

# MilsatMagazine

THE MILITARY MARKET



## PRIORITY BRIEFINGS WITH:

- » GENERAL MICHAEL HAMEL
- » BRIGADIER GENERAL ELLEN M. PAWLIKOWSKI
- » GENERAL JAMES ARMOR (RET.)

## MILSATMAGAZINE MAY 2008

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*Lt. Gen. Michael Hamel officially retires from his posting as the Commander of Space & Missile Systems Center (SMC) on July 1, 2008. We discuss the history and future of SMC as well as the General's distinguished career.*



#### 10 Brigadier General Ellen M. Pawlikowski - Vice Commander, Space and Missile Sys- tems Center, Los Angeles AFB, El Segundo, CA

*On July 7<sup>th</sup> of 2007, Gen. Pawlikowski was assigned to the SMC as the Vice Commander. During MilsatMagazine's opportunity to speak with the Commander of SMC, Lt. Gen. Hamel, Gen. Pawlikowski also made herself available to our publication to give answer some questions as well as give our readers some insight into her U.S. Air Force career and her opportunities with SMC.*



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*Excerpted from the Department of Defense's Missile Defense Agency's STSS Fact Sheet and their BMDS Booklet entitled "Missile Defense—Worldwide" The United States has come a long way since President Ronald Reagan first delivered his challenge to the defense community 25 years ago—to develop antiballistic missile technologies to improve our national security and lessen our reliance on nuclear deterrence.*



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# PRIORITY BRIEFING

## GENERAL MICHAEL HAMEL

COMMANDER, SPACE & MISSILE COMMAND, LOS ANGELES AFB, EL SEGUNDO, CA

### *MilsatMagazine*

General Hamel, your career in the U.S.

*Air Force has been an exemplary example of leadership and innovation. As you approach your retirement, would you care to pass along to our readers some of the history of those watershed events for which you have become so well known? What do you consider to be the missions with the most impact within the U.S. Air Force during your career in milsatcom?*



### *General Hamel*

During my 36 years in the United State Air Force, I have had the very good fortune to work on a fascinating array of military space programs and duties; from development, to launch, to on-orbit operations, to intelligence, to command and national policy levels. In each job, I've had the opportunity to work on leading edge efforts in; the National Reconnaissance Office, integrating and launching DoD (Department of Defense) payloads on the Space Shuttle, building capabilities critical to preserving peace and winning our nation's wars. I commanded the Air Force's Space Operations after 9/11, and now lead Air Force Space Development as we deliver the next generation of space capabilities that will shape our military operations and national security for decades to come.



### *MilsatMagazine*

*Your work at SMC has lead to an amazing record of successful launches. Would you highlight the events you feel are the most significant, in as far as being true assets to our warfighters?*



*The Schriever Space Complex is home to the Air Force's Space and Missile Systems Center*

### *General Hamel*

Air Force Space Command and SMC are proud of our record of 58 consecutive successful major operational launches. To select which of those launches are the most significant is difficult, as each one was extremely important, and all are contributing every day to our warfighters.

Ushering in the EELV (Evolved Expendable Launch Vehicle) families of Atlas V and Delta IV has been a major accomplishment. The vehicles are proving to be a reliable means in which to ensure the United States' access to space in the future, and, in turn, will guarantee our warfighters have the space assets on orbit they have come to depend upon to accomplish their mission. Without Atlas V and Delta IV, our country's access to space would be limited, and potentially dependent, upon other nations to launch some of our critical space assets.



*This was the first Atlas V launched from Vandenberg and the west coast, as well as the first launch of the year. This milestone for Team Vandenberg is the product of the combined efforts of the 30th Space Wing, the National Reconnaissance Office, United Launch Alliance, the Space and Missile Systems Center, the Aerospace Corporation and more. SLC 3 was significantly modified to get ready for the next generation of space launch vehicles.*

**(U.S. Air Force photo/Joe Davila)**

### *MilsatMagazine*

*Your command's budget is most impressive, and the number of military and civilian personnel you manage is a staggering number. How do you handle the scope of your position, as far as command is concerned? What are the lessons you have learned and wish to pass along to your successor in regard to being successful in this critical endeavor?*

### *General Hamel*

This may sound cliché, but I have to give a great deal of credit to the men and women as well as the leadership team of the Space & Missile Systems Center. The space professionals under my command amaze me everyday with their dedication and devotion to their mission to develop, acquire, field, and sustain the world's best space and missile capabilities for the joint warfighter and the nation. Further, the role the Aero-

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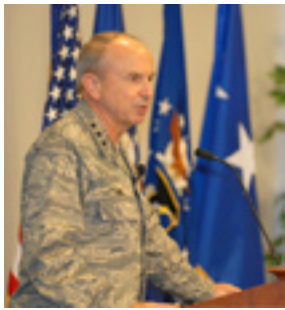
space Corporation plays in providing technical and engineering support to the center is indispensable. I rely on every one of them to be able to do my job.

## *MilsatMagazine*

*Would you be kind enough to offer us a look at your history in the U.S. Air Force?*

## *General Hamel*

I was commissioned a Second Lieutenant through the U.S. Air Force Academy in June 1972, where I earned a Bachelor of Science degree in Aeronautical Engineering. After attaining my degree, I was sent off to be a Staff Development Planner at the then Los Angeles Air Force Station, the first of my many assignments here.



My career includes responsibilities in a variety of command, acquisition, operations, and policy positions involving space, system development, intelligence, space operations, and launch. I have served in senior staff positions at Headquarters U.S. Air Force and Air Force Space Command, and was

Vice President Gore's military adviser on defense, nonproliferation, and space policy.

Prior to my current position, I commanded the 14th Air Force "Flying Tigers", and was responsible for all U.S. Air Force space forces and operations, as well as the execution of assigned U.S. Strategic Command's space operations.

## *MilsatMagazine*

*The latest Global Positioning System IIR-19(M) was recently launched... what are the advantages of the new system over its predecessor, and how will the new GPS system perform in relation to the Russian, Indian, and European navigation systems? Was the inclusion of the civilian component planned from the start? How will the process work?*

## *General Hamel*

The Block IIR(M) modernized GPS satellites offer advantages over previous Block IIA/IIR satellites in



*The fourth modernized CPS-11R-17(M) satellite launch from Cape Canaveral AFS aboard a Delta II rocket*

**Photo: United Launch Alliance—Carleton Bailie**

terms of new signals and improved accuracy. In addition to the Block IIA/IIR civil signal (L1 C/A) and military signals (L1 P(Y) & L2 P(Y)), each of the eight Block IIR(M) modernized GPS satellites will broadcast a second civil signal (L2C) and two additional military signals (L1M & L2M). GPS receivers that process dual frequency signals, whether civil or military, gain a significant accuracy improvement by removing the ionospheric error that results as satellite signals pass through the ionosphere. New military signals are less vulnerable than P(Y). All receivers will benefit from superior clock performance associated with the newer satellites.

GPS technical experts have worked with the U.S. Department of State to proactively engage other global satellite navigation system (GNSS) designers to ensure their radio frequency compatibility and interoperability with GPS. As a result, GPS and Galileo will have a high level of interoperability with the new GPS L1C civil signal that will be



broadcast from GPS Block III satellites. Thanks to a common design effort, the GPS L1C signal has an identical frequency spectrum with that of the Galileo E1 open service (E1OS) signal. As a result, a common GPS-Galileo signal will be broadcast from both constellations. GPS experts have also worked with Japan's Quasi-Zenith Satellite System (QZSS) to achieve a high level of interoperability such that QZSS will broadcast GPS-compatible signals (L1C, L2C, and L5). Likewise, GPS has worked diligently with other GNSS developers to obtain similar levels of compatibility and interoperability.

Yes, GPS has planned to broadcast the L2C civil signal ever since the Block IIR modernization contract was awarded in August 2000.

### *MilsatMagazine*

*What are your thoughts regarding the civilian sector, rather than the U.S. Air Force, now being the driver of government policy when it comes to the joint military and civilian control of GPS, as seems to be indicated within a new Department of Defense (DoD) directive? The new and "firmer" voice in such dealings appears to be the Department of Transportation in the February 19th published PNT directive. The directive seems to indicate that the U.S.A.F. has given up whatever control they may have possessed within this arena, but we do not know what they may have acquired by surrendering such control in a balance of power exchange. How do you see this change?*

## *General Hamel*

The new Department of Defense Directive on Positioning, Navigation, and Timing (PNT) (i.e., DoDD 4650.05, dated 19 Feb 08) is a straightforward update of the previous DoDD 4650.5, dated 2 Jun 03. The new DoDD 4650.05 incorporates national-level changes over the past five years related to PNT policy and governance. Most notably, the previous Presidential Decision Directive (PDD/NSTC-6) on U.S. Global Positioning System Policy, dated 28 Mar 96, was updated with the new National Security Policy Directive (NSPD) on U.S. Space Based PNT Policy, dated 8 Dec 04. Moreover, NSPD replaced the previous governance structure, the Interagency GPS Executive Board (IGEB), with the new National Space-Based PNT Executive Committee (NPEC).

The DoD PNT directive reaffirms that the U.S. Air Force will continue to lead GPS development, acquisition, and operations. Indeed, the DoD PNT directive makes no major changes related to GPS acquisition and operations. The GPS Wing at Los Angeles AFB will continue to acquire and modernize GPS satellites, the ground control system, and military user equipment for U.S. and allied forces. The 50th Space Wing at Schriever AFB will continue to operate the GPS constellation and deliver unrivaled GPS service.

Both GPS performance standards (i.e., the Standard Positioning Service PS dated 4 Oct 01 and the Precise Positioning Service PS dated 23 Feb 07) were developed by the U.S. Air Force and approved/published by the Assistant Secretary of Defense (ASD) office responsible for GPS. In addition, the U.S. Air Force leads GPS radio frequency compatibility and interoperability with other Radio-navigation Satellite Systems. In addition, the U.S. Air Force defends GPS spectrum at the International Telecommunications Union. In line with this new PNT DoD directive, the U.S. Air Force takes great pride in developing and delivering the world's best PNT services and equipment.

Things have not changed in actual operation as much as media reports tend to indicate. There has been civil presence at the GPS Wing, AFSPC and 2SOPS for a very long time. The civil agencies have, for a long time, cooperated on GPS capabilities and operation. The civil presence has brought additional direct contact of many users to the program for the benefit of those and other civil users, which has also provided benefit to the military. The civil agencies and the commercial manufacturers/users help build that cooperation that has made GPS a uniquely significant part of the economic engine delivered by the US Government.

## *MilsatMagazine*

*The future remains a tenuous proposition. Do you feel confident in our nation's ability to counter those who would harm us with our technologies? What do you see as critical for the protection of our nation and to our warfighters, the primary responsibility of a nation to its citizenry? What projects do you foresee as having enormous impact on our security and on our future?*

## *General Hamel*

I believe that with the Chinese ASAT demonstration, proliferation of GPS and satellite communications' jammers, and other anti-satellite technology readily available around the world, our nation's space capabilities face an increasing threat and could be attacked, or disrupted, by those who want to do us harm. A robust and comprehensive Space Situational Awareness capability is critical to protecting our military, civil, and commercial space systems to insure the security and well being of our nation and our friends.

