phone systems. No packets are sent if there is nothing to coalesce.

Despite the header compression, XRT has a valid IP header address so it is fully routable through any network.

XRT is completely independent of the VOIP codec or payload being used, and different codecs can be combined in the same coalesced packet. To ensure that the QoS is properly enforced on the packet as it continues to traverse the network, a different coalescing queue is used for each DSCP value. This also helps ensure that a large video does not get lumped in with a more latency sensitive VOIP packet.

The *XA Appliance User Interface* (**UI**) provides a means to configure what traffic should be compressed. VOIP traffic must be configured explicitly to use the RTP ROHC profile for maximum



Codec & Bit Rate (Kbps)	Capture Window (ms)	# of Calls	Bandwidth Savings %	PPS Benefit Ratio
G.729 (8 Kbps)	20	1	8%	1
G.729 (8 Kbps)	20	2	33%	2
G.729 (8 Kbps)	20	5	47%	5
G.729 (8 Kbps)	20	10	52%	10
G.729 (8 Kbps)	20	20	54%	20
G.729 (8 Kbps)	20	50	56%	50
G.729 (8 Kbps)	20	100	57%	70
G.729 (8 Kbps)	20	200	57%	70

compression benefit, usually by specifying the call manager IP address on the network.

QoS + Prioritization

XipLink Appliances also incorporate advanced QoS functionality, which is tightly coupled with other XipLink optimization functions. The QoS is also capable of working harmoniously with networks that already have an existing QoS implementation to support voice based applications.

On networks with an existing QoS system, XRT ensures that optimized traffic retains the same DSCP tags, such that the QoS through the network is maintained and the VOIP is properly prioritized and served.

On networks without QoS, as is typical of SCPC technologies, the XipOS QoS provides operators with the ability to prioritize and shape traffic using a Hierarchical Class Based Queuing technology. In addition, the operator can configure real-time, maximum and relative priorities. It also provides features specifically of interest for real-time traffic delivery, including latency bounded queues which is a highly desirable feature for managing real-time traffic effectively. These features give an operator a very

Codec & Bit Rate (Kbps)	Capture Window (ms)	# of Calls	Bandwidth Savings %	PPS Benefit Ratio
G.729 (8 Kbps)	20	10	52%	10
G.711 (64 Kbps)	20	10	17%	9
G.723.1 (6.3 Kbps)	20	10	46%	7
G.723.1 (5.3 Kbps)	20	10	49%	7
G.726 (32 Kbps)	20	10	26%	10
G.726 (24 Kbps)	20	10	31%	10
G.728 (16 Kbps)	20	10	30%	7
Skype (variable)	20	10	28%	7

rich classification engine, not only intended to classify the voice packets, but to simultaneously prioritize and ensure quality SLAs are achieved.

In both cases, the end result will be bandwidth efficient, high quality voice and properly prioritized delivery of real-time data.

Analysis

Let us examine the most popular codec for bandwidth efficient networks, the **G.729A codec**. The following diagram illustrates that the benefits associated with XRT delivers approximately a 50 percent savings in bandwidth after just five calls on any particular link. (*See chart at the top of the previous page.*)

When testing using an **Ixia IXLoad** device over an emulated satellite link, the benefits can be clearly seen. Importantly, the MOS quality score that is auto-calculated by the Ixia device remained at 3.4, both with and without optimization. A MOS score of 3.4 is essentially inherent with the G.729 codec with a satellite delay. The use of QoS protects call quality and MOS score against degradation when the network congests.

The benefit varies with the payload; smaller payloads with a higher percentage of header-to-payload will benefit the most. Let us examine the benefit across a sample of different codecs that may be used, with an assumed volume of 10 calls. (*See the chart at the bottom of the previous page.*)

It can be seen that very high data rate VOIP codecs such as G.711 stand to benefit the least, as they carry a large payload compared to the header.

Protocols such as Skype or any other UDP streaming application do not benefit from the RTP level compression, but do benefit from having the UDP and IP headers compressed. A typical 28 percent bandwidth savings for Skype is still very significant.

Predicting XRT Benefits

XipLink has a calculator tool that models the compression solution and accurately predicts the benefit that can be expected from XRT, including the bandwidth and the PPS, using packet sizes, traffic type and packet arrival rates as inputs. Configuration options available from the XipLink UI including the capture window and maximum coalesced packet size can be configured. The XipLink calculator tool is available on request.

Deployment

The XRT solution is a feature of all XipLink XA Appliances and is included free of charge with all XA units. XRT runs simultaneously with other XipLink optimization techniques. The solution can be deployed over point-to-point links as well as hub-spoke networks common to TDMA and meshed network architectures. XA Appliances can be installed inline, use policy based routing, or WCCP for out-of-path deployment; they just simply need to be installed so they can intercept the traffic requiring optimization.

The solution makes use of XipLink Lightweight Tunnels (XLT). XLT has only a one byte header on top of UDP/IP so it is highly bandwidth efficient. At the hub of a network, the XA appliances receive tunnels from the remotes. Up to 1,000 tunnels can be supported simultaneously.

Remote units are simply configured with the IP address of the tunnel server and a password. If the tunnel cannot be established, packets are sent without optimization.

The XRT solution currently does not support the optimization of VOIP between nodes in a meshed network. However, packets going remote-to-remote will work automatically but will not see any compression benefit. If there is traffic to a common node, which is common of meshed networks, those links can be fully optimized.

Consult the model specifications to see how many calls and PPS are supported per particular model.

Bandwidth Savings + Easy Deployment

This article examined how using XRT on a network can provide large bandwidth savings for small packet applications and ensure high quality packet delivery through the network. It can be deployed easily. XRT can be installed with the primary purpose of saving VOIP bandwidth or as part of an integrated solution to bandwidth optimization with XipLink technology.

Packet coalescing capability and QoS capabilities are available in XipOS version 3.2. Header compression capability is available in XipOS version 3.3.

The BIG Book of Satellite Communications

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The Directory is a comprehensive guide to the people, companies, products, services and the market of the booming satellite industry. With changes of all kinds affecting this dynamic industry, the Directory remains a powerful tool, mapping in detail an otherwise uncharted and complex segment of modern communications.

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Diego Paldao, Senior Director—Americas, NewSat

Diego Paldao has been involved with the satellite industry for more than 14 years. His initial exposure to satellites was with UUNET providing IP transit services. His team worked closely with satellite operators to provide connectivity via satellite for areas that were lacking in sufficient or stable fibre connectivity. Following this role, Diego joined global teleport operator, Verestar, which was ultimately acquired by SES. He has held various positions with SES, supporting enterprise and government clients based in North America. Diego then joined Australian satellite specialist NewSat in January and is contributing to the vision and the realization of the vision to launch Australia's first commercial satellite fleet.

MilsatMagazine (MSM)
Diego, can you tell us a bit about NewSat?

Diego Paldoa
It is a very exciting time to be joining NewSat. Our teleport business is growing rapidly, expanding across various sectors and extending into the satellite operator arena with the Jabiru Satellite Program. NewSat currently owns and operates two teleports, one in Perth (Western Australia) and one in Adelaide (South Australia). The teleports' infrastructure provides a differentiated offering from many other teleports. Both teleports provide optimal look-angles into the MENA region and are recognized as highly secure Global Access Points, supporting certified classified networks. NewSat's teleports were recently recognized as a top 3 Finalist at the 2012 World teleport Awards.

NewSat's Jabiru Satellite Program is progressing well. The fleet of geostationary satellites will deliver global Ka-band coverage starting with Jabiru 1. Utilizing the latest Ka-band technology, the Jabiru satellites will provide "raw" capacity and flexible payloads via a range of multi-spot, regional and steerable beams. Construction for Jabiru-1 commenced late last year and is scheduled for launch in the second half of 2014.

MSM
NewSat will soon launch Australia's first commercial satellite, Jabiru-1—will you tell us about the satellite?

Diego Paldoa
The Jabiru-1 satellite will deliver high-powered Ka-band coverage over the Middle East, Asia and Africa. Its 7.6 GHz of "new" capacity will meet the large bandwidth demands from government, energy and carrier-grade telecommunications markets in these growth regions.

The Jabiru-1 satellite is NewSat's first geostationary satellite and will have a dedicated focus on Ka-band. It has a very complex design in order to provide the greatest flexibility to our customers. A combination of multi-spot, regional and steerable beams provides maximum options to accommodate client requirements. The flexibility that Jabiru-1 will bring to customers requires a more complex and larger satellite design which takes longer to build, and it will be launched by Arianespace, one of the best launchers in the industry.

We believe Jabiru-1 is a great transition satellite because it looks like a Ku-Band satellite in its design as well as offering a range of beams, but it makes use of a less congested frequency band. The design is particularly attractive as the satellite will have both commercial and military frequencies available on most beams. NewSat will launch additional Ka-band satellites following Jabiru-1, expanding our fleet to provide coverage over Europe and the Americas.

MSM
Which customers will find the Jabiru-1 satellite ideal for their projects and missions?

Artistic rendition of NewSat's Jabiru-1 satellite

Diego Paldoa
Jabiru-1 is unique because it will deliver "new" high-powered Ka-band coverage to regions that are in need of more capacity. Jabiru-1 is ideal for both government and enterprise projects looking to support increased throughput requirements, but are unable to grow due to the limited availability of Ku-Band capacity in most markets. NewSat's Jabiru fleet will focus primarily on meeting customer demands for expansion, as well as developing strategic opportunities with clients interested in launching new platforms and services.

MSM
The perception of Ka-band is varied. What is your opinion?

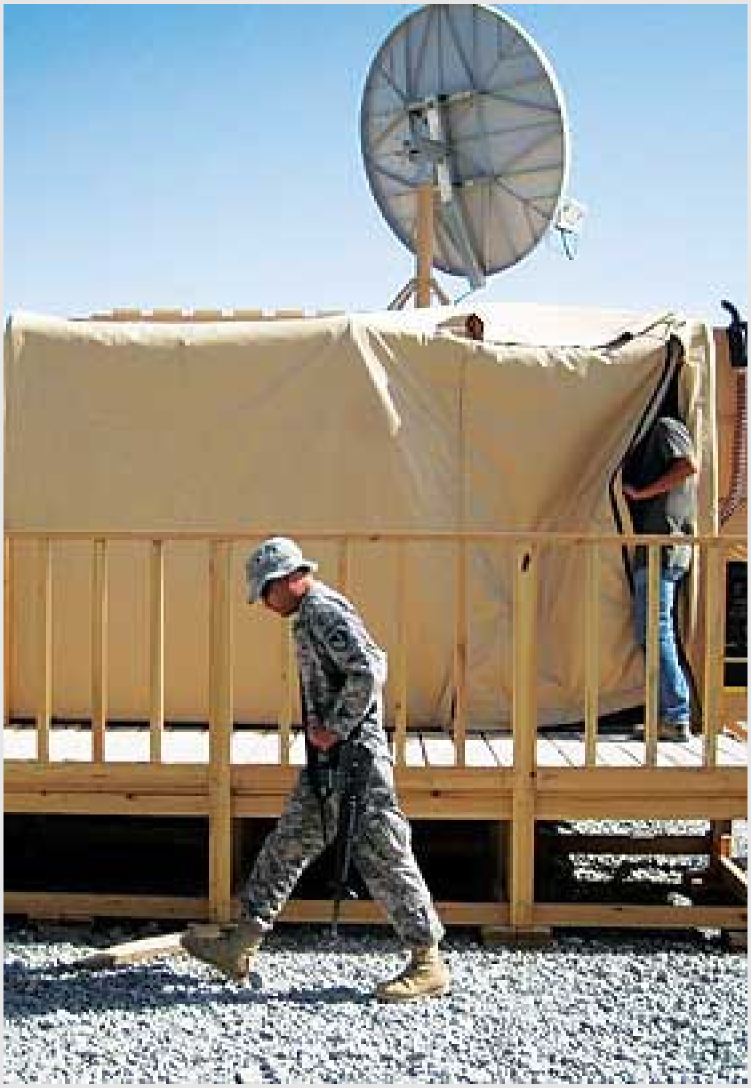
Diego Paldoa
Ka-band is the next generation of satellite technology. There are some forward thinking companies like ViaSat, DIRECTV, SES and EchoStar who have been promoting and leveraging Ka-band capabilities for some time. I believe that in the very near future, Ka-band will be more mature and understood in many new sectors. I think we will see a higher proliferation of Ka-band terminals due to higher demand, which will help drive down costs and standardise design, just like we saw with Ku-Band. As with any technology, it's important to know what the correct fit is. We are not trying to be all things to all people, but certain applications such as ISR are an ideal fit for Ka-band.

