Summer 1998

Volume 5, Issue 2

SWC Space Tactics Bulletin

SPACE WARFARE CENTER

"Achieving America's Victories Through Space Power"

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IN THIS ISSUE

The Space Tactics Bulletin
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The Space Tactics Bulletin is an official, nondirective SWC publication. Its purpose is to update warfighting staffs and units on SWC efforts to effectively employ space assets in support of operations, and provide a forum for information exchange to improve space tactics and procedures. The views and opinions expressed herein, unless otherwise specifically indicated, are those of the individual author. They do not purport to express the views of the SWC Commander, the Department of the Air Force or any other department or agency of the United States Government.

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Welcome to the Spring 1998 edition of the Space Tactics Bulletin (STB). The response to our last issue was outstanding and has drawn many interesting articles from a wide spectrum of players in the space field. We've incorporated a USAF Weapons School Space Division section giving them access to the STB's 4,000 customers. It contains a Weapons School paper on the use of unattended measurement and signature intelligence (MASINT) Sensors to counter the Scud TEL problem--a critical issue for all theaters. You can expect the Weapons School section to be a permanent part of the STB.

Continuing to highlight the importance of ongoing efforts integrating the space and air forces, we've featured articles from AFSPC and USSPACECOM addressing this hot issue. We've also included a short article on how we continue to refine our space tactics now that the first space volume (Volume 28) to Air Force Tactics, Techniques and Procedures 3-1 (AFTTP 3-1) as well as the newest chapter of Volume 2, Space Threats and Countertactics are completed.

In an effort to keep you apprised of emerging technologies, we've included articles on space-based warning for the 21st century and its linkage to the key operational concepts of GLOBAL ENGAGEMENT and Full Force Integration. We've also included the status of the Space-Based Infrared System (SBIRS) designed to replace the aging Defense Support Program (DSP) and the Space Operations Vehicles (SOV) designed for high sortie rate and assured affordable access to space.

Additionally, we'll update you on the Rapid Execution and Combat Targeting (REACT) improved command and control system for our Launch Control Centers across the US. Included is information on the Higher Authority Communications/Rapid Message Processor Element (HAC/RMPE) software operational test, improving Emergency Action Message processing and targeting capabilities of our ICBM force. This will allow extension of the strategic nuclear triad's Minuteman component well into the next millenium.

Keeping you aware of ongoing space warfighter efforts, we have an article on Operation SEEK GUN-FIGHTER--an initiative to raise awareness of the emerging commercial space reconnaissance threat. You will also read about the Space Tasking Order, the use of COMBAT TRACK in Exercise NORTHERN EDGE in Alaska, and the Command and Control Mobile Capability (C2MC) assisting theater command and control centers in the detection, nomination and prosecution of time-critical targets. In addition, there's discussion on two concepts refined by the Space Battlelab and the Air Force Tactical Exploitation of National Capabilities Program (AFTENCAP) project selection and operational test and evaluation processes.

This edition of the STB highlights the overwhelming support from the space audience. The sheer volume of articles submitted emphasizes the need for continued dissemination of space tactics and issues. We thank you.

WILLIAM R. LOONEY III
Brigadier General, USAF
Commander, Space Warfare Center

OPERATIONAL TEST AND EVALUATION DEMYSTIFYING SPACE

Capt Dwain Hamilton, 17 TS/TEK, DSN 560-9682

Difficulty in quantifying the benefits and limitations of many space products is one of the obstacles to moving to a "space and air force." Doing business hundreds or thousands of miles above the planet will bring uncertainties. When uncertainties play into life and death decisions, they are hard to accept. Most space products come with error estimates and caveats. The Global Positioning System (GPS) navigation signal is an example. The 17th Test Squadron (17 TS) recently conducted a preliminary tactical assessment to improve the GPS signal accuracy. Assessments of this type can lead to full scale tactical testing designed to present a warfighter with an accurate picture of the benefits and limitations of using the tactic. Reporting this assessment and communicating the benefits and drawbacks of the tactic to warfighters required carefully worded definitions of what we could and could not test.

Just explaining why GPS isn't 100 percent accurate illustrates the confusing nature of space products. The error experienced by GPS users is comprised of two components, signal-in-space error and user error. Signal-in-space error is made up of satellite position error (the differences between where the satellite thinks it is and where it actually is), timing errors, as well as satellite position in relation to the receiver. You begin by telling a warfighter that GPS accuracy depends on where they are and when they're using the receiver. A GPS receiver looks for a number of satellites to determine its location. The position of the chosen satellites plays an important role in the accuracy of the receiver's solution. Satellites that are spaced apart provide better solutions. These factors can't be glossed over with a "trust-me card," because knowledge of how the system works can lead a user to get a better solution. Knowing that a good solution is influenced by satellite location will hopefully tell the downed aircrew member to not place as much confidence in a reading taken deep in a valley as opposed to one taken from a nearby hilltop.