## *MilsatMagazine*

*With your well-deserved retirement just around the corner, were you able to assist in the selection of a successor at SMC? If so, who might that be and what can we expect from the new commander?*

## *General Hamel*

Lt. Gen. (select) Tom Sheridan, currently the Deputy Director of the National Reconnaissance Office and Program Executive Officer and System Program Director for Space Radar, has been named as my successor at SMC. He has an extensive career in space development and operations, and has been a personal friend and colleague for some 25 years. He is the perfect choice to assume command of this extraordinary organization and its critical mission.

## *MilsatMagazine*

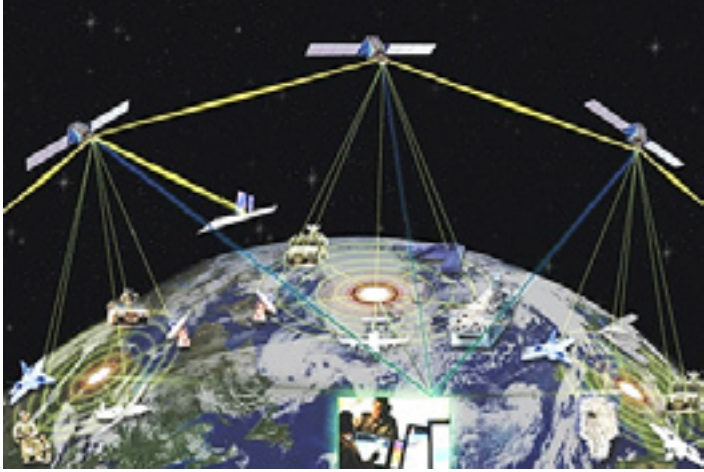
*We hear a great deal about new programs... would you please tell us a little bit about each of these systems? Which ones are on track for on-time completion and which are the critical systems you feel we simply cannot do without? Would you please tell us a little bit about each of these systems?*

## *General Hamel*

TSAT is the Transformational Satellite Communications System and will provide worldwide, secure, survivable satellite communications to U.S. strategic and tactical forces during all levels of conflict. It is the future of the Military Satellite Communications (MILSATCOM) architecture and will provide a magnitude of increased capability across the spectrum of mission areas, to include land, air, and naval warfare; special

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operations; strategic nuclear operations; strategic defense; homeland security; theater operations; and space operations and intelligence. TSAT will provide Internet-like capability and extend the DoD Global Information GIG to deployed users.



TSAT diagram

TSAT will deliver huge improvements in connectivity, capacity, interoperability, availability, security, and speed. TSAT will provide increased connectivity for protected communications (low probability of detection, low probability of intercept and jam resistance) to users "on the move" with small antennas. Additionally, TSAT will enable real-time and persistent worldwide connectivity to Air and Space Intelligence, Surveillance and Reconnaissance (AISR/SISR) assets, thereby providing increased situational awareness and targeting information to the warfighter. TSAT's total worldwide capacity will be 36 Gbps, and will support a broad range of users across ground, air and space from the foot soldier to the Network Command Authorities.



The Transformational Satellite Communications System Mission Operations System will provide network management for the TSAT system, providing network-centric interoperability between TSAT and the Department of Defense's Global Information Grid. For the joint warfighter and deployed worldwide users, this means they are one step closer to obtaining network-centric warfare.

## *MilsatMagazine*

*Is TSAT on track for on-time completion?*

## *General Hamel*

The Department of Defense is reassessing the optimal strategy for satisfying future satellite communication requirements in light of economic realities, program interrelationships, and user demand for these services. The Department remains committed to delivering the transformational communications capabilities envisioned for TSAT. However, until this assessment is complete, the long term TSAT program schedule remains to be determined.

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## *MilsatMagazine*

*Is the TSAT system critical and do you feel we simply cannot do without?"*

## *General Hamel*

Yes. There are validated warfighter requirements for assured, global, network-centric, high-capacity communications. User needs cannot be met with more of our current systems, or solely by ground, aerial, or commercial SATCOM systems. TSAT is the nation's only protected net-centric MILSATCOM program that will provide survivable and enduring communications crucial to joint warfighting.

TSAT supports the Army's Future Combat System (FCS) program by enabling Communications On The Move (COTM) to users with small terminals. TSAT will also collect information from protected Airborne and Spaceborne Intelligence, Surveillance and Reconnaissance (AISR, SISR) assets to enhance situational awareness.

## *MilsatMagazine*

*And AEHF?*

## *General Hamel*

The Advanced Extremely High Frequency (AEHF) system will consist of four satellites in geosynchronous earth orbit (GEO) that provides 10 times the capacity of the 1990s-era Milstar satellites. AEHF will provide continuous 24-hour coverage between 65 degrees north and 65 degrees south latitude.



The AEHF system is composed of three segments: space (the satellites), ground (mission operations and mission planning) and terminals (the users). The system will provide communications in data rates from 75

bps to approximately 8 Mbps. The space segment consists of a cross-linked constellation of four satellites. 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 will 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 UK). MCSW is responsible for acquisition of the space and ground segments, as well as the Air Force terminal segments. The Army and Navy will acquire their own terminals.



The second AEHF satellite's core propulsion module  
**Photo: Lockheed Martin Space System**

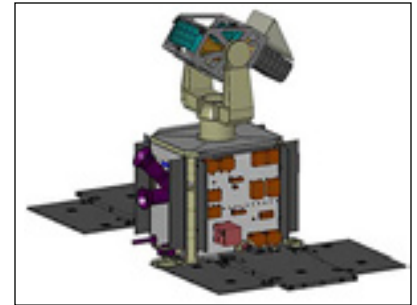
AEHF is essential, as it's the follow-on system to Milstar. It will provide the protected satcom capability to the highest priority users in the nation, even including the President. Protected, survivable strategic communications is the foundation of our nation's communications capability. With the AEHF system, it will assure continuity, and will deliver an order of magnitude of improvement in capacity. AEHF is currently on track for the inaugural launch of Space Vehicle (SV)-1 in the First Quarter of 2009.

## *MilsatMagazine* SBSS?

### *General Hamel*

The Space Based Space Surveillance System (SBSS) is a space situational awareness system, comprised of space, ground, and launch segments. The SBSS mission is to provide timely detection, collection, identification, and tracking of man-made space objects from deep space to low earth orbits.

The first SBSS satellite, designated Block 10, is a single Low Earth Orbit (LEO) satellite. The satellite is comprised of a space vehicle bus with a visible optical payload and associated command, control, communications, and computer (C4) equipment. It is on schedule to be launched from Vandenberg AFB in early 2009 on a Minotaur IV space launch vehicle. The ground segment provides satellite control, mission operations, and interfaces to users and the command structure from a new Space Operations Center, located at Schriever AFB, CO.



The SBSS system is a critical system that will operate in conjunction with the Space Surveillance Network (SSN) to support spaceflight safety, ensure space catalogue completeness, warn of on-orbit separations and maneuvers, and provide indications and warnings in space.

### *MilsatMagazine*

*Thank you, General Hamel, for this interview. We also wish to express our gratitude to you for your selfless and dedicated service to our country and our citizens. We wish you well in your new career—well-deserved retirement.*



*Listening to the audience cheer, Lt. Gen. Hamel attends the Team Spirit competition during the SMC Quarterly Awards*

Lt. Gen. Michael Hamel officially retires from his posting as the Commander of SMC on July 1, 2008. He has received the Distinguished Service Medal, Defense Superior Service Medal, Legion of Merit with oak leaf cluster, Meritorious Service Medal with three oak leaf clusters, Air Force Commendation Medal with two oak leaf clusters, the Air Force Organizational Excellence Award with three oak leaf clusters, and the global War on Terrorism Service Medal.

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## BRIGADIER GENERAL ELLEN M. PAWLIKOWSKI

*Vice Commander, Space and Missile Systems Center, Los Angeles AFB, El Segundo, California*

On July 7<sup>th</sup> of 2007, Gen. Pawlikowski was assigned to the SMC as the Vice Commander. During MilsatMagazine's opportunity to speak with the Commander of SMC, Lt. Gen. Hamel, Gen. Pawlikowski also made herself available to our publication to give answer some questions as well as give our readers some insight into her U.S. Air Force career and her opportunities with SMC.



### *MilsatMagazine*

*General, you have a distinguished career in the U.S. Air Force. Your service started in 1978 with the ROTC Program at New Jersey Institute of Technology and culminated in a PhD in Chemical Engineering at the University of California, Berkeley. Would you be kind enough to give our readers insight into the reasons why you decided to enter the*

*military at a time when “gender equality” was a term not usually heard of or considered?*

### *General Pawlikowski*

My reasons for entering the Air Force were not influenced by my gender. At the time, it never even occurred to me that there would be a reason why being a woman would prevent me from pursuing a military career—although there were certainly restrictions at the time, much more than there are today, in terms of what jobs I could have. From the time I started in undergraduate studies, I was interested in the advanced technology the Air Force was pursuing.

I had spent some time working in private industry during the summers when I was an undergraduate. I had a strong desire that I would much rather see my technical talents being used in service to my country, and in service to others, than for profit within the private industry. My motivation really was to serve both my country and my fellow citizens. I wanted to

use technology for the good of all as opposed to being stove-piped into the profit motivation of a particular company.

My background and the support I had from my family and parents encouraged me to pursue whatever I wanted to do, regardless of whether it was a male-dominated field or not—I could pursue anything, including a military career, without the thought of whether being a woman was something that might be a limitation.

### *MilsatMagazine*

*What are the various command positions you've held within the U.S. Air Force?*

### *General Pawlikowski*

I started my career in charge of the development of gas systems for separating and analyzing gases as part of the U.S. Nuclear Detection System, which was designed for monitoring the Nuclear Test Ban Treaties. From that assignment, I led some of the efforts at the Air Force Research Laboratory to transform the way the Air Force was conducting science and technology programs. This was a leadership role to help guide the way science and technology efforts in the Air Force would be approached.

My first actual program leadership responsibility was when I was in the Office of the Secretary of Defense. I was in charge of a program called the Counterproliferation Program. We had a number of efforts at establishing capabilities for the Department of Defense to protect against weapons of mass destruction, specifically in the area of chemical and biological defense. Moving from there, I was responsible for starting a program called Distributed Mission Training at Wright-Patterson AFB. That effort looked at how to better leverage the advances that had taken place in modeling and simulation to be able to offer realistic training of our flight crews using ground-based simulators. My first large program leadership position was the Airborne Laser Program at Kirtland AFN. That was a very high-tech program for leveraging high-energy lasers for missile defense.

My first “real command” was as the MILSATCOM Systems Wing Commander, which was responsible for five or six major programs providing satellite communication to our war fighters—not just the Air Force, but all of DoD, from Protected Comm Systems such as Milstar, to wideband communication such as Wideband Global SATCOM, to the transformation into the digital era of TSAT.



Today I serve as the Vice Commander of SMC and support General Hamel across the entire spectrum of projects. I've enjoyed a variety of different leadership positions, from the beginnings in the Nuclear Detection System all the way up to Military Satellite Communications, spanning some 20 years of my career.