MSM
Why are satellite communications so imperative for military and government operations?

Diego Paldoa
The inherent benefit of satellite communications is the flexibility and reach it is able to provide. Satellite communications have the ability to deliver a point to multi-point solution and can provide communications in a region lacking stable ground infrastructure. All of these capabilities are ideal for users whose areas of operation are global and in less than stable environments.

It is imperative for the military to be able to control their communications and not be at the mercy of local connectivity options. We have seen recently how cable cuts in Eastern Africa and Asia have seriously impacted the areas' ability to maintain even the most basic communication and data transport.

Given the option of fiber or satellite for network reach, fiber is certainly a preferred option; however, military networks are heavily aligned with satellite communications because of the nature of military activities. If there is satellite communications capacity active in one region it can easily be transported to another region, as troops re-deploy to new conflict areas or to support new missions.



VSAT in use during a military operation, photo courtesy of NewSat

Ka-band in particular is critical in today's world of budget constraints. The United States Government (USG) wants to be able to do more with less. You can get many times more data (megabits per second) through a Ka-band satellite than through a Ku-Band satellite of the same size and weight. It's almost like a "two for the price of one" or even better deal for the USG.

MSM
What advancements do you see occurring in military communications in the future?

Diego Paldoa
The migration of terminals to dual Ku-, Ka-band really demonstrates the government's confidence in Ka-band as the future and its own WGS fleet in particular. Additionally, it is known that many of the remotely piloted ISR platforms are scheduled to add a Ka-band capability as the need for greater data throughput grows.

I think it is particularly important that as the government further defines and develops its terminal requirements, they consider making sure the designs include the option for commercial frequencies and work with vendors to have this flexibility available. NewSat's Jabiru fleet is very complementary to WGS and other Ka-band systems being deployed. As a comparison, even with all the military satellite communications available today, over 85% of the Department of Defense's (DoD) satellite communications is on commercial satellites, which highlights the partnership between DoD and commercial providers such as NewSat. NewSat also has the benefit of being able to offer commercial and military frequencies on most beams.

MSM
How will NewSat approach the United States Government (USG) market?

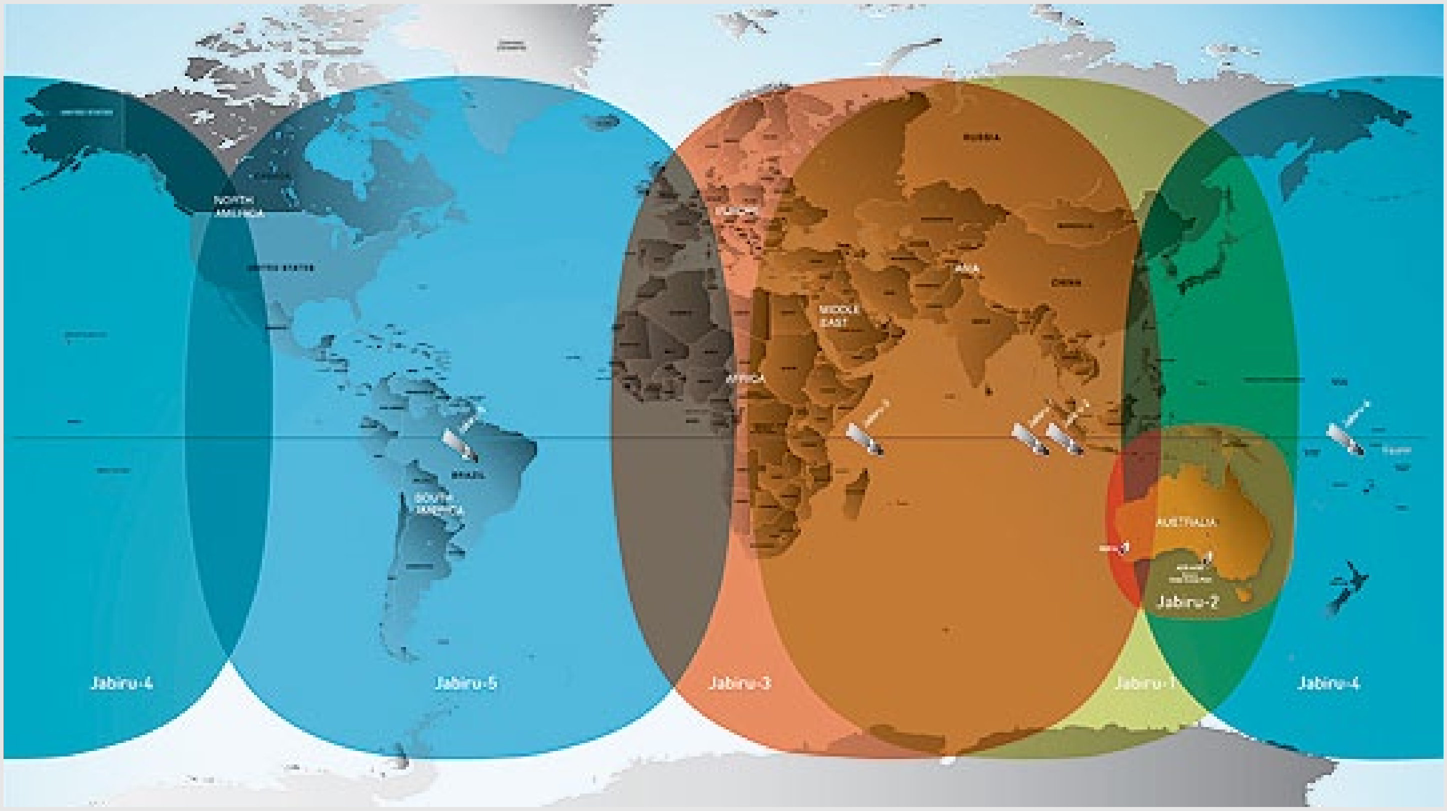
Diego Paldoa
Through partnerships with our partners, prime contractors, resellers and integrators. As a satellite operator we can certainly evaluate what USG contract vehicles are a fit with our business. However, we are primarily interested in approaching the USG market by working closely with our partners, not by competing with them. We will provide our part-satellite capacity, so our partners can provide the complete end-to-end solution.

Hosted payloads are certainly a topic of key interest and discussion today to all satellite operators. The strong military and diplomatic relationship between Australia and the United States is a logical start to discussions regarding hosted payloads on the NewSat fleet. We will certainly rely heavily on guidance from our partners who have experience in this area. By soliciting direct input from the USG, NewSat will be able to ensure our satellites are designed to support future missions in projected areas of operation.

MSM
Are the Americas a key growth area for NewSat, and what is in store for NewSat for the rest of 2012?

Diego Paldoa
The Americas region will certainly benefit from NewSat's global plans. We are planning to expand our presence in the region to support the growing demand from clients based in the Americas in general, and specifically the United States. NewSat has tremendous flexibility today in structuring agreements that help our clients start a new business or service so that we can grow together. Clients serving a growing market such as Latin America can certainly benefit from our partnership approach.

It is a very exciting time for NewSat. Lockheed Martin is several months into the build of Jabiru-1 and Jabiru-2, a hosted payload with MEASAT will launch next year. Further satellites, such as Jabiru-3, Jabiru-4 and Jabiru-5 are being designed and we are well underway to determining the best use of our remaining orbital slots.



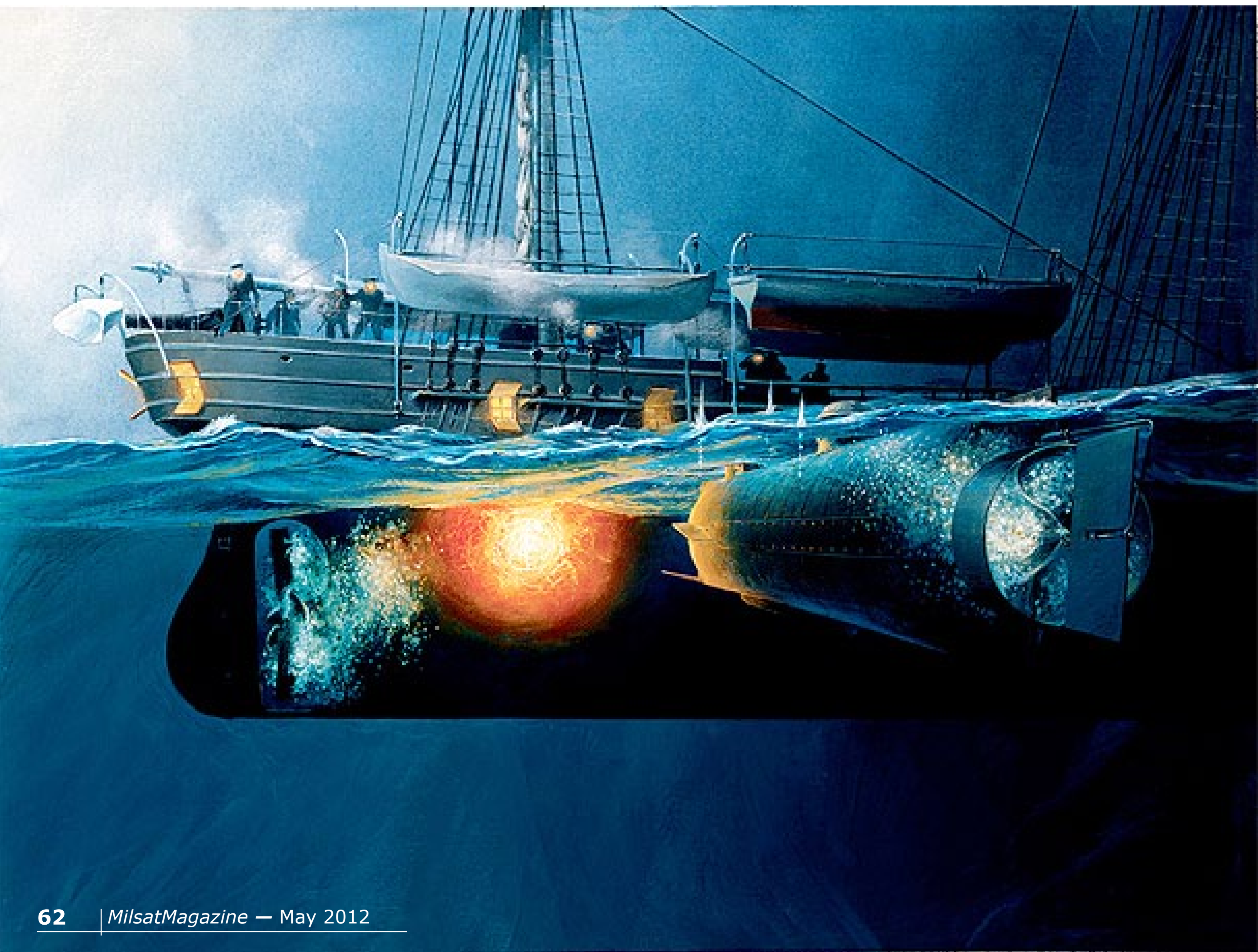
Jabiru-1 coverage map

Space: Disruptive Challenges, New Opportunities, + New Strategies

by
Ellen Pawlikowski, Lieutenant General, U.S.A.F.
Doug Loverro, DISES, U.S.A.F.
Tom Cristler, Colonel, U.S.A.F. [Ret.]

February 17, 1864 was a cold night just outside Charleston Harbor. The War of the Rebellion had raged for the prior three years as a bitter struggle of will and staying power. Key to that staying power—or more precisely, to breaking it—was the strategic blockade Union forces had imposed on the South, the so-called Anaconda Plan;[1] and no single point in that blockade was more important than Charleston Harbor. As the site of the Civil War's first real battle and the largest port in the South, it bore both symbolic and strategic significance.