The second component of GPS error is user error; it is derived from errors in the receivers. Sources include receiver noise, interference, signal degradation as it passes through the atmosphere and multipath-errors generated when the same GPS signal bounces off objects and enters the receiver from multiple directions. Now we've added another dimension to the "when and where" argument and said that each receiver, even of the same type, will have a slightly different accuracy capability. So far, we've checked off seven things that can impact GPS accuracy and all of them change from place to place, time to time and receiver to receiver. Confused yet? Have you noticed we haven't even arrived at whether or not the tactic works?

The tactic assessed by the 17 TS sought to optimize the constellation of satellites in a manner that improves the accuracy of the GPS signal across the earth. The tactic, called Global Optimization, appears to reduce the signal-in-space error. Since signal-in-space error and user error combine to make up the total navigation error, GPS users should see an increase in receiver accuracy. We have to say "should" instead of "will" because we're only talking about one component of GPS error. The other component may randomly increase and nullify the tactic's effect.

The goal of testing a tactic is to illustrate the benefits and limitations to the warfighter. This has proven to be especially difficult in this test, not because there wasn't a benefit, but because the benefit is hard to quantify. During this assessment, the 17 TS learned volumes about quantifying the improvement in total navigation accuracy. Our first limitation centered on the way signal-in-space error and user error combine. A 1-meter improvement in signal-in-space error does not necessarily mean a 1-meter improvement to total navigation accuracy. So we try to quantify it by looking at percentage improvements. The percentage improvement in total navigation error depends heavily on the magnitude of the user error. For instance, given the same signal-in-space error improvement, the smaller the user error, the bigger percentage improvement in total navigation error. The accuracy improvement the warfighter sees also changes because GPS accuracy changes from time to time, place to place and so on. Just to complicate the matter further, the 17 TS assessment showed that while the tactic improved signal-in-space error, those improvements also varied from time to time and from place to place around the globe. The variations seem to be caused by the dynamic nature of the satellite constellation and ground segment capabilities. As you can probably tell, it's easy to lose the important point that there was always improvement, it is the amount of improvement that was hard to quantify.

Lessons learned from this tactic assessment emphasize the need for a comprehensive GPS follow-on operational test and evaluation (FOT&E). The goal is not only to evaluate the system's capability to meet warfighter needs, but to find a way to easily, concisely and accurately communicate how the system does or does not meet those needs. The initial focus of this testing will be to baseline the performance of the system. This is of primary concern because any tactics developed to improve system performance must be compared against realistic expectations of current operational capabilities. This baseline will set meaningful limits to the variations in system capabilities. These limits will enable warfighters to plan on realistic worst-case and best-case scenarios. Testing will also be designed to help identify cause and effect relationships between system configurations and signal-in-space accuracies. The focus on signal-in-space accuracy is necessary because that is the only part of the GPS error budget Air Force Space Command operational crews can affect. To bring results into a warfighter realm, the test would seek to tie the improvements in signal-in-space accuracy to improvements in total navigation. Working closely with GPS users and developers, we can quantify as much of the error budget as possible and come up with meaningful accuracy limits. This would provide a more definitive and useful picture of navigation capabilities for warfighters.

Communicating specific benefits of space to the warfighter can still be challenging. To communicate an accurate picture of space capabilities we are often forced to caveat our advantages, over-emphasize our limitations and use terms normally found in graduate level engineering classes. Comprehensive operational testing of space systems will give us the answers we need to determine space assets' capabilities to meet warfighter needs. The next challenge is to design the tests so that the results are easily communicated and meaningful to warfighters. The GPS FOT&E will be a good opportunity to learn how to do this and apply those lessons to other space systems. Demystifying the capabilities and limitations of the common GPS receiver is only a small step towards operationalizing space. That small step is an important one, however, because as the warfighter becomes more comfortable with space, we can take longer strides toward becoming a "space and air force."