### *MilsatMagazine*

*On June 1st in 2005, you were promoted to the rank of Brigadier General. This is a tremendous step for any officer in the U.S. Air Force, and with a family to nurture as well; this must have been an especially proud moment for you. Can you describe your efforts to gain this command rank while balancing gender, family, and duty?*

### *General Pawlikowski*

I was honored to be selected for this promotion. Such a small percentage of officers are selected to serve as general officers, and of course, the first step is to become a Brigadier General. I was particularly proud of the fact that I was able to accomplish that promotion, or that recognition in selection, at the same time I was providing a balance between my family and my career. My family is extremely important to me. I have two daughters who, I like to say, are really my two shining stars. That's because in the overall scheme of things, my contribution to our society is as much in what I leave behind in terms of their ability to contribute as citizens of the country and affect the global world, as much as it is whatever I might accomplish in my Air Force career. Through the years, my husband and I have been mutually supportive of each other in trying to provide that balance between a successful career and service to the country.

There were situations when I made decisions that, at the time, may have been detrimental to my career progression, but were

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important to my family. For example, when I graduated from Air Command and Staff College in 1990, most of my fellow classmates went to the Air Staff in the Pentagon. That was because it was, perhaps, considered the best experience to obtain when it came to one's Air Force career. But for my family's sake, it was more important that my husband and I were geographically located in the same place. He had already been identified to go to Rome, New York, to Griffith Air Force Base, to return to flying in B-52s. For the sake of my family, I elected to go to Rome Laboratory at Griffith Air Force Base for our family to stay together.

In the end-run, it was a good move. I was able to contribute to the Air Force in a very substantial way, and, at the same time, meet my family's needs. Later on, we made sacrifices in the other direction, when I was selected to be the Director of the Airborne Laser Program. Every step along the way, my husband and I would make a family decision as to which was the right balance. To be promoted to Brigadier General, while our family remains a tight and cohesive unit, is extremely rewarding. My two daughters at the end of this month complete college with professional degrees so they, too, can contribute to our country.

## *MilsatMagazine*

*General, did you have a role model in the Air Force, as far as your goals were concerned? We understand General Vaught outlined the difficulties you would face as you entered your Air Force career, and she attended your promotion ceremony. How much influence did General Vaught have on your decision-making process?*

## *General Pawlikowski*

General Vaught was one of my early role models. I aspired to be able to accomplish what she had done. General Leslie Kenne, who was the first Air Force female three-star, was also a role model to me, particularly as she was an Acquisition Officer as I. Major General (Retired), Paul Nielsen, my Commander at Rome Lab, is another role model, particularly in the way that he was able to maintain a careful balance between his family and his successful career.

In the case of General Vaught, I learned a good understanding of what I was getting into... I observed the way she progressed and the decisions she made over her career. Generals Kenne and Nielsen provided good advice as to how to pursue situations while maintaining a balance between what you do in your

career and your personal life and ambitions as well as what's important to you in terms of your health and wellbeing.

General Vaught also helped me understand the tough decisions and the sacrifices I was going to have to make and then proceed with my eyes wide open. There were certain decisions I was going to make that were of importance to me, for my family, which might sacrifice my ability to progress in my career.

## *MilsatMagazine*

*From June of 1994 through June of 1997, you were assigned to the Deputy Assistant to the Secretary of Defense for Counterproliferation Office of the Secretary of Defense at the Pentagon. This must have been a challenging position. Was it at this time you developed a taste for the satellite environments? If not, how did you gain the technical knowledge for your future assignments involving MILSATCOM?*

## *General Pawlikowski*

The position in the Office of the Secretary of Defense was one of the most challenging and exciting positions I have held. It was an opportunity for me to be able to see the convergence of technical decision-making in a political environment. Many of the activities I was involved in, when it came to counterproliferation, required me to develop an understanding of what we needed to do in terms of protecting ourselves from weapons of mass destruction. There was clearly a need to have a solid technical foundation for decision making. But at the same time, being exposed to how those decisions were formulated in an environment where there were other political and social considerations, was invaluable to me for the rest of my career. I learned how decisions were made in the Pentagon. As I've gone forward, I have learned the right decision isn't always the one that's the best technical decision because of these other considerations.

I didn't really receive much exposure to the satellite world there. My first real exposure to the space community was when I was assigned to Space and Missile Systems Center. My years at the Airborne Laser Program were probably the best preparation I could have had, because the technical challenges of putting a high-energy laser into an airplane, as well as pointing and tracking the laser, were similar to the technical challenges we face in putting together satellites.

The type of engineering discipline, the focus on mission assurance, the demand of technical maturity—all of those elements that went into the Airborne Laser Program are similar to the ones that are made here at SMC on space systems. I had to learn quickly once I got here, and with the assistance of

the aerospace team members and some support contractors, I got up to speed quickly. They helped me build upon what I had learned when I was part of the Airborne Laser Program.

## *MilsatMagazine*

*Of all of these positions, would it be safe to state your current position as the Vice Commander of the Space and Missile Systems Center at Los Angeles Air Force Base is your most satisfying assignment? If so, why? How did you acquire this post, and what are your duties in relation to Lieutenant General Hamel?*

## *General Pawlikowski*

First of all, I'd like to say I never really like to talk about anything as being the *most* because it seems like that can change pretty quickly. And *all* of my assignments have been very challenging and satisfying. Almost every assignment I've had in the Air Force has shown me that one gets out of an assignment what one puts into it. This current position has been extremely satisfying and rewarding. It's an exciting mission we have here, with an incredible responsibility when you look at the impact that space systems have on our ability to protect our country and implement our national security strategy.

It can be overwhelming to realize just how important the projects we manage here actually are for our country. From GPS, which is at the heart of our ability to know where we are and where our adversary is located—to MILSATCOM, where our capability of acting quickly and effectively is just as strongly tied to our communication—to our missile defense and missile warning capabilities through SBIRS—all of these missions are at the heart of our nation's ability to be able to remain secure and safe.

The role General Hamel has provided to me in terms of his empowerment for me to go out and to work with the wing commanders, and with the Headquarters of Air Force Space Command and our counterparts in the Pentagon, has enabled me to be able to make a contribution on a daily basis. Whether that contribution is working with the wing commanders to help them with what they need to get their mission done, or helping interface with Air Force Space Command in framing the way the command is able to do its mission, or working with the Pentagon in understanding that decision-making process, all of that has been very rewarding.

My job is to complete whatever assignments General Hamel delegates to me and to help him complete his mission. It's been a most satisfying and rewarding assignment, not only because of the importance of what we do, but his confidence in me with empowerment given me to represent him, and to resolve issues for him.

# PRIORITY BRIEFING

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## *MilsatMagazine*

*How has your engineering degree assisted you with your understanding of the challenges at SMC?*

### *General Pawlikowski*

My engineering training has been an absolutely essential part of who I am and how I approach things. I have a PhD in Chemical Engineering, and many ask, Chemical Engineering, what does that have to do with space systems? I think the important part of it is the discipline that one needs to learn as you go through a PhD program. I had someone tell me when I started my PhD effort that the value of a PhD is not necessarily the technical expertise you develop in a particular area that you're studying, but your ability to go into a technical area that you know very little about initially, and in a short period of time, make a contribution.

That discipline and the thought process I learned through my technical education I have used repeatedly throughout my career. I used this training when I was involved in counterproliferation and had to learn all about chemical and biological defense for the first time. I used the training when learning all about lasers and optics when I was at ABL. Here at SMC, I used my training as I entered MILSATCOM to learn about communications, satellites, and space in a short period of time. And that has been important to me through my whole career, and even more so here because of the technical nature of what we do.

## *MilsatMagazine*

*If possible, please discuss the projects you are currently involved with at SMC within the six wings and three groups that are responsible for everything from GPS to MILSATCOM and space situational awareness. How do you prioritize your responsibilities? Would you please describe these projects and the goals you hope they accomplish?*

### *General Pawlikowski*

General Hamel has split his portfolio between myself and the executive director. This methodology allows both of us to be more effective with a focus on a smaller group of elements rather than trying to focus on everything. The element General Hamel has asked me to focus on specifically is SBIRS, and we are working hard towards getting to that first geo satellite launch.

We've had some setbacks with a few issues we found late in our integration and test of the flight software. It's been a major focus for us to get back on track. We think we are making substantial progress in building the satellite, testing it, and driving towards that first launch. SBIRS is an incredibly important program when it comes to our missile defense and

missile warning capability. We are trying to help the teams at Lockheed Martin and the SBIRS wing here and this is one of the major focus factors I'm concentrating on.

Our launch capability has been another focus area and involves consummating our activities with United Launch Alliance (ULA) to bring to closure a consolidation of those contracts and successfully bring the ULA contract on board. At the same time we've tried to continue our record of 58 successful national security space launches. Our Satellite Control Network brings the latest set of software updates and antenna modernization efforts into play, as well as ushering in a new era of consolidated architecture for our command and control. Plus, we are looking at additional capabilities such as the Secretary's focus on new and innovative ways of bringing forward space capabilities.

I spend time making sure we've got the facilities and the programs here to take care of the support staff, and to bring the best qualified people, and further their professional development.

## *MilsatMagazine*

*What do you see as the most important project at SMC for the next year or so, and why?*

### *General Pawlikowski*

In my opinion, it is continuing to institutionalize the back-to-basics approach. We've spent a lot of time over the last three years bringing back, and introducing, some good, solid processes, and techniques to ensure mission success. Not just in the sense of making sure that we put capability on orbit, but also our ability to deliver when we say we're going to and at the cost we stated. We've come a long way in renewing our focus on systems engineering discipline. That includes good, solid contracting strategies, and professional program management efforts. We need to continue those efforts to ensure continued mission successes.

## *MilsatMagazine*

*This year's presidential and congressional elections are crucial in regard to defense budgets. Reducing costs could be a call for action from Washington, depending upon who is elected and what committee posts they hold. How can you be effective in helping persuade the authorities of the need for continued support for our defense and space equipment? One example is the DoD Homeland Security alternation of the final decision making processes for GPS. How did that newly instituted procedure affect operations at SMC?*

## General Pawlikowski

I am not familiar with the GPS issue, so I can't comment on that. I think the bottom line is our job here is to make sure that we define programs that can be executed and that we formulate them. What we need to do is to bring forward the systems and programs our nation needs. It's the national decision makers, the Congress and through their purse strings, and the President and Executive Branch, who will decide how we will move forward. We need to guide them as to how we move forward as a country.

## MilsatMagazine

*Given the last question, General, how do you see the development of GPS and MILSATCOM over the next year or so?*

## General Pawlikowski

GPS clearly plays a role globally, so GPS needs to continue to be able to provide the capability that we all rely on today. As we look to the future, we must be able to deal with a contested environment. That's kind of the direction we're going when we talk about GPS II and GPS III. GPS is going to play an enabling role and critical role. I see us continuing to move forward in that direction—maintaining the capability and gradually improving it as we go forward as we transition from the current set of satellites and the constellation to future ones.

MILSATCOM is going to continue to be a mixture of protected comm, which means satellite communications absolutely have to exist in any environment, whether it's a jamming environment or a contested environment for operations and for strategic communications. At the same time, we will continue to need communications of a wideband nature, which may be less protected. I see MILSATCOM continuing to provide capability across the spectrum in much the same way as GPS. MILSATCOM will continue to evolve so we can leverage the advancements we have made in digital processing and digital communication to live with the growing need for increasing comm with greater speed and higher capacity.