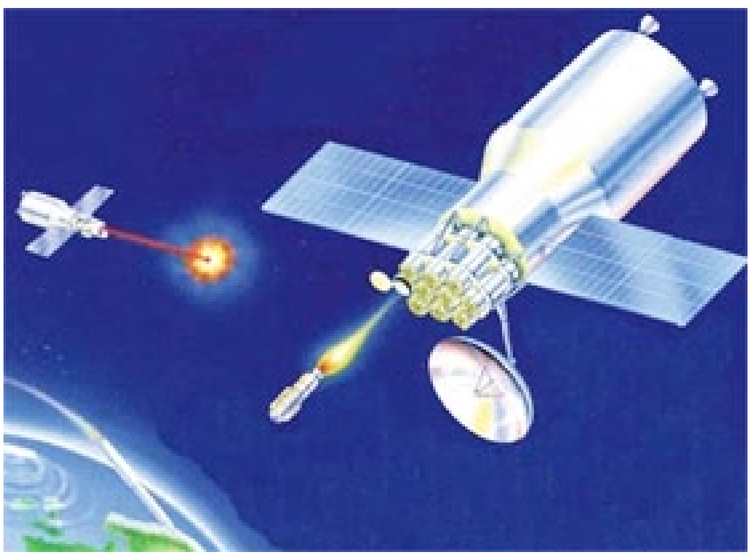
On that night, though, a new strategic dynamic was about to unfold. Beneath the dark, frigid waters of the Atlantic, the *H. L. Hunley* steered toward its target, the *USS Housatonic*. RADM *John Dahlgren*, the U.S. Navy commander of the South Atlantic Blockading Squadron, had heard of the new Confederate vessel—a submersible that could engage ships while under water—and its two previous failed missions;[2] but this knowledge was not able to save his fleet from loss. As alarms rang out above, and with cannons ill adapted to target the low lying vessel, the *Hunley* rammed its 135-pound torpedo into the hull of the *Housatonic*, and in less than five minutes, the *Housatonic* was lowered to its watery grave (along with its attacker just a few hours later). Submarine warfare had begun, and the Union navy, and every subsequent navy, had to either adapt or sink into insignificance.



A century and a half later, "In the predawn darkness of 11 January 2007,"[3] a similar strategic shift was emerging. Symbolically and strategically, the U.S. position in space had been a source of strength and prowess since the dawn of the space age. The space race of the late 1950s and early '60s was a formative surrogate for the more expansive superpower contest that raged on for the next three decades. The U.S. "victory" in the race for the moon was a defining moment for our nation and for our adversaries. That symbolic victory underscored the strategic import yet to come.

In times of disruptive change your expected future is no longer valid. Leaders need to think and act differently in order to chart a new course for the enterprise.—Doug Berger, *Innovate*, **August 2005**

The technological edge that led to this victory had sharpened over the ensuing 50 years. At the close of the last millennium, the United States enjoyed dominance in space power that, while waning, was still head and shoulders beyond its closest competitors. The U.S. reliance on that dominance had not gone unnoticed. Chinese strategists recognized their ability to counter U.S. military capability lay, in part, in the ability to target space.[4] As in the case of the Hunley, the U.S. apparently knew of the upcoming Chinese kinetic anti-satellite (ASAT) weapon test and its previous failures.[5] But with measures ill adapted to intervene in such a test, all the U.S. could do was observe and take heed. Space warfare had begun anew, and the space community, along with every space-faring nation, was now on notice that they had either to adapt or plummet into insignificance.



Disruptive change is not a new phenomenon. New technologies, unexpected threats, novel tactics and techniques, and altered approaches can create changes to the strategic environment in which we operate. Those changes can alter the landscape in ways that, if not addressed, can dramatically upset the existing order. They can render effective strategies impotent, change winners into losers, and turn victory into defeat.

Disruptive change has been a decisive force throughout history. The English longbow rendered knights' armor ineffective in the **Battle of Crécy** and is considered by many historians as the beginning of the end of classical chivalry. (*Once mounted, knights became vulnerable to common soldiers firing from a distance; the classic use of armored cavalry and hand-to-hand battle became of lesser significance in the outcome of battles*.) Assembly line mass production not only dramatically impacted the speed at which manufactured goods could be assembled, but also reset the productivity curve for each worker, significantly increasing their value and wages and precipitously driving down the cost of manufactured goods (For example, wages in the Ford factory doubled while the cost of an individual automobile fell by almost 30 percent)—a major step in the growth of the middle class. Today, digital music and file sharing have upset 50 years of unimpeded growth in the record industry, with many predicting its end is near.[6]

Disruptive change rarely involves a single element, nor does it happen abruptly. It has taken over 30 years for the record industry. The introduction of digital music in 1982,[7] along with high-speed Internet, high-capacity digital storage drives, and a change in public focus from high-quality music to readily available music, have all led to the extended downhill slide that leaves many big music labels grasping for how to cope with the threat.

How will disruptive change impact the direction of U.S. space power, and what strategies will be effective in dealing with it? The answer lies in our understanding of the rise of space power and how that led to the conditions of today. This article examines the forces of disruptive change in addition to the ASAT threat, presents a set of possible responses to the challenges, and investigates whether the responses group into logical categories of actions. It then delves into how those actions might be implemented in future architectural states for space systems and if the conditions of the space market are appropriate for those responses. Finally, it asks how we might change the acquisition of space capabilities to better allow these responses and what that might mean in specific mission areas.[8]

The Growth Of Space Power

The current generation of U.S. satellite systems emerged in an era far removed from today. From the very beginning of the space age to the last days of the Cold War, most space systems were focused on strategic conflict. They were highly classified, with services and information that had little impact on the tactical landscape. Space warfare was viewed as unlikely—just another element of the strategic détente between the Soviet Union and the United States. If a war in space were to occur, it would be as a prelude to a strategic contest between the world's two superpowers.

Depending upon one's view, either the United States or the Soviet Union was the preeminent space power during the early days of the Cold War.[9] But by the late 1970s, the U.S. space industrial base, powered by simultaneous investments of Apollo, ICBMs, and SLBMs—was unmatched, robust, and vibrant, with multiple competitive sources of supply at every level of production. Retired general *Tom Moorman* said, "The 1960s and early 1970s saw the rapid growth of military space technologies, infrastructure and programs. The breadth of space capabilities developed during this time was indeed quite remarkable and in a word—breathtaking."[10]

In those days technology was king, and experimentation in the military uses of space was expansive. From manned military programs, such as ***Dyna-Soar*** and the ***Manned Orbiting Laboratory*** (**MOL**),[11] to unmanned nuclear detection and warning programs and early space reconnaissance programs, failures preceding success were common, if not expected. And failures could be tolerated, because dependence on specific systems for everyday war-fighting was minimal. In fact, due to their highly classified nature, most of the failures were shielded from the kind of scrutiny that other programs endured.[12]

Lastly, the cost of space, while important, was of lesser concern. As part of the superpower contest between the United

States and the Soviet Union, most space programs were viewed as vital and nonnegotiable. The price tag for a program was regarded in contrast to its larger strategic purpose rather than as an element of discretionary military spending.

With these conditions as backdrop, the U.S. space program and the systems it developed were aimed at only a few primary ends—pre-conflict intelligence, nuclear attack warning and response,[13] and continuity of nuclear command and control. (*It is interesting to note that the GPS system was justified for part of its development, not on the basis of its impact to tactical maneuver warfare, but on the role it played in nuclear attack assessment*.) Continuous war-fighting resiliency, short of nuclear survivability,[14] was sacrificed for technical capability. There was no "live-fire survivability testing" or requirement that accompanied similar war-fighting systems. Additionally, space was viewed as an extension of strategic détente; the same kind of deterrence that prevented nuclear war was relied upon to protect satellite systems.

These forces had a direct impact on the way space systems were designed. An unchanging dynamic of space systems is that their utility on a per-pound basis tends to increase as their weight

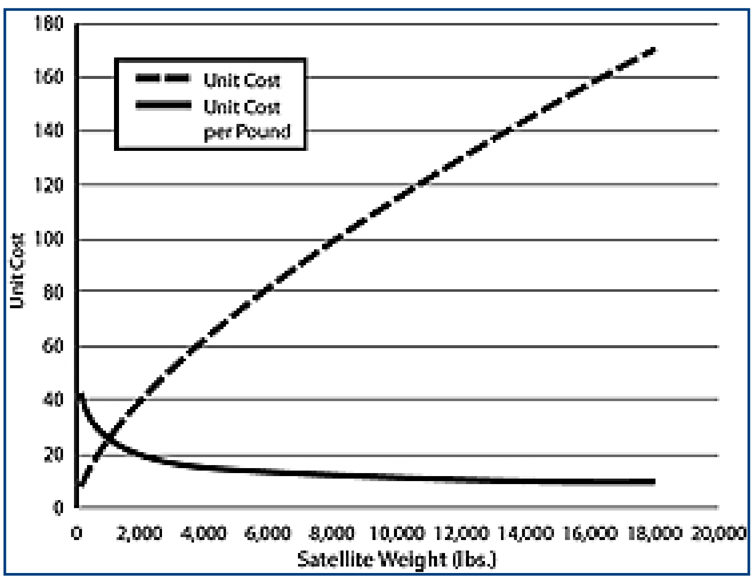


Figure 1. Satellite cost versus weight
(Graph generated through the unmanned space cost model, or USCOM.)

increases, with a simultaneous decrease in cost per pound (*see Fgure 1*). Similarly, the cost of launch was significant, but once a launch vehicle was determined, it made economic sense to maximize the system weight within the launch vehicle constraints.

In traditional war-fighting systems, the concentration of so much capability onto a single platform might not make military sense; but the lack of a direct threat to the system reduced the consequences of that decision. Plus, given the short lives of space systems (most at that time were planned to last 3-5 years), production runs were relatively large and replacement satellites could be called up in comparatively short time frames.

As the space enterprise matured, this approach continued. The evolution of the ***defense meteorological satellite program*** (**DMSP**) is instructive. The original (Block 1) satellite launched in the early 1960s weighed about 175 lbs. By the late 1990s, the Block 5 satellites had swelled to more than 2,500 lbs. Had it been completed, the replacement ***national polar orbiting environmental satellite system*** (**NPOESS**) would have weighed in at more than 5,000 lbs. Even though the cost-per-pound of such a satellite would be about one-third of the initial smaller design, the total cost would have increased by a factor of 10.

Space Begins To Blossom

As the Cold War began to thaw, space was poised for change. Space capabilities during that era had been primarily focused

An artist's rendition of a DMSP satellite orbiting Earth.

on supporting strategic warning, intelligence, and continuity of operations in the event of nuclear war. In contrast, its role in non-nuclear force enhancement was modest at best.[15] Yet today, U.S. space dominance has become a crucial element of how the United States fights wars. Our use of space capabilities has transformed over the past two decades.

The First Gulf War was labeled by then-U.S. Air Force chief of staff General *Merrill McPeak* as "the first space war."[16] Indeed, the impact of space power on the conduct of **Desert Shield/ Desert Storm** was substantial;[17] substantial enough for both space advocates and non-advocates to take notice. However, the true war-fighting impact was arguable. Precision bombing was still dependent upon laser or electronic designation (For example, in the 1991 Gulf War, 92 percent of the bombs were unguided and 8 percent were laser guided. By contrast, nearly 60 percent of the bombs dropped on Afghanistan in 2001 and 2002 were either laser or GPS guided) rather than GPS guidance;[18] imagery products, too large for broadcast through existing satellite communication (SATCOM) networks, were delivered to theater by air transport; and while DSP-detected scud launches were useful for warning troops and civilians, the information was neither timely nor accurate enough to allow "scud hunters" to find their targets.19 Space power was still in its infancy.

These facts were not lost on senior DoD and Air Force leadership. Their sentiment was best expressed by the commander of Desert Storm allied air forces and future commander of U.S. Space Command, General *Chuck Horner*: "What we have to do is change our [space] emphasis from strategic war to theater war. We have to get over the Cold War and make sure that we're equipping and training and organizing to fight the kind of war that's probably going to be thrust upon us."[20] And from his perch at **U.S. Space Command**, he had the wherewithal to make it happen. Over the next 10 years, the integration of space and theater tactical forces expanded beyond expectations. While these capabilities exercised their adolescence in Kosovo, they reached true adulthood in Operations Enduring Freedom and Iraqi Freedom.