## MilsatMagazine

*The pride of those who serve at L.A.F.B. and at SMC is quite evident in contacts our publication enjoys with your command. To what do you attribute this sense of duty and service to our nation including your own?*

## General Pawlikowski

Everybody that works here has an appreciation of just how important what we do is, not just to our military or our country, but also to the world. I think all of us at SMC take that

responsibly very seriously. Moreover, when you look at that, it drives you to have a pride in everything you do. And that pride in what we do is not just because we're attempting to achieve—it's because we know how important it is that we do things correctly. None of us wants to deliver a satellite on orbit that doesn't provide the necessary and critical capabilities. Our attention to detail is present because we recognize just how critically important what we do is to our country.

## MilsatMagazine

General, are there other concerns or comments you or your team feel would add value to our readers? Is there anything you'd like to add?

## General Pawlikowski

You started out with the question about a time when gender equality was not usually considered—I think I'd like to share some thoughts concerning that subject. In my 26 years on active duty, I don't think


I have ever experienced a situation where my gender impacted my ability to do my job and to contribute. I know there are challenges and the world is not perfect, but in the overall construct of how the Air Force treats all our airmen, I think it is one of the most open and equal-opportunity institutions I've been exposed to throughout the years. I've had experiences, not related to the Air Force, where such is not the case. I think that's evident as you look today at the number of women that are in leader-



*Brigadier General Pawlikowski has been awarded the Defense Superior Service Medal, the Legion of Merit, Defense Meritorious Service Medal, Meritorious Service Medal with two oak leaf clusters, Air Force Commendation medal with oak leaf cluster, Air Force Achievement Medal, and the Air Force Individual Recognition Ribbon.*

ship roles throughout the Air Force. I believe this is something the Air Force doesn't receive as much credit for as it deserves—this is what makes it such a positive experience for me, and hopefully for others who follow.

## MilsatMagazine

Thank you, General, and we wish much continued success with your career and thank you for your service to all of us. 

# PRIORITY BRIEFING

## GENERAL JAMES ARMOR (RET.)

MEMBER, BOARD OF DIRECTORS, INTEGRAL SYSTEMS, INC.

### *MilsatMagazine*

*General Armor, you've had quite a prestigious career in the Air Force. A little history is in order here... please talk to us about your last few assignments and when you retired from the service?*

### *General Armor*

I retired on January 1, 2008 after more than 34-years of service. In my last assignment, I served as the Director, National Security Space Office, supporting the Under Secretary of the Air Force, Washington, D.C. I coordinated all Defense Department and Intelligence Community space activities.



Previous to the Pentagon position, I was the Director, Signals Intelligence Systems Acquisition, and Operations, at the National Reconnaissance Office (NRO), Chantilly, Virginia. There, I worked with some truly amazing intelligence professionals at the NRO and the National Security Agency (NSA), in support of global military and intelligence operations, including those in Afghanistan and Iraq. Prior to my NRO service, I accomplished a short tour as Vice Commander of the Warner Robins Air Logistics Center at Robins Air Force Base (AFB) in Georgia, where I learned hands-on aircraft maintenance and logistics.

Probably the most exciting position I held was as Program Director of the Global Positioning System at the Space and Missile Systems Center, Los Angeles AFB, California. GPS is changing civilization and working with the military, civilian, scientific, industry, and international users was exhilarating. Earlier in my career, I also had the opportunity to train as a Shuttle payload specialist, although I didn't get to fly due to the Challenger disaster.

### *MilsatMagazine*

What have you done since you retired?

### *General Armor*

After re-introducing myself to my wife and family, I established an Aerospace consulting firm, The Armor Group, LLC. I've supported several large space firms with their project planning and contract activities. For example, I support Iridium Satellite on its current business expansion, as well as its future satellite constellation development. Their NEXT constellation has tre-

mendous global communication capability as well as providing some exciting, hosted payload opportunities.

I'm on the board of advisors for space activities at Johns Hopkins University Applied Physics Laboratory. I'm continuing to support some US Government activities as well. For instance, I'm a reader on the Space National Intelligence Estimate and I'm on the Senior Advisory Group to the Commander of the Space and Missile Systems Center at Los Angeles AFB. I also enjoy being active in professional and space associations, which support investment in space, such as space-based solar power. Space-based solar power was the last architectural study I conducted at the National Security Space Office (NSSO), the organization responsible for the design of military space architectures. I've also expressed the need for a new space industrial base policy with the US Chamber of Commerce, the Aerospace Industry Association (AIA), and others.

### *MilsatMagazine*

*You recently were invited to join the board of directors at Integral Systems, Inc. and how does your military background match up with their business focus?*

### *General Armor*

I believe I can add some perspective to Integral Systems (ISI) from the standpoint of an Air Force and NRO space system customer. Air Force Space Command is responsible for securing the space domain for all legal users and needs to get the absolute most for every tax dollar.

The same holds true for the NRO. For historical reasons, the Air Force and NRO have somewhat neglected the ground segment of space systems, mostly due to the nature of the spacecraft. These organizations are now realizing the biggest payoff is derived from managing the information "on the ground".

This is where ISI, as a corporation, has done a great job of providing commercial and government space operators cost effective, operational capability over the years. I hope to use my Air Force and NRO experience to help guide, lead, and support their continued growth into the government market.

The company has done a fantastic job of delivering the Command and Control System – Consolidated (CCS-C). The project is on time, on budget, and the operators are transforming their operations through CCS-C capability. I'm also energized

by their Rapid Attack Identification Detection and Reporting System (RAIDRS) efforts and looking forward to their GPS OCX solution in their role as part of the Northrop Grumman team. I think we're a good fit for one another.



## *MilsatMagazine*

*In addition to the normal board member duties, what role do you expect to bring into play for Integral's business?*

## *General Armor*

I plan to get involved with their strategic planning and help them lay out a five-year roadmap for getting more classified and open National Security business. They're doing some good IR&D Internal Research and Development.



ISI has developed great solutions to difficult problems. I have perspective on the Air Force and NRO corporate and acquisition processes, as well as an appreciation for government space ground system needs, which I intend to share. I believe I can provide feedback and direction on their IR&D efforts. In addition, I believe I can provide insight into more avenues of opportunity that could lead to further growth by informing our customers of the ISI's capabilities.

## *MilsatMagazine*

*Integral's CCS-C ground system program for Milsatcom has been quite successful. To what do you attribute this success?*

## *General Armor*

Great people, an open architecture based on ISI products, and a sound Air Force acquisition strategy.

# PRIORITY BRIEFING

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ISI is recognized for its ability to find a way to get the job done. Our technical experts are the best team in the space ground system business. They're dedicated, hard working, innovative, and solution-oriented and they take pride in delivering capability to our Air Force customers.

One of the outstanding attributes of the CCS-C architecture is the ability to upgrade or refresh the system without an impact on satellite operations. Once the system was rolled out to the operational community, there were many requests for addition-

al features and capabilities. ISI's relationship with our government's procurement agency and the developed creative atmosphere allows for available schedule and funding maximization. Change is a constant; our configuration allows for a seamless implementation of the Epoch product improvements.

## *MilsatMagazine*

*What are some of the benefits that the CCS-C system has brought to Air Force Operations?*

## *General Armor*

One significant benefit of CCS-C has been in the area of automation. 3 SOPS (3rd Satellite Operations Squadron) has taken the lead in using the automated capabilities inherent within CCS-C. Staffing savings are now being realized. 3 SOPS has created and instituted automated satellite state-of-health supports along with other automated features. The WGS satellite is quite complex and we were able to automate the WGS command procedures. This resulted in much more efficient operations. The onus is on the system rather the operator, which is a consistent trend within the satellite industry.



## *MilsatMagazine*

*Integral has been promoting the idea of making the CCS-C system the standardized Satellite Operations Center (SOC) for AF satellites. What do you think of this plan?*

## *General Armor*

A common infrastructure would cost less, be easier to maintain and upgrade, and would simplify military operator training. CCS-C is an open architecture with flexibility and scalability to support all missions, plus it's proven and operationally tested. The system was built using ISI's EPOCH Integrated Product suite, which is operating with more than a hundred commercial satellites. The system architecture allows mission unique capabilities to be included through its API's, which allows for incremental upgrades without changes to the core operational software. By virtue of having a commercial, scalable approach able to operate any satellite, the Air Force has already acquired a standard satellite core system.



## *MilsatMagazine*

*Do you know what is Integral doing in the Space Situational Awareness area? How does their work in this area match up with the needs you saw as head of the NSSO?*

## *General Armor*

ISI is the prime contractor for the Rapid Attack and Identification Detection Reporting System (RAIDRS). ISI also provides commercial RF interference detection systems and a low cost geo-location capability for the commercial market. ISI demonstrated a space "neighborhood watch" capability for the government. Working with the commercial community, ISI was able to offer status information on commercial satellites for the government. The company has also come up with an innovative scheduling toolkit called MANTIS. MANTIS optimizes sensor tasking, significantly increasing the efficiency of the entire space surveillance network.

Recently, ISI also started work on the Executive Dashboard. This provides a "manager of managers" capability for SOCs to monitor and control multiple satellite buses and missions. Additionally, the Air Force customer can use the Executive Dashboard application in a Wing Integrated Operations Center. The capability gives quick insight into satellites, networks, and control centers and provides the Wing Operations Center with constant status on the systems—this increase Space Situational Awareness (SSA).

## *MilsatMagazine*

*General, what do you expect to see in regard of trends and developments in Command and Control systems in the future?*

## *General Armor*

Future budget constraints will drive government acquisitions to consolidate their space systems on common, COTS-based, Command and control systems save both development costs and long-term logistics and sustainment.

ISI expects the government to consolidate systems with proven performers in the satellite ground system industry, aptly demonstrated through the CCS-C program, civil programs, and ISI's proven performance as the most widely used command and control system in the commercial satellite industry. Couple the life cycle cost benefits with the lower development risk, along with the superior performance and capability of the ISI EPOCH IPS product baseline, and that's a winning solution.

## *MilsatMagazine*

*Are you involved in other projects, as well?*

## *General Armor*

Yes, and I'd like to mention one other activity simply to make a point. I'm on the board of directors of NAVSYS Corporation. This is a small business headed by Dr. Alison Brown. NAVSYS is working on some incredibly innovative R&D work with GPS. Among other things, NAVSYS built a server with augmented precision navigation data that the warfighters in Iraq and Afghanistan use directly. NAVSYS won the DoD SBIR Tibbets Award last year for this work.

I continue to be inspired by the creativity and energy of small businesses. Integral Systems management has recognized and taken advantage of this innovative power and has brought on RT Logic, Newpoint Technologies, SAT Corporation and other small businesses as part of their team. I believe US small technology businesses need far more policy and funding support from the U.S. Government. They are the foundation of the future of US leadership in space—commercial, civil, and national security.

## *MilsatMagazine*

*General, thank you for your time and your thoughts, as they are much appreciated.*



# FEATURES

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## THE SWAP MEET

by Nicholas Yuran

### *Trends in Reducing Size, Weight, and Power in the Modern Military Satcom Architecture*

Mobility is a critical requirement in today's tactical satellite environment, with manpacked systems and vehicular Communications-On-The-Move (COTM) at the forefront of the US military's most high-profile satcom programs. Major pro-

grams such as Win-T (Warfighter information Network—Tactical), CAMC2 (Common Army-Marine Command and Control), FBCB2 (Force XXI Battlefield Command Brigade and Below), SWAN (Satellite Wide Area Network), FCS (Future Combat System), HC3 (High Capacity Communications Capability), among many others, all incorporate a requirement for motility or mobility. This has influenced military requirements to steadily trend away from the traditional transit case solutions toward more lightweight and portable technologies.

Size, weight and power, or “SWaP” in military parlance, is being reduced both at the terminal level and the individual networking device to more effectively provide COTM capabilities. These trends are compelling satcom vendors to make some bold R&D investments in new and emerging technologies, and develop a new generation of satellite products to meet the requirements of the modern mobile warfighter.

### *The COTS Factor*

Just as many military programs are looking to reduce their SWaP, so, too, are commercial networks investing in technologies that minimize the footprint of their equipment. The emerging market for satellite capabilities in private and commercial aircraft and vehicles closely parallels the requirements of the airborne and vehicular comms programs in the U.S. DoD (Department of Defense).

Satellite equipment vendors are capitalizing on this shared requirement to build smaller systems that can be simultaneously sold into both markets. This reduces development costs and encourages more rapid technology release cycles. Military programs benefit from this trend

in Commercial Off-The-Shelf (COTS) products through shorter acquisition cycles and a broader choice of technology vendors from which to procure. As more COTS products are specified for military programs of record, expect to see increasing competition among vendors based not only on technical capabilities, but also on how small they can make those capabilities.

### *The Transit Case Dinosaur*

In recent years, the tactical satellite (TACSAT) terminal has been deployed in a series of hardened transit cases. These cases typically house cryptographic equipment, routers, accelerators, and other baseband equipment. While the capabilities of these systems have increased substantially over the last 20 years, the embark footprint has generally remained the same.

The SWaP of such architecture has limited the on-the-move warfighter to what is commonly termed a “comms-on-the-halt” capability. Many transit cases fielded today can weigh between 150 and 200 lbs, requiring 2-man and 3-man lift teams to transport them. While this architecture may be movable, it does not fit the modern military definition of mobile. Such is not a practical response to the rapid and highly portable deployment requirements of today’s on-the-move warfighter.

In addition to being cumbersome, high SWaP systems put a security strain on the warfighter. “One of the primary concerns in the combat zone is that when you send out a comms team, someone has to provide security”, says Captain *Billy Cornell*, USMC, of the Marine Corps Tactical Systems Support Activity (MCTSSA). “The smaller, lighter, vehicle-mobile terminals are much easier to secure and safeguard”.

In his role as Engineer Support Officer for the Satellite Wide Area Network (SWAN) program, Captain *Cornell* has worked



*The IPT Mil Suitcase is a member of DataPath's earch terminal family of ultra-portable systems*

**Photo: DataPath**

# FEATURES

with the satellite communications integrator DataPath, Inc., to produce a small, lightweight, baseband package that meets the portability requirements of the SWAN program.

Dubbed the “SWAN Mini”, this package features a man-portable baseband package weighing a fraction of its predecessor cases. Despite the significant reduction in size, it provides all the networking capabilities of many of its larger transit case equivalents. Captain Cornell views the SWAN Mini as a model for future comms packages, since it combines the best features of a transit case, including ease of access and manageability, with the mobility of a man-portable kit.

## Communication Kits

An emerging technology that is starting to see deployment in airborne, naval, and ground forces networks is a line of products generally classified as *communication kits*. For all practical purposes, they are a mobile, lightweight equivalent of the transit case solution, reduced in SWaP to better suit the man-carried and on-the-move environment. Typically housed in a weatherproof and ruggedized briefcase-style enclosure, and powered either by internal batteries or an external power source, these devices combine cryptography, SCPS (Survivable Collective Protection System) acceleration, and routing into a single man-portable product. With all the baseband equipment conveniently stored in a single suitcase, all that is needed is a bandwidth source (Inmarsat, VSAT, terrestrial media) and the warfighter can be connected to their home network.



Dataline's Data Communications Device (DCD)

One vendor leading the trend in communication kits is Norfolk, Virginia-based Dataline, Inc., According to Dataline's Vice President of the Communications Products Group Dr. Dave Glover, they first observed the urgent need to reduce satcom equipment SWaP several years ago in the systems that were being deployed on C-130 aircraft.

“The systems took up most of the aircraft”, says Dr. Glover, “and when we reduced the solution to a 14u case, it exceeded everyone's expectations”. But Dataline realized they could go even smaller. After an extensive R&D effort focused on miniaturization, they found the solution in their Data Communications Device (DCD) product line. The DCD kits took the 14u solution down to the size of a briefcase and reduced weight to less than 40 lbs.

The kit supports voice, video, and command and control communications over SIPR (Secure Internet Protocol Router) and NIPR (Non-Secure Internet Protocol Router) channels and can also support a broad range of power sources. Of the mobility of the product, Dr. Glover adds, “Simply stated, our users can now take their garrison or command center capabilities with them anywhere in the world independent of the communications path and power available. What once took almost an entire aircraft to house can now fit in the passenger's overhead compartment.”

## SWaP and “Cool Software”

What may not be obvious is that just as hardware vendors face SWaP issues in DoD, so do their counterparts in the software industry. At Global Protocols, Inc., a company that produces the SkipWare® software line found in most of today's DoD satcom acceleration products, producing more efficient software with less resource consumption and a smaller footprint is critical.

“Our licensees are all going smaller with their hardware”, says Global Protocols president Monty Deel. “As they shrink their hardware, we have to make sure our software can shrink with them. The software we develop today is designed to be as lean as possible, with a smaller footprint and minimal resource consumption. This allows us to port to virtually any of our partner's platforms regardless of the form factor”.

In addition to the portability issue, Mr. Deel points out that efficient software puts less of a strain on the hardware's resources, allowing it to operate without radiating a high thermal signature. Producing “cool software” reduces the detectability of the host hardware and makes it much more durable when operated in a high-temperature theater.

## Limitations on Reducing SWaP

While every program office may be demanding a reduction in their equipment SWaP, there are considerable limitations that will prevent wide scale miniaturization of the military satcom equipment suite from occurring overnight. The technologies required to reduce SWaP are often the result of considerable R&D investments by the commercial vendor community. These investments can only be recovered by passing on the costs to their customers, and the assumption is that the military will pay a premium for equipment with a reduced SWaP. However, as Gerry Michael, Chief Engineer for Satcom Space Systems at the US Army CERDEC sees it, not everyone is going to be able to pay this price.

“Everyone wants smaller and lighter technology”, says Mr. Michael, “but even in the on-the-move programs, there has to be a balance between SWaP and price”. Mr. Michael notes that the optimal form factor and high performance must be affordable, especially in large programs with high volume procurements. Otherwise, the perfect low-SWaP technology can lose out to a larger, heavier, but much more affordable solution.

As Gerry Michael points out, there are always going to be the limitations of physics that prevent miniaturization from going beyond a certain point. Physics simply won't allow a 9-meter antenna to be replaced by a 6-inch equivalent, for example.

Nevertheless, where there is necessity, there is invention—it is becoming increasingly apparent to satcom technology vendors that in order to remain competitive, they must find innovative ways to miniaturize their solutions. The physics of the matter notwithstanding, the vendor community is beginning to recognize that in order to grow their business—they must first shrink it.

### *About the author*

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



## SPACE TRACKING AND SURVEILLANCE SYSTEM

*Excerpted from the Department of Defense's Missile Defense Agency's STSS Fact Sheet and their BMDS Booklet entitled "Missile Defense—Worldwide"*



The United States, in active partnership with its allies, has fielded an initial layered integrated Ballistic Missile Defense System (BMDS). The United States has come a long way since President Ronald Reagan first delivered his

challenge to the defense community 25 years ago—to develop antiballistic missile technologies to improve our national security and lessen our reliance on nuclear deterrence. Although the nature of the threat has changed substantially since he envisioned the Strategic Defense Initiative, the harsh realities of today's global security environment push the United States to field missile defenses as soon as possible.

Ballistic missile defense is one of the most complex and challenging missions in the **Department of Defense (DoD)**. A ballistic missile's altitude, speed, and range leave a defender little time to react. To meet this challenge, the **Missile Defense Agency (MDA)** is developing a layered, integrated system capable of destroying a ballistic missile in each of three distinct phases of flight—boost, midcourse, and terminal. The system requires accurate missile identification and tracking with advanced sensors; advanced interceptor missiles or directed energy weapons (e.g., lasers); and reliable Command and Control, Battle Management, and Communications (**C2BMC**) to integrate the system and direct the engagement.

With the initial fielding of the BMDS in July 2006, the United States now has a limited defense against ballistic missile attack. This initial capability provides a defense against short- and medium-range ballistic missiles using **Patriot Advanced Capability-3 (PAC-3)** missiles and **Aegis Ballistic Missile Defense (BMD) Standard Missile-3 (SM-3)**. The initial capability also enables engagement of intermediate-range and intercontinental ballistic missiles in the midcourse phase using *Ground-Based Interceptors (GBIs)*. These layers are integrated through an advanced C2BMC network.

The Agency's mission—to develop and field an integrated, layered BMDS to defend the United States, its deployed forces, allies, and friends against all ranges of missiles in all phases of flight—is more relevant now than ever before. The years ahead will be demanding as MDA continues the tough

### Integrated Ballistic Missile Defense System



task of developing, testing, and enhancing our worldwide ballistic missile defenses.

Hot from the Missile Defense Agency is their latest *Fact Sheet* and *BMDS Booklet* entitled *"Missile Defense—Worldwide"*. These publications inform interested parties of the agency's pursuit of the **Space Tracking and Surveillance System (STSS)** program as a space-based sensor component of the **Ballistic Missile Defense System**. The STSS program uses sensors capable of detecting visible and infrared light. STSS will become part of a constellation of land, sea, air, and space-based Ballistic Missile Defense System sensors.

During 2008, two research and development satellites will be launched via **Delta II** launch vehicle into low earth orbit, with a ground segment developed to operate the satellites. This ground segment will also be designed for re-use with subsequent research and development satellites. The STSS ground station will become operational approximately one year prior to the launch date, which will allow for adequate time to train the operators. The ground segment will communicate with the missile defense Command, Control, Battle Management, and Communication system.



*STSS Satellite, Cycle 1, Flights 1 and 2*  
**Credit: Northrop Grumman**



The *STSS Demonstration Program* will demo the key functions of a space-based sensor. Missile tracking data will be passed to missile defense interceptors with the accuracy and timeli-

ness necessary to enable them to successfully intercept missile targets. The lessons learned from the on-orbit operation of the demo satellites will provide a sound foundation to proceed with the fielding of an operational constellation.

In the initial program, the demo satellites are comprised of refurbished hardware that was originally built as flight demo satellites. STSS will perform on-orbit testing of sensor performance against ground targets, airborne targets, as well as short and long-range ballistic missile targets. The demo satellites are expected to be available for between two to four years after their launch.

The *Future Development Program* of STSS will use the lessons learned from design, development, and early on-orbit test-

ing of the demo satellites and use that data to upgrade the system. Through ground station and spacecraft software upgrades, this effort will improve the Demonstration Satellite experiment, reduce risk for the STSS follow-on program, and improve the contingency operations capability.

The *Follow-On Program* will find the MDA continuing to plan for the operational constellation of STSS satellites to enable missile tracking. There will be improvements made in satellite lifetime, producibility, and the ability to process and communicate missile-tracking data to interceptors.