Today, the direct combat support role of space is inarguable.[21] Without exaggeration, the combat effects we have come to expect from our smaller, more mobile force structure would not be possible without space capabilities.[22] The impact of GPS alone has fundamentally shifted the way U.S. forces locate and destroy targets, plan operations, control both material and war-fighting assets, synchronize effects, and guide both troops and remotely piloted aircraft (RPA) home. Beyond GPS, the impact of SATCOM (RPA control, direct broadcast of real-time imagery), space imagery (target location and identification), space weather (route and operations planning), and overhead persistent infrared reconnaissance (missile warning, missile defense, and battlespace awareness) have had wide-ranging impact on every element of war.

Compounding Changes—Disruptive Forces

As stated by then-Deputy Secretary of Defense *Bill Lynn*, "In less than a generation, space has fundamentally and irrevocability changed... Without [space capabilities], many of our most important military advantages evaporate."[23] In Clausewitzian terms, space has become a U.S. center of gravity,[24] a fact as apparent to our adversaries as to our own defense establishment. Thus, borrowing from their own military philosophy, "What is of supreme importance is to attack the enemy's strategy,"[25] Chinese planners set out upon an ambitious effort to hold U.S. space systems at risk; an effort that culminated with the events of January 2007 described in the prologue above.

China is not the only nation capable of threatening U.S. space capabilities. The technological capability to jam satellites is fairly simple and can be easily assembled by either individuals or nations for a fairly modest investment. Multiple reports of both state and non-state groups jamming satellites have been seen over the last decade. GPS jammers are well known and offered openly for sale on the Internet. Satellite transit times are available from several websites and can be downloaded onto smart phones.[26] While none of these threats rise to the level of an in-space ASAT test, they demonstrate how technologies once reserved for only advanced space-faring nations are now the purview of smaller states and individuals alike. The days of space chivalry are clearly numbered.

These fundamental changes—the growth of space as a tactically vital resource and the demonstration by adversaries of their intent to make space a target in both a nuclear and conventional contest—are two of the critical disruptive forces sweeping over US space strategy today. However, there are others.

Space technological strength is no longer a monopoly for American industry; multiple nations now boast a fully developed space industrial base, from satellite technologies to launch. By 2011, over 50 countries had at least one satellite in orbit;[27] they, and multiple consortia, vie for orbit positions and expansion of capabilities and can buy those capabilities from an increasing number of companies that provide space technology to the world.

The expansion of space industrial capability beyond the shores of the United States or Russia coincided with the "peace dividend" in the early 1990s; both led to a rapid consolidation of industry within the United States. The robust industrial base of the ICBM and Apollo eras that had empowered growth and competition in the space industry during the Cold War was disappearing. U.S. suppliers, especially those in the second and third tiers, came at risk due to inconsistent acquisition and production rates, long

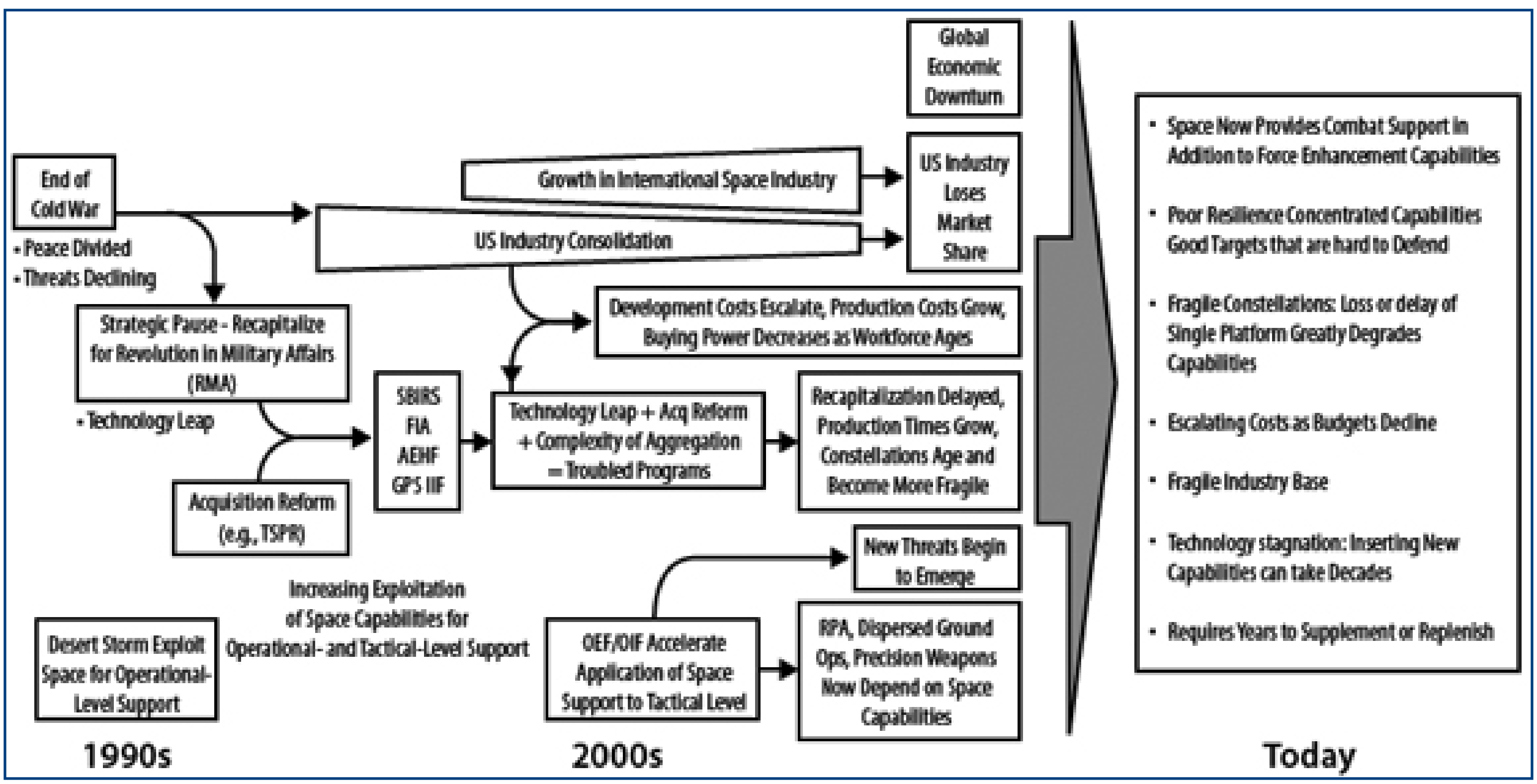


Figure 2. Evolution of today's challenges.

development cycles, consolidation of suppliers under first-tier prime contractors, and a more competitive foreign market.[28]

At the same time, industrial competitiveness waned, costs began to grow, and delivery times began to stretch. Since the mid-1990s, we have seen some of the longest delivery times for major space systems since the beginning of the space age.[29] The causes are multifaceted—higher spacecraft complexity, fewer sources of space-qualified parts, increased software complexity—and it is the continuation of a trend that started a decade before.

Higher costs were already leading to fewer satellites being ordered, each one built with greater and greater capability. As older satellites began to die, cautions were raised by many, including **STRATCOM** commander General *Kevin Chilton*, about the fragility of satellite constellations and "gap management."[30] Launch costs had also been rising for well over a decade, and the flexibility of the launch base had decreased. Driven by the critical role satellites had come to play in both nuclear and routine defense activities and the increased investment of dollars and schedule that those satellites represented, launch was becoming a "fail-safe" activity. The space business had come a long way from the days of Corona, where the first 13 missions ended in failure, to the present. *Figure 2* on the previous page provides a broad picture of how some of these forces were leading to change in the space establishment.

These forces tended to build upon one another. Shrinking constellations, rising launch costs, increasing satellite costs,

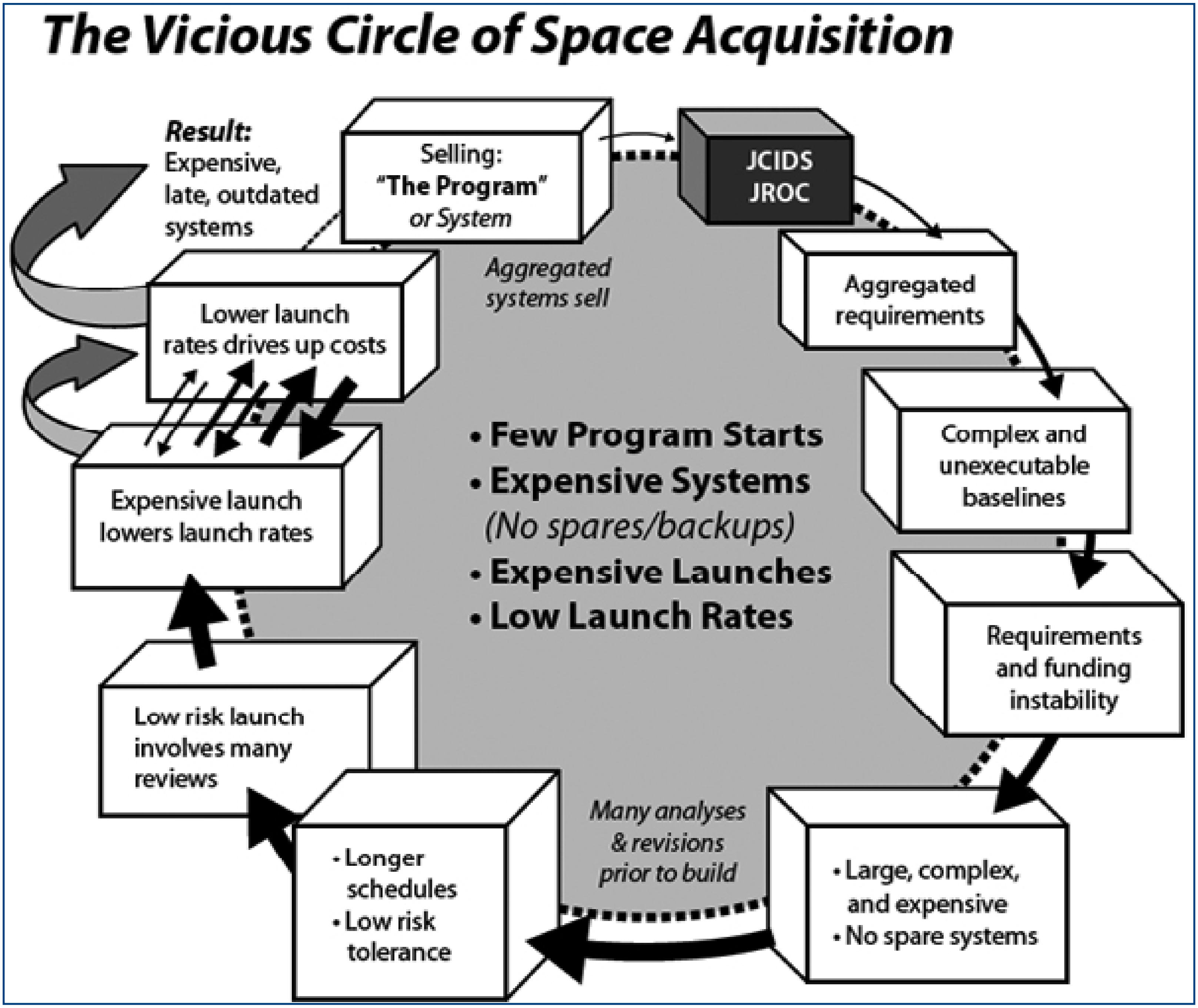


Figure 3. Space system acquisition "vicious circle" (Major General Thomas Taverney, "Resilient, Disaggregated, and Mixed Constellations," Space Review, 29 August 2011.)

greater reliance, and longer build cycles have all led to the phrase, "The vicious circle of space acquisition." While there are several illustrations of this cycle, the one developed by Major General *Tom Taverney* provides perhaps the most comprehensive view (*see Figure 3 on the previous page*).

The cycle drove multiple undesirable outcomes. One of the worst was the impact on technology risk. As constellations become more fragile, and satellite costs increase and schedules are extended, the risk of inserting new technologies into a space-system build increases. As a result, spacecraft planned for construction in the next decade are still using computer processing technology from the late 1990s when they were designed. For example, some billion dollar satellites launching in 2020 will have missed over 24 years of capability increases driven by Moore's law, or roughly 16 cycles of processing power increases. (*Moore's law states that the processing power of semiconductors doubles about every 18 months. By missing 16 cycles, the processing speeds of our future spacecraft could be more than 50,000 times less capable than they could be if technology risk did not inhibit its adoption*.) Another by-product of this cycle is an increase in ordering period between satellites. As it does, obsolescence creeps in, factories become less efficient, and any industrial learning to be garnered is lost. The result, of course, is that costs climb and the cycle spins off into a parallel spiral.

The Final Straw

The forces discussed in the preceding section represent significant changes in the industrial-dependency-threat equation under which space systems developed. The uses, importance, industrial base, cost dynamics, complexity, and competitiveness of space have all fundamentally changed from where we began; but the trajectory of system architectures did not change with them—rather, they continued on their original path. This disparity might be practical if money was no object, but unfortunately it is.

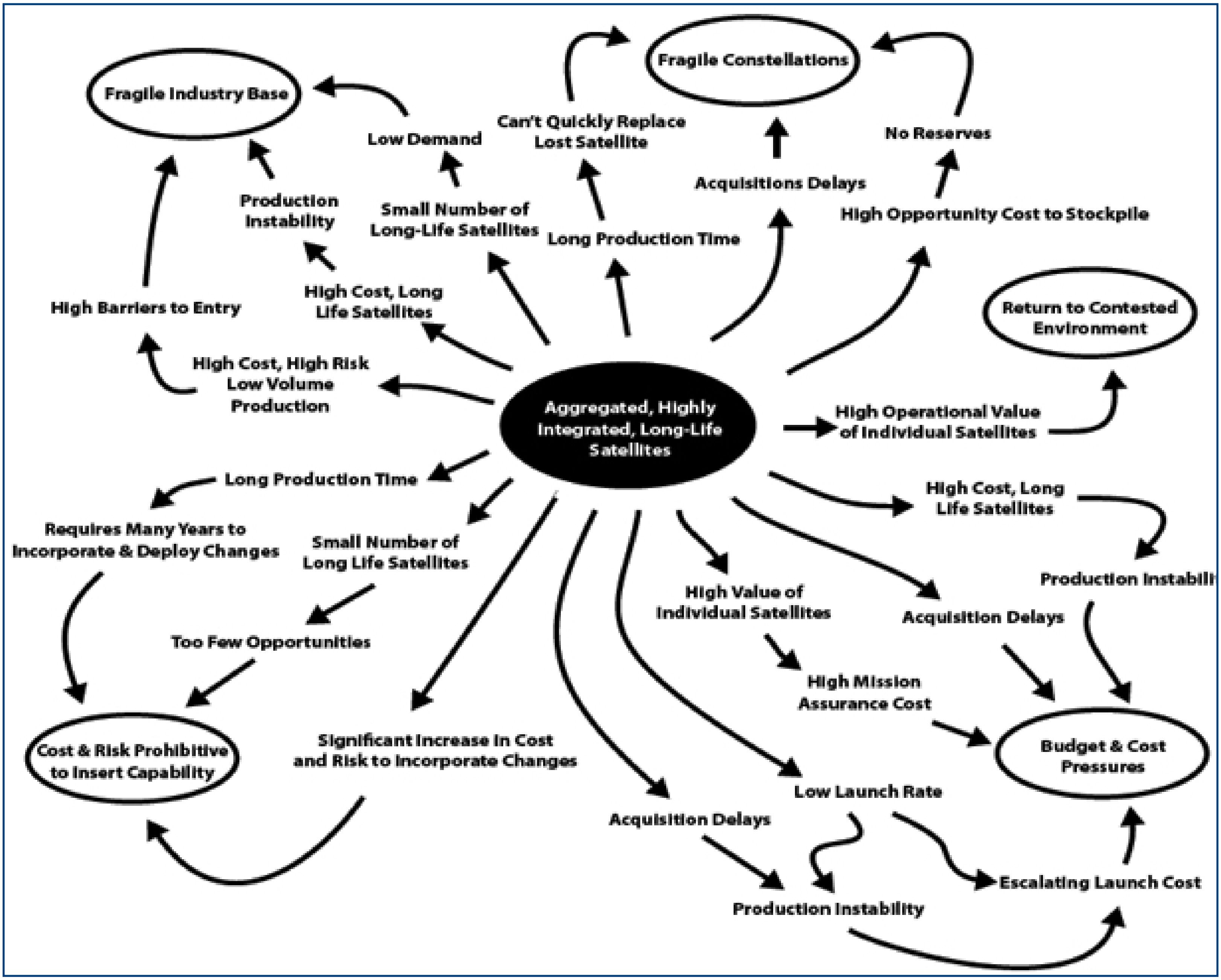


Figure 4. Effect of aggregated, highly integrated, long-life satellites

The days of unhindered spending for space superiority and technical advancement are over. At the annual *Acquisition Symposium* at the **Naval Postgraduate School** in 2009, Secretary *Gates* said:

> *Given America's difficult economic circumstances and perilous fiscal condition, military spending on things large and small can and should expect closer, harsher scrutiny. . . . The gusher has been turned off, and will stay off for a good period of time. . . . The Defense Department must take a hard look at every aspect of how it is organized, staffed, and operated—indeed, every aspect of how it does business.*

The combination of all these forces represents disruptive change in the way we approach space systems. As with the music industry discussed earlier, the changes have occurred over decades. Some, such as the Chinese ASAT attack, were acute; others, such as changes in the industrial base, evolved slowly. But the sum total is disruption of the forces that led to the path we have taken. Like the music industry, we ignore these changes and continue on that path at our own peril. A more prudent approach would be to examine the elements of these changes and try to understand if a better path exists.

Formulating Responses

Recognizing disruptive change is difficult enough—determining how to deal with it is even harder. The first step is to try to understand more clearly how the various forces combined with other elements of the system to create the challenges faced. We examined several elements including the impact of acquisition policy and reform, technology readiness, the rise of a commercial satellite market, and the competition for engineering talent. We found the most important elements were not the conditions surrounding what we build, but rather the architectures we choose to build. In *Figure 4* on the previous page, we trace the impact of building aggregated, highly integrated, long-lived satellites. The impact of that choice contributes directly to many of the challenges we discussed above. Dealing then with those challenges will require we deal with this underlying architectural issue.

Adapting to disruptive changes through an architectural response is not unique to the space industry. In the prologue, we discussed the first submarine attack during the Civil War. As noted there, Admiral Dahlgren was aware of the possibility of attack by this new submersible. In his orders to the fleet a month before, he noted:

> *I observe the ironclads are not anchored so as to be entirely clear of each other's fire if opened suddenly in the dark. This must be corrected . . . It is also advisable not to anchor in the deepest part of the channel, for by not leaving much space between the bottom of the vessel and the bottom of the channel it will be impossible for the diving torpedo to operate except on the sides, and there will be less difficulty in raising a vessel if sunk.*
>
> Order of Rear-Admiral Dahlgren, U.S. Navy, commanding South Atlantic Blockading Squadron, FLAG-STEAMER PHILADELPHIA, Off Morris Island, South Carolina, January 7, 1864.

Both these tactics involved deployment or architectural responses to the new weapon he anticipated within the limits of what he could do with the equipment he had. Of course in the century following the attack, the navies of the world adapted many more responses to this submarine threat (and to an air threat still to come) by creating naval battle groups consisting of disaggregated capabilities as opposed to the unitary battleship architecture which previously had been the rule.

A similar architectural response is demonstrated by the successful music companies of the current decade. Those successful companies (Apple, Amazon, et al.) changed the architecture of the music (and book) distribution business in response to the digital challenge brought about by the CD, Internet, and storage discussed earlier. Interestingly, this shift was not just a change in the architecture of how music was delivered but also what was delivered. The record industry had abandoned the "single" decades earlier in favor of an integrated album. By delivering songs for 99 cents each, Apple changed both how music was delivered and what was delivered. These architectural responses serve as a guide for how we might address the disruptive challenges we find ourselves facing today.

Understanding The Details

The preceding discussion is a simplification of both the historical examples as well as the current challenges in space power. In fact, we did a detailed analysis of a variety of areas to understand the root causes of these challenges to determine what responses would be most successful in addressing them.[31] Using an eight-step approach, we decomposed each of the challenges into its driving causes and then looked across all challenges to identify the causes with the greatest effects.

The primary causes found to be propelling all the challenges are shown in *Table 1*. When combined with the lessons we derived from the architectural response to the historical challenges, they provided us with guideposts to judge the adequacy of our responses.

Next, using the same eight-step process, we analyzed potential responses to each of the challenges. We decomposed all the challenges through a series of fishbone charts and examined potential responses to each. We were especially interested in

- Aggregated, concentrated architectures
- Systems vulnerable, little/no ability to deter/withstand attack
- Integrated, closed ground architectures
- High cost of launch
- Export controls limiting competition/partnering
- Space acquisition culture and processes biased toward top-down redesign and re-optimization for all new requirements

Table 1. Primary causes of disruptive challenges

determining if there were common solutions that simultaneously addressed multiple challenges. For example, when we examined the challenge of fragile constellations, we found several possible solutions including investing in protection, buying more and smaller satellites, storing spare satellites in orbit, and reducing satellite complexity. Similarly, we examined the hesitancy to adopt new technologies due to the impact on the cost and schedule of a system. Possible responses here included taking more risk, buying more and smaller satellites, investing a greater share of resources in technology maturation, and changing U.S. export controls. In both cases, we noted one common response: buying more and smaller satellites. We did this same exercise for each of the challenges enumerated in the discussions above and collected all the common potential responses, as shown in *Table 2* below.

Finally we examined whether the common responses were able to deal with the fundamental causes enumerated in *Table 1*. It was clear that by using more, smaller, and less-complex satellites, we directly addressed the issue of aggregation. Disaggregation lowered the cost of individual vehicles and the operational impact of losing a vehicle. This approach allows more tailored mission assurance and smaller launch vehicles, which reduces the cost of launch. Encouraging the development of low-cost, medium-launch vehicles can lower associated costs even further. By reducing the operational impact of losing an individual vehicle, increasing constellation size, and distributing capability, we also change the effect of an attack and make it harder for an adversary to attain his intended results. Thus, distributing capabilities becomes a foundation for changing the conditions for deterrence. Using smaller satellites, coupled with increased constellation size, requires a more continuous production rate. A production line enables lower-cost options for on-orbit sparing, ground reserves for reconstitution, and a responsive capability if a surge is needed. Finally, smaller, more distributed capability leads to a more open ground architecture, which is now required to integrate the contributions of these individual and potentially mixed families of capabilities.

While it is clear in theory the responses discussed above could address the challenges that have grown into the space enterprise, it is less than clear if they can be executed in practice. The responses will surely lead to increased resilience and help unwind the vicious circle discussed earlier. And it is clear these responses are capable of controlling cost escalation of individual satellites and launches; however, we need to establish disaggregation and production modes which are also affordable at the architectural level. Disaggregated architectures certainly provide greater resilience, more opportunity for technology integration, an enhanced industrial base with more-frequent production buys, and the means for a quick response to changes in the strategic dynamic. But are they more affordable? To understand this question, we looked at the conditions existing in the commercial space market.

Commercial Space Market

The maturity of technology and markets outside of DoD acquisition has changed substantially since the current generation of systems was developed. Historically, the national security segment dominated the global market. In terms of number of vehicles launched, the commercial and military markets reached rough parity around 2000. In 2010, the commercial market launched 50 percent more than the military segment, with growth projected to double the military market by the middle of this decade.[32] This growth and maturity have created new realities in the marketplace that provide significant new opportunities for the DoD.

First, the commercial satellite bus market is the most competitive segment of the space enterprise. This competition has driven companies to find efficiencies in parts and processes to minimize costs and time to market. The result has been to maximize the use of common bus components and modular structures, providing a core capability that enables them to configure, rather than redesign, a satellite to meet its specific mission requirements. This approach minimizes the amount of redesign required for different missions, reducing cost and production time. The result has been a consistent ability to produce satellites in 24 to 36 months, and at much lower price points than the DoD has been able to realize.[33] If our architectures can be adjusted to take advantage of this highly competitive market, we have the potential to gain substantial savings.