### *Ballistic Missile Defense Space Sensors*

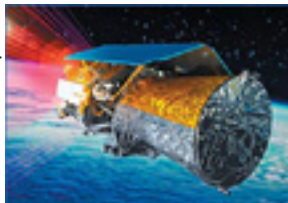
The **MDA Space Applications Product Center of Excellence** is responsible for leading a multi-agency DoD and industry team in developing, testing, and deploying space systems to detect and track ballistic missiles from launch through mid-course flight and eventual intercept or reentry. Mission objectives include developing space technologies that support MDA's space assets, including sensors, space qualified components, optics, and algorithms.

# FOCUS ON

The *Space Applications Center of Excellence* will play a lead role in any future space initiatives undertaken by MDA and facilitate the integration of external Overhead Non-Imaging Infrared (ONIR) sensors.

## Program Description

Each of the two low earth orbit research and demo satellites use an acquisition sensor for missile launch detection and a movable tracking sensor to follow midcourse objects in space. The STSS demonstration satellites will demonstrate the ability to pass missile-tracking data to system interceptors with the accuracy and timeliness necessary to enable them to successfully intercept missile targets. MDA will be able to make more informed decisions regarding the fielding of satellites for the operational architecture as the data is obtained from these satellites.



NFIRE satellite with Track Sensor Payload (SAIC) and Laser Communications Terminal (Tesat-Spacecom)

Credit: GDC4S

The *Missile Defense Space Experimentation Center (MDSEC)* in Colorado Springs, Colorado is the integration center for MDA's *Space Applications Center of Excellence*, which provides a single location for operating STSS and *Near-Field Infrared Experiment (NFIRE)* satellites and for conducting space-related *Research Development Test and Evaluation (RDT&E)* activities in support of the missile defense mission.

The **NFIRE** satellite, built by General Dynamics Advanced Information Systems, was launched on April 24, 2007 and will reduce the risk to next-generation BMDS interceptors on land, at sea, and in space by collecting signature data on boosting ballistic missiles at close range in real-world conditions. The data collected will anchor design tools for future interceptor hardware, software, and algorithm development. NFIRE also will provide MDA with early experience coordinating space assets with BMDS flight tests.



The *Missile Defense Agency's NFIRE satellite* lifted off aboard an *Air Force Minotaur 1 rocket* April 24 from NASA's *Wallops Flight Facility* on the east coast of Virginia.

Photo courtesy of NASA

The objective of the *Space Test Bed* is to evaluate the utility and cost-effectiveness of enhancing missile defense by adding a comprehensive space layer to overcome basing and geographical limitations of land, sea, and airborne defenses. The evaluation would include multi-use sensors and C2BMC.

## Contributions To The BMDS

MDA Space Sensors will play a significant role in a global missile defense capability by providing continuous tracking of ballistic missiles and passing tracking information to BMDS radars and interceptors. Accurate tracking data provided by space sensors will increase the robustness of the BMDS, allow additional and earlier intercept opportunities, and provide coverage in locations inaccessible to

## BMDS radars year 2007 accomplishments:

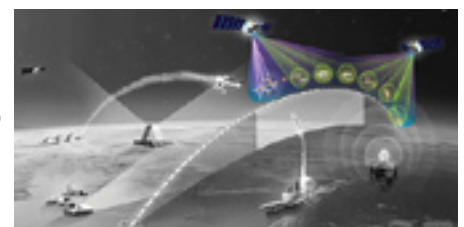
- Completed NFIRE satellite integration and ground testing
- Launched NFIRE satellite and began operating from the MDSEC
- Continued integration and testing of two Space Tracking and Surveillance System Demonstration satellites
- Delivered payload #2 to space vehicle integration
- Completed thermal vacuum testing on both satellites
- Completed final acceptance of ground software
- The *Ground-Based Midcourse Defense (GMD)* program is developing and fielding a capability to defend the United States against intermediate- and long-range ballistic missile attacks in the midcourse phase of flight.

GMD uses a variety of satellites and radars (*Cobra Dane Radar, Upgraded Early Warning Radars, Sea-Based X-Band Radar, Forward-Based AN/TPY-2 Radar, and the Aegis AN/SPY-1 Radar*) to obtain information on launch warning, tracking, targeting, and discrimination via the Command and Control, Battle Management, and Communications system and the *Ground-Based Midcourse Defense Fire Control and Communications* component. This information enables the *Ground-Based Interceptor (GBI)* to locate, identify, and destroy the incoming ballistic missile warhead.



Raytheon's advanced STSS Block 06 Sensor Suit  
Image: Raytheon

The Contracting Authority is the *Missile Defense Agency (MDA)* through the *U.S. Air Force Space & Missile Systems Center (SMC)*, El Segundo, California. MDA plans to eventually expand STSS to at least 18 satellites in order to cover key threat regions such as Asia and the Middle East. STSS will achieve worldwide coverage once 30 satellites are deployed.



Raytheon's STSS Block 06 program extends the reach and effectiveness of the *Ballistic Missile Defense System*, enabling intercept events from launch through midcourse and coordination with ground-based platforms.

Image: Raytheon

# Executive Spotlight On...

## **GREGORY SMOLKA**

*VICE PRESIDENT, INDUSTRIAL, MILITARY AND SPACE, VECTRON INTERNATIONAL*



Gregory L. Smolka is responsible for growing Vectron's strong market positions in test and measurement, medical imaging, process control and other industrial applications while reinforcing the company's leadership position in defense

and space markets. He has nearly 20 years experience in worldwide marketing and sales of high technology in multiple markets, including medical imaging, industrial, communications, homeland security, and military. Prior to joining Vectron in 2007, Mr. Smolka held management positions with Axsun Technologies, the Industrial and Defense business unit at Bookham Technologies, Big Sky Laser Technologies, and Texas Instruments.

We had an opportunity to discuss with Mr. Smolka the role that Vectron has for the space industry, with particular focus on the impact Vectron's patented EMXO technology has in the satellite and aerospace industry.

### *MilsatMagazine*

*Gregory, could you start this interview by giving us an overview of Vectron's history in the space industry?*

### *Gregory Smolka*

Certainly. Vectron's heritage of providing frequency control solutions to the military and space markets spans more than six decades. The company's proven, high quality and high reliability solutions are represented in the military and space programs of industry leaders that include **Lockheed Martin, Northrop Grum-**

**man, General Dynamics, Harris, Raytheon, ITT, Boeing, NASA, Honeywell**, as well as international customers such as **ISAC, Thales Alenia Space, and Astrium.**

# Executive Spotlight On...

Vectron's timing solutions have been designed in various military, communication and scientific satellite applications, including the *Mars Pathfinder*, **Iridium** satellites, and **Globalstar** satellites, as well as in military radios, aircrafts, as well as radar and missile applications.

In short, Vectron has fully dedicated its resources to providing premier frequency control solutions to the space indus-

try ever since the company's inception. Today, we offer a full line of space qualified frequency control products including clocks, oscillators, VCXOs (Voltage Controlled Crystal Oscillators), TCXOs (Temperature Controlled Crystal Oscillators), OCXOs (Oven Controlled Crystal Oscillators), EMXOs (Evacuated Miniature Crystal Oscillator), and filters.

## *MilsatMagazine*

*The aerospace market has been evolving a great deal over the past decade. From the components provider perspective, what are the key changes you have seen?*

## *Gregory Smolka*

The industry continues to drive towards smaller footprints and lower power consumption, while simultaneously demanding higher performance. In addition, robust, reliable performance in harsh environments is a necessity. Vectron is addressing this trend by combining our unparalleled expertise and experience in the crystal oscillator industry with our state-of-the-art fabs to offer customers innovative solutions that address such challenging trends.



*Vectron EX-380 low profile 4-pin DIP Evacuated Miniature, Oven Controlled Crystal Oscillator.*

It is also exciting to be a part of the industry at a time when companies are investing more

# Executive Spotlight On...

in creating innovative products to stretch the boundaries of what is possible. For example, we're now delivering MEMS based oscillators capable of operation, after shock, of up to 30,000 g's. Other programs have us developing and delivering frequency control products that must operate at temperatures of over 200 degrees C.

In addition, power consumption, which continues to be a huge driver for many markets, is especially important for space applications. One of the most significant developments from Vectron in this space has been the emergence of our patented EMXO technology, which was originally developed and optimized to address this and other precise needs of space contractors.

## *MilsatMagazine*

*Please give us an overview of what EMXO technology is and why it was developed?*

## *Gregory Smolka*

We developed our EMXO technology to answer customer demand for a high-performance, high-stability oscillator with significantly lower power consumption with a package size less than oven controlled crystal oscillators (OCXOs) that are traditionally used for space applications, such as satellite deployments.



As you may know, many companies in the military and space industries use OCXOs because they can meet the stringent frequency vs. temperature requirements required

by these applications. OCXOs perform better than basic crystal oscillators (XOs) or Temperature Compensated Crystal Oscillators (TCXOs). Because OCXOs control the temperature of the crystal with an oven, they can keep the temperature of it and the component's critical circuits constant, even as the outside temperature fluctuates.

However, while an OCXO can improve a crystal's inherent stability by more than 5000 times, the oven control system comes at a cost: a larger package and more than 200 times the power consumption of an XO or TCXO.

Increasingly, more and more of our space customers have been demanding smaller and less power-hungry devices that could "get the job done" as well as an OCXO. The EMXO, designed and patented at Vectron's Mil/Space Center of Excel-

lence in Mount Holly Springs, Pennsylvania addresses this need by delivering a solution four times smaller than a comparable OCXO and with a third of the power consumption.

Over the years, we've continually improved and enhanced this technology to meet the changing needs of our mil and space customers. The latest iteration of these EMXO oscillators offers radiation tolerance to more than 100 kRads(Si) total dose, lower power consumption rates (less than 0.7 W at 25 degrees Celsius and less than 1.1 W at -40 degrees Celsius) and an impressive warm-up speed (3 minutes at 25 degrees Celsius). EMXOs also offer a ten-fold improvement in stability compared to similarly sized temperature controlled crystal oscillators (TCXOs).

## *MilsatMagazine*

*Who stands to benefit from this technology?*

## *Gregory Smolka*

Our EX-245, released last year, is aimed at satellite applications where power and size are critical to operation. With this product, OCXO stability is maintained, while size and power consumption are minimized. The result is the best combination of size and performance in the industry.



In general, our EMXO is ideally suited for any application requiring small size, low power consumption, and fast warm-up time. The smaller size and lower power consumption available with these EMXOs makes them ideal for portable and battery-powered applications. In fact, our EMXO has been successfully designed into portable test equipment as well as military man-pack radios.

## *MilsatMagazine*

*How does the size of EMXOs compare to OCXOs?*

## *Gregory Smolka*

Space customers are always concerned with minimizing their payload and Vectron's EMXOs allow them to do just that. The EX-245, for example, is about one-quarter the size of a conventional OCXO, without sacrificing performance.

Our EMXOs are smaller because the unique cold weld dip package provides the hermeticity necessary to allow the use of an open blank SC cut crystal, eliminating the crystal package and minimizing the mass to reduce the power consumption.

# Executive Spotlight On...

## *MilsatMagazine*

Are there any other industries in which EMXO technology might be applicable?

## *Gregory Smolka*

Our EMXOs have broad applicability wherever high performance is needed and size and power are constrained. Portable test instrumentation, for example, is a great fit, as manufacturers are designing very sophisticated, high performance instruments in small, portable battery-powered configurations. EMXOs are also well suited for manpack radios, which require an oscillator with fast warm-up time, small size, and low power consumption. Also, in the world of medical instrumentation, where the trend is towards greater portability, our EMXOs are ideal for driving the performance of the new portable, battery-powered imaging instruments..

## *MilsatMagazine*

Can you name three trends or technological advances we can expect to see in the space industry in the next five years?

## *Gregory Smolka*

Size reduction continues to be a driver in the industry. As a result, we expect MEMS products, which are currently starting to be deployed in commercial and military applications, will eventually show up in satellite applications, as well. We're active in this space today and will be releasing our first military MEMS oscillators later this year.

We are also seeing a trend with our customers towards higher levels of frequency control integration. Smaller engineering staffs and compressed development schedules for the primes



means that they are asking their development partners to take on more of the design load. Now, rather than simply buying an oscillator, for example, customers are increasingly looking for complete timing modules. With our broad product lines ranging from crystals, filters, clocks, VCXOs, TCXOs to EMXOs, our strong engineering capabilities and six decades of involvement in this market, we've been able to combine products and develop these integrated solutions for our customers.

Clearly, the technology will continue to move forward at a rapid pace. I'm confident that the investments we've made in our people, our factories, and infrastructure as well as in continued innovation will allow us to help our customers grow their businesses.

## **Editor's Note:**

To learn more about crystal oscillators and their space capabilities, Visit:

<http://www.vectron.com/whatsnew/space/index.htm>,

Vectron's space products information page.

## TSAT TECHNOLOGY IS MATURE READY FOR DEVELOPMENT PHASE

by TSAT Program Staff

The Air Force has faced many challenges over the years in the acquisition of complex space systems. Under the direction of the Undersecretary of the Air Force, *Dr. Ronald Sega*, the Air Force developed a “*Back to Basics*” approach to maximize the probability for success in its space acquisition programs. This approach focuses on “mission success”, a key tenet of which is ensuring that technologies are matured to the appropriate levels during the acquisition lifecycle. The Transformational Satellite Communications System (TSAT)—a system that is being designed to introduce technologies that will address warfighter needs 10-15 years from now—implemented this back-to-basics approach and successfully matured key technologies to a level that will ensure success on this vital satellite system.

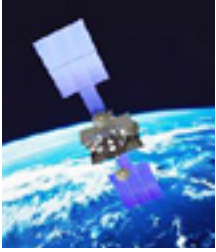
providing new capabilities through the use of technologies such as Internet Protocol, onboard routers and large aperture antennas. These technologies provide the potential for enabling Communications On The Move (COTM) to users with small terminals and allow TSAT to collect information from protected Airborne and Spaceborne Intelligence, Surveillance and Reconnaissance assets to enhance situational awareness. TSAT delivers these capabilities in a broad, integrated information-sharing environment, thereby enabling interoperability on an unprecedented scale in military communications.



### *TSAT Overview*

TSAT will be a major enabler of the **Transformational Communications Architecture** (TCA). The vision of the TCA is to provide a protected, secure Internet-like communication system that integrates space, air, ground, and sea networks. On a global scale, TSAT will provide high assurance, automated and dynamic capabilities. In addition to providing a significant increase in capacity over current satellite systems, specific emphasis is placed on

# FOCUS ON



*Transformational Satellite Communications System*  
**Image: Boeing**

The TSAT program is composed of three segments and a systems engineering and integration function. The *Space Segment* will consist of five satellites in geosynchronous orbits interconnected by high data rate laser crosslinks. The Space Segment is also comprised of the *TSAT Satellite Operations Element*, which includes a primary TSAT satellite operations center for on-orbit satellite control and the *CONUS Ground Gateway Element* to receive

high rate data transmitted by a TSAT satellite for linking into the *Global Information Grid* (GIG). The *TSAT Mission Operations System (TMOS)* is responsible for network and operational management for the TSAT system, effectively managing TSAT interactions with the GIG. TMOS will incorporate Advanced Extremely High Frequency (AEHF) mission planning capabilities as well. The terminal segment consists of the terminals that will be designed and procured by each of the armed services, based on the requirements allocations from the TSAT program. The Systems Engineering and Integration effort is responsible for integrating Space and TMOS with each other,

and with a broad range of external programs including terminal programs, and the other network domains comprising the GIG.

At program initiation in 2003, the TSAT Program office, in coordination with the Government Accounting Office, identified seven unclassified Key Technology areas as requiring additional maturation. Among these were the antenna system that is being designed to support COTM; laser communications; Next Generation Processor Router, specifically software algorithms that will allow *Dynamic Bandwidth Resource Allocation (DBRA)* and *Bandwidth Efficient Modulation (BEM)*. The DBRA algorithms will provide the military the ability to assign access to the system based on demand and link conditions, while the BEM algorithms allow more efficient use of available bandwidth when link conditions permit. Other key technology areas identified included cryptographic devices—*High Assurance Internet Protocol Encryption* and *Transmission Security*.

These Key Technology areas were the focus of the TSAT program's rigorous risk reduction and system definition activities

over the last four years. The results of these activities were independently reviewed in 2007 as part of a *Technology Readiness Assessment (TRA)*. The TRA results clearly indicate that the technology maturation efforts in each of the Key Technology areas have been highly successful and that each technology is now at an appropriate level of maturity for this phase of the program.

### *TSAT Risk Reduction Program*

The TSAT risk reduction program featured extensive testing and demonstration of contractor prototypes associated with key technologies. The prototypes underwent extensive testing at contractor facilities, and were frequently demonstrated for a broad range of audiences. Government and *Federally Funded Research and Development Center (FFRDC)* personnel were heavily involved in monitoring and assessing these development and test activities.

These tests included not only functional tests of required capabilities, but so-called “pre-qualification” testing aimed at helping the contractor design sound programs for flight hardware qualification.

Prototypes for lasercomm terminals and digital processors underwent an additional level of testing through use of independent government test assets and programs. In 2006, and again in 2007, the prototypes were placed into MIT/Lincoln Labs testbeds that allowed operation and evaluation of the subsystem in signal environments closely approximating that anticipated for the operational system. These tests examined a broad range of required capabilities and proved highly successful in testing and demonstrating the maturity of TSAT’s key technologies. Oversight on the testing was provided by the TSAT program office and its FFRDC support including **The Aerospace Corporation, Mitre Corporation, and MIT/Lincoln Laboratory**, and, in certain cases, **Air Force Research Laboratory** staff members.

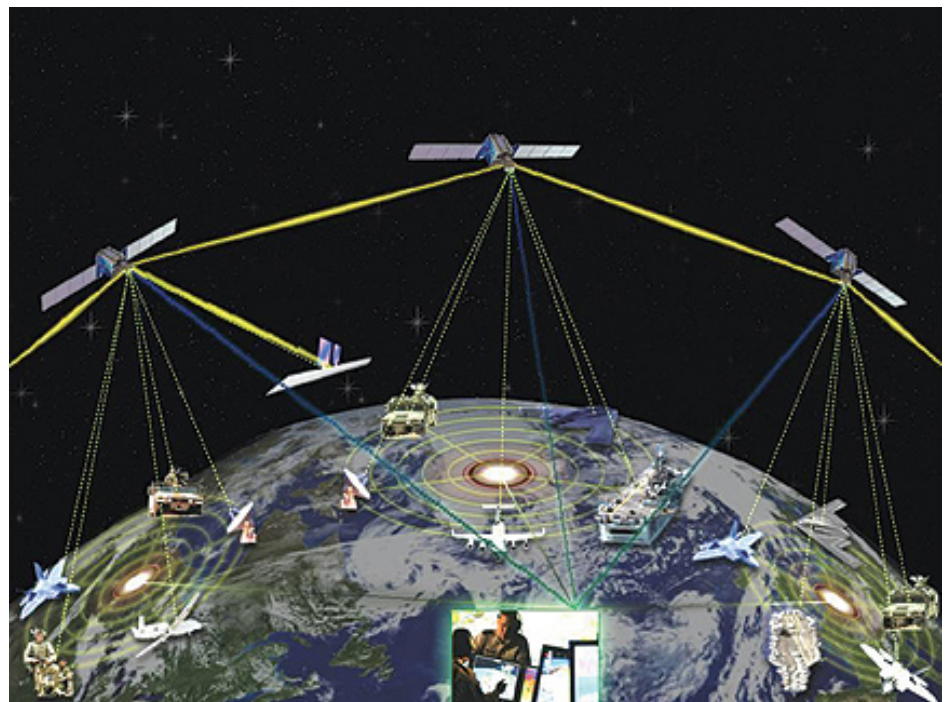
### *TSAT Technology Readiness Assessment*

The *TRA Independent Review Team* consisted of 26 technical experts from AFRL, MIT/Lincoln Laboratory, Mitre Corporation, the *Office of the Assistant Secretary of the Air Force for Acquisition*, and The Aerospace Corporation. In order to provide an independent assessment of TSAT technologies, a criterion for the IRT membership was that members “at present”

not be involved to any significant extent with the TSAT program. The primary function of the team was the identification of *TSAT Critical Technology Elements* and the assignment of *Technology Readiness Levels* to CTEs.

The CTEs were selected based upon the following criteria of criticality of the technology to the program in terms of performance, schedule, or cost; being new or novel; or being an existing technology used in a new or novel manner or in a new environment. Following the review of introductory materials supplied by the TSAT Program Office, a series of kick-off meetings with TSAT contractors, and attendance at Space and TMOS System Design Review Dry Runs, the TRA IRT Team identified approximately sixty-five potential technology items as CTEs. This list was further reduced to a final set of fourteen unclassified CTEs after the team investigated NGPR and laser communications test efforts; reviewed contractor technology demonstrations; held extensive focused discussions with program office personnel and contractors addressing technology criticality, and the viability of technology off-ramps; and continued review of numerous program documents.

TRLs were then assigned to each CTE based on DoD-established definitions that are used to communicate the maturity of the technology. In these definitions, TRL 1 represents the lowest level of technology readiness and TRL 9 represents the actual application of the technology in its final form. TRL 6, a requirement for entering into the preliminary design phase, requires testing of systems in “a relevant environment.”



# FOCUS ON

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## *TRA Results*


The results of the TRA indicate that, of the original seven unclassified Key Technologies, *all* were identified by the TRA to be at TRL 6 or higher. Of the additional seven technologies identified by the TRA as CTEs, six were at TRL 6 or higher. For the one CTE that was not yet at TRL 6 (Application-Specific Integrated Circuits (an integrated circuit that is customized for a particular use), the TRA recognized that significant effort had been applied to maturing the ASIC process and in ensuring that a sound qualification program could be designed. While the TRA assessed ASICs as being at TRL 5, they concluded this was sufficient for the TSAT program to proceed into the preliminary design phase. They also noted that final steps needed to bring the technology to TRL 6 were already underway with completion anticipated in calendar year 2008.

The TRA team also considered the subsequent maturation steps required to take the CTEs to TRL 8 in preparation for flight or operational use, which is a required step for a program to move beyond the preliminary design phase. In no case were significant obstacles identified.