Second, many of the commercial and international satellites being launched today have sufficient margins to allow for a secondary, or "hosted," payload. With the large number of vehicles going to orbits compatible with DoD missions, hosted

Challenges	Common Responses
• Fragile constellations	• More, smaller, less-complex satellites
• Lack of resilience	• Mixed constellations
• Technology stagnation	• Increase constellation size
• Fragile industrial base	• Distribute capability
• Inability to quickly supplement or replenish	• Encourage low-cost medium launch
• Rising, uncontrollable cost	• Change export controls

Table 2. Common Responses to Challenges

payloads provide an opportunity to deploy capabilities at a fraction of the cost of our current systems. There are limitations we must be aware of in using this approach, such as restrictions on the ability to reposition the asset in response to contingencies. But given the global nature of our space missions, hosted payloads could provide a base level of coverage with DoD-owned satellites providing the flexible response needed.

The third opportunity in this commercial environment is the emergence of new entrants, such as **SpaceX** and **Orbital Systems**, to the medium-launch market. Both have contracts for 10-12 launches to supply the International Space Station. SpaceX is also under contract with a variety of commercial satellite vendors to support their payloads.[34] This volume is sufficient to establish the reliability and price point these vendors will require to offer medium-launch services and reintroduce competition into this segment of the launch market. While the jury is still out on these specific carriers, the handwriting on the wall is clear—the launch market is going to be more, not less, competitive in the years to come.

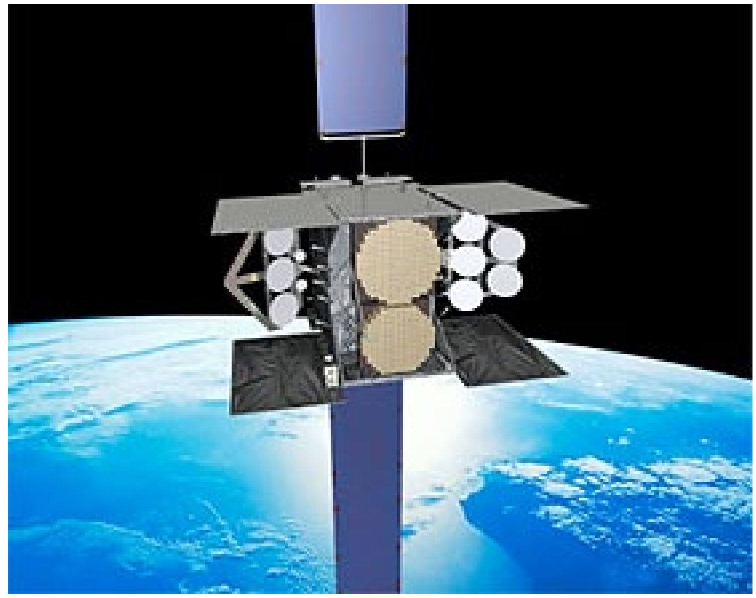
If we are to take advantage of these opportunities, the technology enablers must be in place to package our space systems to use commercial buses, hosted payloads, and smaller launch vehicles. With the exception of nuclear hardening, those enablers are already in place today. We demonstrated these enablers recently with the hosting of a *widefield-of-view* (**WFOV**) infrared sensor package aboard a commercial communications satellite launched by **SES**. The so-called *commercially hosted infrared payload* (**CHIRP**) was launched from an international launch base late last year and is now undergoing checkout on orbit.

The CHIRP demonstration showed that standard commercial bus specifications were sufficient to support the power, pointing, and stability necessary for *overhead persistent infrared* (**OPIR**) mission area sensors. We, likewise, have demonstrated

Artistic rendition of the SES-12 satellite, the CHIRP's host

off-the-shelf commercial bus capabilities can meet the core requirements needed to support DoD missions and payloads in the communications mission area. The ***wideband global SATCOM system*** (**WGS**) was developed based on commercial capabilities and is produced on a commercial production line at Boeing. Power, pointing, and stability requirements are met using commercial components.[35]

It is interesting to note that the WGS was originally the wideband gap-filler system. It was intended as a placeholder until a more ambitious (advanced wideband) satellite could be developed; later advanced wide-band was supplanted by the drive toward an even more ambitious system, the ***transformation satellite system*** (**TSAT**). Both these programs would have



Artistic rendition of WGS, courtesy of the U.S.A.F. WGS will provide high-capacity connectivity into the terrestrial portion of the Defense Information Systems Network (DISN).

represented one more run around the vicious circle with costs constraining us to a four-ball constellation. By staying with the less-complex, more easily produced WGS system, the DoD has been able to save substantial cost, and the size of the WGS constellation has grown from the originally envisioned four satellites to an inventory of 10. Given this experience, it is clear we have the ability to use a commercial bus at a lower cost to significantly reduce the time to produce and deploy capabilities

Transformational Satellite Network (TSAT)

for the war fighter, and to provide those capabilities in a more resilient mode than we have done historically.

The technology to package militarily useful capabilities small enough to be hosted, or to make use of smaller launch vehicles, was demonstrated by CHIRP. Similar small sensors from other vendors have been through ground testing. In the communications mission area, robust commercial encryption standards and components are being leveraged to define releasable, protected communications waveforms, payloads, and terminals that are smaller and less complex than our current systems. Commercial capabilities for unprotected wideband communications supporting RPAs and AISR are already in use and can be packaged as either a hosted payload or on a dedicated platform. These technologies enable options for both hosted payloads and smaller, less-complex satellites. In turn, the smaller satellites enable expanded use of medium-launch vehicles.

Taken together, these opportunities indicate there are approaches available to implement the common responses of smaller, less-complex satellites and distributed capabilities. This opportunity encourages the lower-cost medium-launch market and allows disaggregation of mission capabilities, which supports mixed constellations of small distributed capabilities complemented by the more robust, nuclear-hardened systems.

The successes of the commercial space marketplace suggest these responses can serve to reduce overall system cost.

Changing How We Buy—A Payload-Based Approach

To take advantage of opportunities and effectively and efficiently implement a distributed architectural strategy, some of our acquisition strategies will have to change. Our historic approach to designing and procuring satellites has been to optimize performance from the top down, which almost invariably results in a highly customized bus for each mission, requiring uniquely designed and manufactured components. This approach served us well when the space industry was still in the early stages of discovering what is possible for the war fighter from space. Now the industry and market have matured from building almost exclusively unique and cutting-edge technology systems to a more flexible model of commoditized capabilities and economies of scale; a payload-based approach allows us to follow them.

Continuing our top-down performance optimization approach, which drives unique requirements for things like the satellite bus, will prevent the DoD from taking advantage of the most competitive part of the space industry. It also hamstrings our ability to take advantage of hosted payload opportunities. Today's "top-down" payloads require unique support from the bus; using them as a hosted payload would require support to be added to the commercial bus, or re-engineered in the payload itself. At best, this requirement just adds cost. In most cases it prevents using the payload as a hosted capability at all because the changes in the technical baseline and schedule are unacceptable to the host, even if we are willing to pay the additional cost.

For this new strategy, we need to consider a focus shift of DoD space system development efforts more toward mission payloads. If we design a payload to provide the capability needed by the war fighter and be supported by a commercial bus, the ability to leverage both the commercial bus market and hosted payload opportunities opens up. By acquiring the mission payloads as the core element of a mission-area architecture, we can create a product with the inherent capability to fly on either a dedicated bus or as a hosted payload with minimal or no changes to the production baseline. This shift in focus would allow us to compete for procurement of a block of buses to support the next several payloads coming off the production line, mirroring current commercial practices.

Hosting payloads need no longer be a "one off" exercise requiring heroic efforts to win approval, modify products, and meet commercial timelines. It becomes an inherent part of our strategy to deploy capabilities on orbit. We can rapidly adjust to take advantage of the host opportunity by matching the timing of a payload coming off the production line to the host schedule. Overall, the time to produce and deploy a new payload can fall from the standard 7-8 years toward the commercial standard of 2-3 years. This change in time line alone will drive a significant reduction in cost.

A second aspect to consider is the amount of capability we choose to package into a single payload. While physics and technology will determine the smallest viable increment, shifting the procurement toward a greater number of smaller payloads creates additional opportunities. If there are a sufficient number of common payloads in the architecture, we can establish production lines to realize the benefits of a learning curve, reducing unit costs and risk and allowing more tailoring for the mission assurance process. This greater number of payloads also creates regular, planned technology/capability insertion points, reducing the time to deploy enhanced capabilities.

A risk to consider is whether or not we will have to compromise mission performance if we use this new strategy. Based on the technological opportunities discussed above, the risk is low for most of the DoD space-mission capabilities. (*This is not necessarily the case for intelligence community space missions. The peculiar demands of intelligence are less amenable to the disaggregated, smaller approach that appears to bear benefit for the national defense side of space. This article is not intended to discuss those issues.*) Nuclear-hardened capabilities, such as strategic missile warning and nuclear command and control, are the primary areas where we will need to proceed cautiously. These complex, nuclear-hardened systems can especially benefit from disaggregation of unrelated capabilities, such as battlespace awareness and tactical-protected MILSATCOM. Disaggregation will allow us to realize more affordable and resilient capabilities for the theater war fighter while at the same time allowing smaller, nuclear-hardened cores to be retained.

Finally, when we combine a payload-focused acquisition strategy with the distributed architecture strategy we can see a path to unwinding the vicious circle facing today's space acquisitions. Such an approach:

- Reduces complexity, allowing for more predictable and executable program baselines
- Stabilizes requirements by providing a predictable process for capability insertion
- Reduces operational and economic consequences of losing a vehicle, allowing for a more tailored and less-costly risk management, vice risk avoidance, mission assurance approach
- Establishes a consistent replenishment cycle, stabilizing satellite and launch vehicle production lines and creating the opportunity for affordable on-orbit and ground spares
- Creates more numerous launch and deployment (hosting) opportunities, reducing the cost of getting to space
- Complicates any adversary's calculus of its surety of ability to deny the advantages of space for an extended period of conflict

It is interesting to note at least one satellite system has followed this architectural and procurement approach from its beginning. GPS is a distributed, disaggregated assemblage of individual payloads, none of which can do its job individually. But taken together, they form a robust, affordable, and resilient architecture, which has an established production line with routine insertions of new technology.36 The GPS III system has also adopted a payload approach, as indicated above, that uses a nearly off-theshelf commercial bus paired to a purpose-built navigation payload.[37]

Transition—Taking The Next Steps

These new strategies cannot be implemented instantaneously, nor do they need to be. Our current space systems, highly capable and the most technologically sophisticated in the world, are serving us well. However, we must begin to move in a new direction if we are to address the disruptive changes discussed above. To begin this shift we need to choose to go against the status quo and undertake the following:

- Define alternative architectures to provide passive resilience and enable protection in depth. Allow mixed architectures that leverage government, commercial, and international opportunities.
- Demonstrate a path through early prototyping and on-orbit demonstration.
- Begin the shift to smaller, distributed, diverse constellations.
- Curtail current productions once a new capability is demonstrated and secure

This plan establishes a path to enable migration to a mixed architecture over the next 10-15 years. We have taken the first steps along this new path. We have examined the options and opportunities for increasing resilience and affordability in several of our mission-area architectures using the tenets established above. The most mature evaluations are in the OPIR and MILSATCOM mission areas.

OPIR

Figure 5 shows some of the future architectural options considered for the OPIR mission area and the assessment of how well those architectural options would meet our goals of delivering the required war-fighting capability while increasing the resiliency and affordability of the capability. The criterion used to assess the architectural option against those goals is shown in each respective box. The assessment concluded all the options could meet the capability requirements, but continuing with the status quo architecture (aggregated clones) or evolving the current platform could not meet the resilience or affordability criteria.

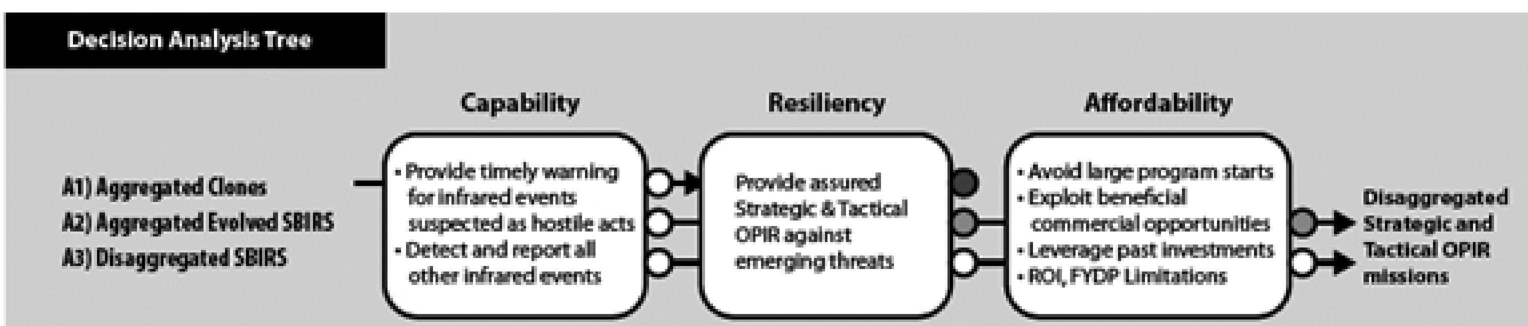


Figure 5. OPIR architecture decision analysis tree

Therefore, a disaggregated approach to the OPIR mission area splitting strategic and tactical missions into separate payloads which can be flown on a variety of platforms, such as the legacy platform (but now dedicated to strategic warning), a dedicated, small, commercial bus, or a commercial, international, or other U.S. government host is required.[38]

Development of a low-cost WFOV staring-sensor payload for tactical missions offers opportunities for significantly lower cost and risk as well as increasing overall resilience by proliferating capabilities across multiple platforms.[39] Strategic warning remains healthy and is less costly due to a smaller strategic-warning payload and significantly reduced complexity and weight.[40] This approach also enables incremental deployment of tactical capabilities to augment current capabilities and gain operational confidence in how to best employ the capability. By conducting an operational demonstration of this capability based on leveraging the technology and experience gained through the CHIRP experiment, we will have the information needed to understand the costs and risks associated with a mixed architecture before needing to make a disaggregation decision on the next production increment of the ***SBIRS*** program (Vehicles 7 and 8).

MILSATCOM

Figure 6 below shows the future architectural options considered for the MILSATCOM mission area for both the contested/nuclear and benign operational environments. In the case of protected MILSATCOM, there is currently a significant shortfall in capability. The current protected communication capability must grow by a factor of 10 or more to support the full tactical protected requirement. Also, due to the high-grade cryptography employed, the current capability cannot be used to support lower-echelon units or RPAs where there is a likelihood of equipment capture and exploitation. As with OPIR, we assessed how well the alternative architectural options would meet our goals of delivering the required war-fighting capability while increasing the resiliency and afford-ability of the capability.

The assessment concluded the status quo would not be capable of meeting the required future capability. Evolving the current capability could meet the future capability requirement but with only a limited increase in resiliency and at very high cost. Disaggregating strategic and tactical protected communications enables smaller, lighter, less-expensive payloads for both services. This disaggregation creates the option for a simpler tactical protected capability using releasable cryptography supporting lower-echelon units, RPAs, and allies; it can be provided with much lower cost and risk. It also enables incrementally deploying the tactical protected capability more frequently and in smaller increments, decreasing the impact of delays or unexpected loss of a satellite, and offering a wider variety of deployment options such as hosting the tactical protected payloads or packaging them on a small commercial bus and more responsive, lower-cost launch vehicle.

Capabilities for the benign communications environment were also assessed. As in the contested environment, there is a growing shortfall in basic capacity and in the specialized support needed for long track airborne ISR platforms. Current programs were not sized to address this requirement, so some modification is necessary. Today's capabilities are largely based on commercial capabilities, the primary difference being the use of communication frequencies reserved for the military; however, they are still concentrated in a small number of platforms. In this area we have already achieved some level of distributed capability between dedicated wideband MILSATCOM platforms and widespread use of leased commercial SATCOM services. To provide the needed capabilities and increase resilience with an affordable solution, we concluded diversifying the wideband SATCOM capability is the best approach. We should continue investments to reduce the cost of our military wideband backbone, augment that capability with hosted payloads and international partnerships, and pursue innovative business strategies with commercial providers, which will enable wider and more-flexible access to commercial SATCOM capabilities.

Conclusions

Having looked at the disruptive changes and challenges facing the United States today in space, we formulated responses to those changes, explored the new opportunities enabling implementation of those responses, and developed a new strategy to allow the DoD to mitigate the challenges (see Table 3). From this study we conclude the best means available to affordably provide resilient space capabilities the war fighter can depend upon and adapt as

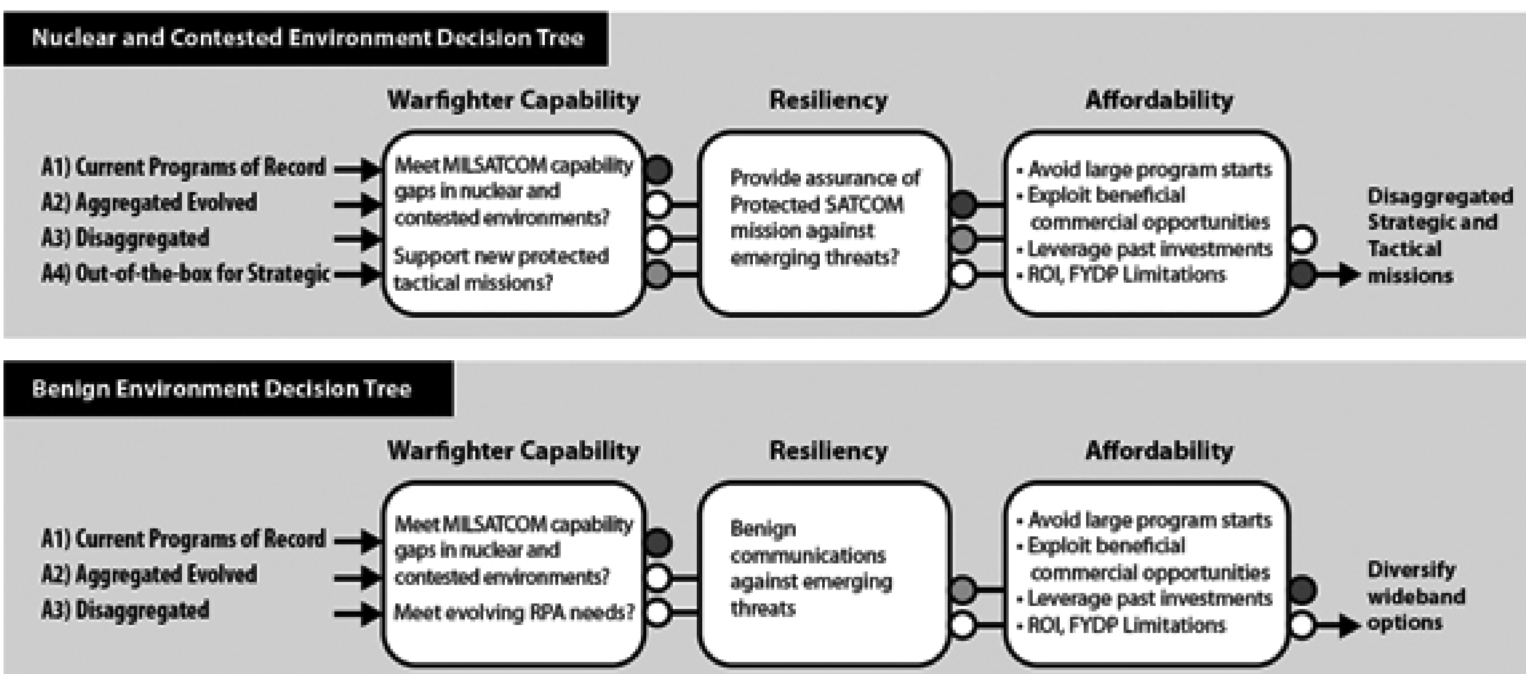


Figure 6. MILSATCOM alternative architectures decision analysis tree

mission needs evolve is to use a distributed architecture strategy coupled with a payload-focused acquisition strategy that will:

- Focus government development on mission payloads designed to be supported by commercial bus capabilities,
- Create stable payload production rates,
- Leverage the highly competitive commercial satellite bus market, and
- Leverage hosted payloads on commercial, international, and allied platforms

Challenges	New Strategy
• Poor Resilience—concentrated capabilities are good targets that are hard to defend	• Distributed architecture disperses capability across multiple hosts and smaller platforms, complicating adversary targeting and making it harder to sustain effects
• Fragile Constellations—loss or delay of single platform greatly degrades capabilities	• Distributed architecture is less dependent on individual platforms; more frequent deployment of smaller increments of capability reduces impacts of delay
• Escalating costs as budgets decline	• Costs controlled or reduced through reduced complexity, leveraging highly competitive commercial bus market and hosted payloads, stable production, and more frequent launch to drive down costs through learning curve and other efficiencies
• Fragile industry base	• Stabilize lower-tier suppliers through stable production and launch; focuses development resources on maintaining intellectual capital needed for unique military capabilities
• Technology Stagnation—inserting new capabilities can take decades	• Consistent and frequent technology insertion opportunities due to lower procurement risk; mirror commercial time to market of three years or less
• Requires years to supplement or replenish	• Affordably establish on-orbit reserves through smaller, less-complex satellites and hosted payloads; also enables affordable ground reserves and ability to surge production through a stable production line. More frequent launch and expanded number of launch providers enhances the capability to surge launch if needed

Table 3. Resolution to Challenges

This approach greatly enhances the resiliency of our space capabilities. By increasing the number of platforms and dispersing our capabilities, we reduce the impact on the war fighter if a satellite is lost to mishap or hostile action. By reducing the cost of each platform, we can affordably create on-orbit reserves for rapid recovery and ground reserves for timely reconstitution. We also have determined this strategy will enhance the affordability of our space capabilities. The distributed architecture strategy looks at the entire architecture cost to determine the best trade between capabilities on individual satellites and overall architecture cost. The cost of higher quantities are offset by savings from hosting, continuous production lines, commercial bus procurements, smaller and less-complex satellites, more-frequent and lower-cost launch, and a more tailored approach to mission assurance. To achieve this goal, it is essential we implement the architectural, business, and budgeting practices to enable the DoD to create sufficient volume so we can access and realize the economies of scale we are seeing in other segments of the space marketplace.

We should also note the new strategy can form the basis of a different framework for deterrence. By using greater numbers of smaller platforms, orbital diversity, rapid recovery, reconstitution options, and international partnering, we increase the complexity of a potential adversary's attack calculus. Such a strategy imposes higher force-structure requirements, more-complex targeting and demanding situational awareness, greater risk of collateral damage, difficulty in sustaining desired effects, and the risk of entangling other parties in the conflict.

With these elements we will have taken the first substantive steps to addressing the disruptive changes that could otherwise lead to a diminution of the critical advantages space forces confer on our war-fighting capabilities today. The early airpower strategist *Giulio Douhet* said, "Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur."[41] The U.S. Navy enjoyed victory in naval conflict by recognizing submarine warfare had created a disruptive change in the character of war. Major record labels, failing to recognize the disruptive influence of file sharing and digital media and adapt their systems before those changes occurred, began a long, slow decline in stature while digital-ready adversaries such as Apple and Amazon were poised to take their place.

A system's evolutionary path stays relevant only if the environment that spawned it remains static; but disruptive forces require those paths to be reevaluated. The disruptive forces that drive the need for change to our space architectural strategy are already evident. The means are available, and we have defined a way to adopt them. Space is too important to the national security of our nation for us not to adapt until after change is upon us.

Notes

1 Bern Anderson, By Sea and By River: The Naval History of the Civil War (1962; reprint, New York: Da Capo Press, 1989), 34.

2 Official Records of the Union and Confederate Navies in the War of the Rebellion, series 1, vol. 15 (Washington: Government Printing Office, 1921), 226-27.

3 Ashley Tellis, "China's Military Space Strategy," Survival 49, no. 3 (September 2007): 41.

4 Ibid., 45.

5 "Space to Manoeuvre—Satellite Attack Upsets US Space Supremacy," Jane's Intelligence Review, 7 February 2007.

6 Scott Karp, "Music Recording Industry Will Be First Traditional Media Industry to Be Utterly Destroyed by Digital Technology," Publishing 2.0, 28 December 2007.

7 "And 25 Years Ago Philips Introduced the CD," GeekZone, 1 November 2008.