## *Summary*

TSAT will use Internet-style technology to connect warfighters all over the world in a global information network with unprecedented carrying capacity, accessibility, reliability, and protection from jamming, eavesdropping, and nuclear effects. It is the lynchpin of 21<sup>st</sup> century net-centric warfare and will revolutionize military communications. As part of the basic to basics approach, TSAT invested approximately four years and significant resources into maturing critical technologies to the appropriate levels. The success of these efforts has been inde-

pendently assessed and validated by the TRA and TSAT has clearly benefited from its risk reduction efforts. TSAT, therefore, is poised to enter the next phase of development, and continue towards its goal of delivering a revolutionary communications infrastructure to the warfighter.



## MILITARY SATELLITE SYSTEMS: A HISTORY — PART ONE

### *IN THE BEGINNING... The Dance of the Acronyms*

The Space and Missile Systems Center is the birthplace and cradle of military space and the central hub of military space acquisition excellence. SMC's mission is to deliver unrivaled space and missile systems to the joint warfighter and our nation, producing innovative, affordable, and operationally effective space systems.



*The U.S.A.F.'s Space and Missile Systems Center at Los Angeles AFB*

The Space and Missile Systems Center traces its ancestry back to the *Western Development Division (WDD)* of the *Air Research and Development Command (ARDC)*. WDD was activated on July 1, 1954 and was redesignated the *Air Force Ballistic Missile Division (AFBMD)* on June 1, 1957. The organization's original mission was to develop strategic missiles for the Air Force, but ARDC added the responsibility for developing the first military satellite system in October of 1955. The accountability for strategic missiles remained with AFBMD and its successors through the decades that followed, but the Department of Defense (DoD) continued to modify and add to its space mission responsibilities.



*Eisenhower*  
**Credit: Nasa**

In February 1958, the *Eisenhower* administration activated the *Advanced Research Projects Agency (ARPA)* and placed it in charge of all military space programs during their research and development phases. In September 1959, ARPA lost its dominant role. Secretary of Defense *Neil McElroy* divided responsibilities for developing military satellites among the three services. The Army was to develop communication satellites; the Navy, navigation satellites; and the Air Force (in effect, AFBMD), reconnaissance, and surveillance satellites.

Only the Air Force, however, was to develop and launch military space boosters. This arrangement continued until March 1961, when Secretary of Defense *Robert McNamara* gave the Air Force a near monopoly on development of all military space systems, ending the role of the Army and the Navy, except under exceptional circumstances.



*Secretary of Defense Robert McNamara*

# FEATURES

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Some important exceptions to this developmental monopoly occurred during the next 40 years. For example, the development of reconnaissance satellites and related systems soon came under the authority of the *National Reconnaissance Office (NRO)*, and the Navy developed the first, successful, space-based navigation system.

However, the Air Force continued to exercise a predominant responsibility for military space efforts. DOD's *Commission to*

*Assess U.S. National Security Space Management and Organization* recognized the Air Force's predominance in its report published on January 11, 2001. The report was translated into policy when Secretary of Defense *Donald Rumsfeld*, acting on the Commission's recommendations, assigned to the Air Force the "responsibility for planning, programming, and acquisition of space systems" in his assessment



*Secretary of Defense  
Donald Rumsfeld*

of the Commission's report provided to Congress.

By 1961, AFBMD had two parallel missions to perform, but it was not necessarily clear those two missions actually belonged together. Over the next several decades, the missile and space functions were separated and rejoined repeatedly, causing numerous reorganizations and redesignations.

Due to the increasing importance of space systems, the space and missile functions were separated on April 1, 1961, when AFBMD was inactivated and replaced by the *Ballistic Systems Division (BSD)* and the *Space Systems Division (SSD)*. The space and missile functions were reconsolidated on July 1, 1967, in the interest of economy. BSD and SSD were merged to form the *Space and Missile Systems Organization (SAMSO)*.

On May 5, 1990, BSD was redesignated the *Ballistic Missile Organization (BMO)* and realigned under **SSD**. On July 1, 1992, SSD was redesignated the *Space and Missile Systems Center (SMC)*, the name it is known by today. Finally, in September 1993, **BMO** was

inactivated and absorbed by SMC, recreating the situation that had existed in the 1950s and again in the 1970s, when a single organization was responsible for both space and missile programs.

## WESTERN DEVELOPMENT DIVISION RAMPS UP

Military satellite projects were added to the mission of the Western Development Division in the mid-1950's and came to play an increasingly important role in the activities of the Division's successors. The first satellite program was known as the *Military Satellite System*, or *Weapon System 117L (WS 117L)*.



*SAMOS E-1 launch via Atlas-LV3 Agena-A rocket*

The commander of *Air Research and Development Command* transferred responsibility for the program from *Wright Air Development Center* to WDD on October 10, 1955. WS 117L was, in concept, a family of separate subsystems that could carry out different missions. These included photographic reconnaissance and missile warning. However, by the end of 1959, WS 117L had evolved into three separate programs: the Discoverer Program, the Satellite and Missile Observation System (SAMOS), and the Missile Defense Alarm System (MIDAS). SAMOS may have been made into an acronym after the name had been selected to go with MIDAS. Discoverer and SAMOS were to carry out the photographic reconnaissance mission, and MIDAS was to carry out the missile-warning mission.

Under the **WS 117L** program, the visual reconnaissance payloads (which became the **Discoverer** and **SAMOS** programs) were known as **Subsystem E**. The infrared reconnaissance payload (which became the MIDAS early warning program) was called **Subsystem G**. The spacecraft, which finally became the **Agena** upper stage, was called **Subsystem A** for the airframe and **Subsystem B** for the propulsion elements.

## Rediscovering Discoverer

The Discoverer program aimed at developing a film-return photographic reconnaissance satellite. The satellite would carry a camera that took pictures from space as it passed over the Soviet Union and China. Film from the camera would be returned from orbit in a capsule; a parachute would be deployed to slow the descent of the capsule; and the capsule would be recovered either in mid-air or in the ocean.

However, Discoverer's photo-reconnaissance mission was not revealed to the public at the time. It was, instead, presented as an experimental program to develop and test satellite subsystems and explore environmental conditions in space.



*The Agena spacecraft for Discoverer 13, mated to its Thor launch vehicle, at Vandenberg AFB*

Nevertheless, some Discoverer missions carried experimental payloads instead of, or in addition to, their normal reconnaissance payloads. *Mission 3* carried biological experiments, and mission 2 carried simulated experiments, but both were lost in launch failures. Missions 19, 21, 49, 52, 57, 73, 92, and 99 gathered infrared background data for the MIDAS program. Other missions carried geodetic payloads.

The Discoverer Program carried out 38 public launches and achieved many technological breakthroughs. **Discoverer I**, launched in February of 1959, was the world's first polar orbiting satellite. **Discoverer II**, launched in April of 1959, was the first satellite to be:

- Stabilized in orbit in all three axes
- Maneuvered on command from the earth
- Separate a reentry vehicle on command
- Send its reentry vehicle back to earth

**Discoverer XIII**, launched in August of 1960, ejected a capsule that was subsequently recovered in the Pacific Ocean, the first successful recovery of a manmade object ejected from an orbiting satellite.

**Discoverer XIV**, launched in August of 1960, ejected a capsule that was recovered in mid-air northwest of Hawaii by a **JC-119** aircraft, making it the first successful aerial recovery of an object returned from orbit. The capsule from Discoverer XIV was the first to



*President Eisenhower inspecting the capsule from Discover XIII, the first object ever ejected from an orbiting satellite and subsequently recovered.*



A recovery crew of the 6593rd Test Squadron (Special) performs a midair capsule recovery in a JC-119 aircraft

return film from orbit, inaugurating the age of satellite reconnaissance. Satellite reconnaissance filled a crucial need, because President *Eisenhower* had suspended aerial reconnaissance of the Soviet Union just three months earlier after the Soviets had shot down the U-2 spy plane piloted by *Francis Gary Powers*.

The Discoverer Program officially ended after the launch of **Discoverer XXXVIII** in February of 1962. In reality, however, the program continued in a clandestine form until May of 1972 (the date of the last film recovery), carrying out 145 launches, including the 38 Discoverer launches, under the secret code name *Corona*. At the direction first of President *Eisenhower* and later of President *Kennedy*, the direction and management of *Corona* and other satellite reconnaissance programs passed to a new DOD agency, the *National Reconnaissance Office (NRO)*, when it was created in 1961.

In August of 1960, Secretary of the Air Force *Dudley C. Sharp* created an *Office of Missile and Satellite Systems*. Reconnaissance programs under that office reported to the secretary of the Air Force through an undersecretary, *Joseph V. Charyk*. On September 6, 1961, the new *Kennedy Administration* established the **NRO**.

### *Corona + SAMOS Recover Intelligence*

**Corona's** first major accomplishment was to provide photographs of Soviet missile launch complexes. *Corona* also identified the Plesetsk Missile Test Range, north of Moscow, and provided information about what missiles were being developed, tested, and deployed by the U.S.S.R. These and other accomplishments became known when the *CORONA Program* was declassified in February 1995.

**SAMOS**, the second program that evolved from WS 117L, aimed at developing a heavier reconnaissance payload that would be launched by an **Atlas Agena** booster, rather than the *Thor Agena* which was used to launch *Discoverer*. The payloads were intended to collect photographic and electromagnetic reconnaissance data. Cameras in the *Agena* spacecraft, like the *Corona* payloads, would collect the photographic data. However, the film would be scanned electronically in orbit and transmitted to ground stations.

**SAMOS** had three unclassified launches from the west coast in 1960 and 1961. Only the launch in January of 1961 was successful. In 1962, a veil of secrecy was drawn across the **SAMOS** program and the Air Force halted information releases. After several more classified launches, it was apparent that the technology for the electro-optical film readout system was not yet sufficiently advanced—Air Force undersecretary *Joseph V. Charyk* canceled further work on the payload. However, the technology was secretly transferred to *NASA*, which used it successfully in its *Lunar Orbiter* imaging lunar satellites.



Launch of Samos-F2-2 on a Thor-Agena B (SLV-2)

Although *SMC* did not directly manage the development of imaging reconnaissance satellites at this point, it did manage programs that were linked to them, or their products. One of the most important was the *Defense Dissemination System (DDS)*, whose broad outlines were declassified in 1996.

The *Defense Dissemination Program Office (DDPO)* was established at *SAMSO* in July 1974 to develop a means to securely and rapidly provide reconnaissance imagery in nearly original quality to strategic and tactical users. The *DDPO* developed a system consisting of segments for processing, transmitting, and receiving. The system was deployed to four strategic sites during 1976-1978, providing the first electronic dissemination of digital imagery for targeting and strategic threat assessment.

The *DDS* went through three more generations of increasingly sophisticated improvements for compressing, transmitting, receiving, and reconstructing imagery for military users in the field. One of the third-generation *DDS* units was deployed to the Persian Gulf to support *Operations Desert Shield* and *Desert Storm*. Fourth-generation *DDS* units were fielded to 70 strategic and tactical users by 1998. However, the *DDPO* itself ceased to exist as a program office on October 1, 1996, when it was combined with other agencies to create the *National Imagery and Mapping Agency (NIMA)*. As an organization, the *DDPO* was characterized by unusually high *esprit de corps* and received a larger number of *Air Force Organizational Excellence Awards* than any other program office in *SMC's* history.

To Be Continued...

Please join us in the next issue of *MilsatMagazine* as we continue with the history of military satellites, courtesy of the **U.S.A.F.' Space and Missile Center's History Office**, Los Angeles Air Force Base, El Segundo, California