8 The work reported here is an outgrowth of a think-tank study commissioned in 2010. Contributors to that study include retired general officers Lt Gen Mike Hamel, Maj Gen Tom Taverney, Maj Gen Ken Israel, Brig Gen Jim Armor, Brig Gen Tip Osterthaler, and Brig Gen Len Kwiatkowski; then-Brig Gens Jay Santee and John Hyten, then-RADM Liz Young, Dr. Pete Rustan, Gil Klinger, Joe Rouge, CEO of Orbital Space Systems Dave Thompson, President of Microcosm Dr. Jim Wertz, and author Doug Loverro. Also, a great debt is owed to Tom Cristler and Toni Arnold who led most of the analysis and did all of the writing for the white paper.

9 See Alexei Arbatov, "Russian Perspectives on Spacepower," in Toward a Theory of Space-power (Washington: NDU press, 2007), chap. 23. As stated there, "In 1957, the Union of Soviet Socialist Republics (USSR) was the first nation in the history of the world to put a satellite in space, and in 1961 it followed with the first manned space flight. During the Cold War, Soviet space power was second to none—in some respects behind and in others ahead of that of the United States."

10 Gen Thomas S. Moorman Jr. (ret.), speech at American Institute of Aeronautics and Astronomy (AIAA) Space 2007 Conference and Exposition, 21 September 2007, Long Beach, CA.

11 Curtis Peebles, High Frontier: The United States Air Force and the Military Space Program (Washington: Air Force History and Museums Program, 1997), 15-26.

12 Ibid., 13.

13 Dana J. Johnson et al., Space: Emerging Options for National Power (Santa Monica, CA: RAND, 1998), 38.

14 In the strange calculus of space technology, designing a satellite to survive a non-direct nuclear attack was more straightforward than designing a system that could hold up against nonnuclear mechanisms, since many aspects of a nuclear attack were already accounted for by designing the satellite for extended stay in its natural radiation environment. For example, under natural background radiation conditions in LEO, peak flux for electrons with energy greater than 1 MeV ranges from 10^4 for the outer radiation belt to 10^6 for the inner. Enhanced solar flux is said to have resulted in >1 MeV electron flux to reach 10^8 particles/sq cm sec. Coincidentally, this is the same magnitude computed by the model due to a high-altitude nuclear explosion one day after the burst over Korea. Source: Defense Threat Reduction Agency, High Altitude Nuclear Detonations against Low Earth Orbit Satellites ("HALEOS"), DTRA Advanced Systems and Concepts Office, April 2001, 12.

15 Space-force enhancement is defined as "force-multiplying capabilities delivered from space systems to improve the effectiveness of military forces as well as support other intelligence, civil, and commercial users." JP 1-02, DoD Dictionary of Military and Associated Terms, 8 November 2010 (as amended through 15 October 2011), 312, http://www.dtic.mil.

16 Craig Covault, "Desert Storm Reinforces Military Space Directions," Aviation Week and Space Technology, 8 April 1991, 42.

17 Steven J. Bruger, Not Ready for the "First Space War" What About the Second? Naval War College student papers, 17 May 1993.

18 Ensuring America's Space Security, Report of the Federation of American Scientists Panel on Weapons in Space, September 2004, 12.

19 Gulf War Air Power Survey, Vol. 2, pt. 1 (Washington: GPO, 1993), 189.

20 Bruger, Not Ready for the "First Space War," 21.

21 Combat support is defined as "operational assistance provided to combat elements." JP 1-02, 60.

22 General William Shelton, "The Foundational Role Space and Cyber Play in our Nation's Defense," Global Warfare Symposium, 17 November 2011, Los Angeles, CA, 8-9.

23 William J. Lynn, "A Military Strategy for the New Space Environment," Washington Quarterly 34, no. 3 (Summer 2011): 8.

24 The concept of a military "center of gravity" was first proposed by Carl von Clausewitz in On War. It is defined in JP 1-02 as, "the source of power that provides moral or physical strength, freedom of action, or will to act."

25 Sun Tzu, The Art of War, trans. by Samuel Griffith (London: Oxford University Press, 1971), 77.

26 "Satellite transit" describes the passage of a satellite, normally in low-Earth orbit, overhead. Knowledge of transit times allows individuals to hide their activities from unwanted surveillance.

27 Mike Orcutt, "Space Over Time," Technology Review, 23 July 2011.

28 National Security Space Strategy: Unclassified Summary (Washington: DoD, January 2011), 3.

29 For example, both the space-based infrared satellite and the GPS IIF satellite took over 14 years from contract award to delivery. Other systems (NPOESS, JWST, AEHF) saw similar delays or were even cancelled.

30 General Kevin Chilton, "Commander's Perspective," speech to the 2009 Strategic Space Symposium, 3 November 2009.

31 Douglas Loverro, "Reinventing Space 2011: The Changing Dynamics of Space Power," May 2011, presentation at the Reinventing Space conference, May 2011, Los Angeles, CA, 23.

32 "Toc-satellites-to-be-built-launched-by-2019.29," Euroconsult, http://www.euroconsult-ec.com.

33 Futron Corporation, Satellite Manufacturing: Production Cycles and Time to Market, May 2004, 2, http://www.futron.com/upload/wysiwyg/Resources/Whitepapers/Satellite_Manufacturing _Production_Cycles_0504.pdf.

34 SpaceX has a launch manifest of over 40 launches, including the station resupply and the Iridium constellation, plus multiple other customers. Orbital Space Systems is still in the process of securing its own launch market.

35 The WGS satellite is based on the Boeing 702HP bus. See http://www.boeing.com/defense-space/space/bss/factsheets/702/wgs/wgs_factsheet.html). This is a common platform configured to support multiple commercial communications satellites including PanAmSat, INMARSAT-5, MEXSAT and others. See http://www.boeing.com/defense-space/space/bss /factsheets/702/702fleet.html.

36 GPS modernization was made possible because we found ourselves in the late 1990s with a robust on-orbit constellation and a large number of spare satellites on the ground. We were able to spiral in new technology with the IIR-M satellites (M-code and a second civil signal), provide more in GPS IIF (aviation signal, L5), plus the change to flexible power for both systems. GPS III is being laid out in a similar fashion with routine insertion of technology into an ongoing production line and each satellite simple and inexpensive enough that the risk of insertion remains low.

37 The Lockheed A2100 bus is the basis for the GPS III system, but with hardening appropriate for the medium earth orbit (MEO) in which it flies.

38 Lieutenant General Ellen Pawlikowski, "AF Space Portfolio Future Architectures," briefing to secretary of the Air Force, 24 October 2011.

39 John "Pete" Peterson and Jim Bui, "Overhead Persistent Infra-Red (OPIR) Architecture Study," DoD Executive Agent for Space, 17 June 2011.

40 "Space Modernization Initiative Alternatives Analysis," SMC/IS, 1 November 2011. The analysis used the current CAPE ICE SBIRS GEO 3/4 cost estimate as the basis for disaggregation with the following assumptions: (a) costs up to launch, no launch costs considered; (b) GEO 3 NRE and GEO 4 production article; (c) future costs indexed to inflation; and (d) for a disaggregated GEO, assume single scanner sensor and no staring sensor. Based on these assumptions, initial cost estimates show a 20-percent savings for a single scanner satellite needed to support strategic warning mission.

41 Giulio Douhet, The Command of the Air, trans. Dino Ferrari (1942; reprint, Washington: Office of the Air Force History, 1983).

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Industry Expansion, Exploration, Entrepreneurism Is On The Move

by Elliot Holokauahi Pulham, Chief Executive Officer, Space Foundation

If there's one thing this spring season has demonstrated, it is the fact that our space industry, around the world, has more of the "Right Stuff" than ever before. Consider, for a moment, our recently completed 28th National Space Symposium.

Despite the fact that U.S. government spending on space is flat or declining and that core Space Foundation member companies focused on government contracting are undergoing extreme stress, our 2012 Symposium was the biggest and best ever—growing by 10 percent in key areas and with attendance as strong as ever. That is a real testament to the resilience of the global space community and a real-as-it-gets demonstration of the growth that is taking place in the commercial space sector and among non-U.S. space agencies.

While business-to-business transactions and informative dialog with government customers has always been the hallmark of the Space Symposium, our just-completed event has generated the strongest customer feedback yet. "The most successful trade show we've ever participated in," and "our best and most productive Symposium ever" are typical of the comments that our corporate member companies, exhibitors and sponsors have shared with me. This year, we were able to accommodate 42 new exhibiting organizations, and many have already contracted for larger exhibit spaces for next year.

Our Space Foundation mission; To advance space-related endeavors to Inspire, Enable and Propel Humanity, has also benefitted from this "can do" attitude on the part of the global space community. I was thrilled to be able to announce at the Symposium a major contribution from Northrop Grumman, which will be used to establish the Northrop Grumman Science Center featuring Science on a Sphere™, at Space Foundation World Headquarters in Colorado Springs, Colorado. The Northrop Grumman Science Center will include a space and Earth systems instructional laboratory complete with the amazing Science on a Sphere™, developed by researchers at NOAA.

These important additions to our headquarters are giving us a real jump-start on our plans to create a world class space visitors center in Colorado Springs. If you think about it, Colorado Springs is probably the largest and most important "space city" in the world to NOT have a space visitors center of some kind. Thanks to the generous support of companies and organizations such as Northrop Grumman, we are well on our way to addressing that deficiency.

Other companies and organizations are donating equipment, mockups, models and money toward the effort, which will create a visitors' center serving an estimated 625,000 Pikes Peak area residents, five military bases and more than six million visitors per year. (Our county, El Paso County, has now surpassed Denver County as Colorado's most populous.) During the Space Symposium, we were also able to announce the loan of several Soviet-era space artifacts from the Kansas Cosmosphere, with additional announcements expected in the near future. (That's me in the picture checking out the Luna 16 Probe model.)

And there's a lot more going on these days that certainly qualifies as the "Right Stuff" from our industry partners.

As I write this missive, a SpaceX Dragon capsule mated to its Falcon 9 launch vehicle is counting down toward a historic mission to become the first commercial company to fly a spacecraft to the International Space Station, dock, transfer cargo, and return. Hot on the heels of this mission, Orbital Sciences prepares to conduct the first test flight of its Antares launch vehicle, to be followed by a similar test flight of its Cygnus capsule. And up the

General Shelton, Commander, U.S.A.F. Space Command, offers his presentation to NSS attende–es.

road from Space Foundation headquarters, Sierra Nevada Corp. nears completion of the first flight test vehicle in its Dreamchaser family of reusable commercial crew vehicles.

Meanwhile, development and test of the Orion crew capsule by Lockheed Martin continues on schedule, with an eye toward an ambitious first flight test in 2014, while The Boeing Company has been conducting a series of progressively more challenging parachute and landing tests of its CTS-100 crew and cargo spacecraft.

And, as if that weren't all enough, a company called Stratolaunch Systems was recently formed by aerospace and technology pioneers Burt Rutan, Paul Allen and Elon Musk—to apply the carrier-craft architecture of the SpaceShipTwo/Virgin Galactic System to the orbital payload delivery business. Not to be outdone, XPrize visionary Peter Diamandis, and space tourism pioneer Eric Anderson of Space Adventures, announced only a week after the Symposium the formation of a new company that plans to make money by mining asteroids.

Our friends at Arianespace have two Ariane 5 heavy lift launch vehicles in preparation for missions May 15 and June 19, both with dual satellite payloads. United Launch Alliance is set to boost the AEHF-2 satellite atop an Atlas V on May 3. JAXA has a dual-payload mission set to launch atop an HIIA on May 18. Sea Launch will be orbiting Intelsat 19 this month. ILS just completed a successful Proton launch for Yahsat, its third Proton launch of the year, and ISRO successfully orbited a Radar Imaging Satellite (RISAT-1) just last week.

Fresh from bringing its Beidou satellite navigation constellation to 13 satellites with a dual manifest launch April 30, China is expected to launch its next manned space mission this summer—one that is expected to see a taikonaut crew dock with the Taingong-1 space station module. Meanwhile, Russian cosmonauts Gennady Padalka and Sergei Revin and NASA astronaut Joseph Acaba have passed all their preflight exams and are set to blast off to the International Space Station mid-month.

And all this stuff—the "Right Stuff," to be sure—is just the tip of the iceberg. With commercial satellite services growing worldwide, GPS systems and applications becoming the critical infrastructure of modern life, and vehicles, engines, satellites and systems in development all over the planet, the global space community is charging hot on the heels of the record growth rate of 12.2 percent set in 2011.

From educational programs on Earth to hotels in space—the View From Here is that this industry has the "Right Stuff" to make it happen!