INTEGRATING AIR & SPACE TACTICS

Capt Mike Edinger, 21 SW/OSK, DSN 560-9955

So, we've given you an AFTTP 3-1 manual and now you have a brain full of new tactics ideas. Now what? You need a process to take those ideas, test and evaluate them and get them out to the field. Enter AFI 99-150. From 10-11 February 1998, I attended a conference at ACC, Langley AFB VA, to discuss the development of an all-encompassing Air Force Instruction to govern tactics development for the Combat Air Forces (CAF). This effort will result in a coordinated, integrated tactics development process. The integration of air and space has begun and AFI 99-150 provides us with a golden opportunity to tap into the wealth of experience that exists throughout the Air Force.

The instruction outlines a flexible process for tactics development that involves operators at all levels. Tactics development starts with a recommendation for a new tactic. This comes in the form of a Tactics Improvement Proposal (TIP). Who can recommend a new tactic? That's the best part, anyone can! By submitting a TIP you can suggest a new or improved way of accomplishing your mission. These TIPs are collected by the tactics officers in the operational wings, NAFs and MAJCOMs and reviewed by a board of experts. These boards are known as Tactics Review Boards (TRB).

TRBs are held periodically throughout the year at all different operational levels (squadron, wing, NAF, MAJCOM, CAF). Each board focuses on its particular area of expertise, for example, squadron TRBs focus on mission planning and execution, the NAF TRB focuses on theater level planning, etc. In addition, they review all proposed tactics from the subordinate levels and act as a filter that feeds the next higher board in the chain. The MAJCOM TRB acts as the final filter, reviewing all TIPs and recommendations from subordinate boards.

The MAJCOM TRB then forwards those TIPs they feel are applicable to the CAF TRB for final approval.

The CAF TRB is the final authority for reviewing TIPs and directing tactics development. Their efforts culminate in the creation of a Tactics Development Priority List (TDPL). This document serves as the central tool for tactics development. It sets out a prioritized list of tactics development projects to be worked during the current fiscal year. Then the various test and evaluation agencies conduct development and testing as required.

That's great, but how do we get there from here? Well, the first step is to draft a supplement to the new AFI; this effort is ongoing. We need to build the infrastructure that will allow us to conduct effective tactics development. Next, we need you, the warfighters, to become familiar with the process and begin turning those ideas into TIPs. We must ensure that everyone in the command is exposed to and familiar with the tactics development process. As the system experts, you are the most critical link in the development of effective tactics.

The integration of air and space power is an important first step towards the evolution of a "space and air force." Integrating our tactics is an important milestone along that road.

REDUCING SPACELIFT RANGE TURNAROUND TIME

Capt Wayne Hayes, 45 OSS/OSO, DSN 233-2865

A spacelift range is analogous to a bolt-action rifle; after each launch or shot, a specific sequence of events must be accomplished before the next launch/shot can occur. In spacelift terms, this sequence of events is known as range turnaround. On a rifle range, the quicker you work the bolt between rounds, the more lead you can put on target within any given period. The same holds true for a spacelift range. If we minimize the amount of time required for range turnaround, then we increase the total number of launches possible within any given period. Thus, maximizing our spacelift capacity is the end goal of reducing range turnaround and will enable us to be more responsive to the possible short-notice launch needs of the warfighter.

Turnaround activities common to all launches include reconfiguration of the communications system and various range instrumentation (i.e., optics, radar, telemetry and command systems) along with their supporting computers. After reconfiguration is accomplished, a complete systems check is typically conducted on the day prior to launch (F-1 day). Crew rest requirements must be adhered to throughout the process and, to further complicate the matter, the system operators are, in many cases, the same people who perform the post launch reconfigurations.

Of course, there's no need to "work the bolt" if you're out of "bullets." In effect, we do our own "reloading" by processing each booster for launch. The Space Transportation System (STS) and Titan vehicles are first assembled on a transporter and then moved to the pad for further processing while Delta and Atlas vehicles are assembled on the pad from the ground up. Each of these booster systems have two launch pads at the Eastern Range (ER) specifically configured for their own needs. Booster on-pad processing time lines range from a maximum of 156 days for a Titan IV/Centaur down to a minimum of 30 days for a generic Delta II launch. There are also several days of pad refurbishment following each launch. Although much has been done to streamline booster processing, for the present, range turnaround only becomes an issue between launches from different pads.

Many efforts are underway which, when cumulatively realized, will drastically reduce range turnaround. Much of the ER's instrumentation and infrastructure was built in the 1950's and is very difficult to configure and maintain. Our equipment modernization and automation programs will not only reduce configuration time but will also enhance the reliability and maintainability of range instrumentation. Hand-in-hand with this effort will be the move towards increased reliance on space-based assets for the telemetry, tracking and possibly even command destruct functions historically provided by downrange ground stations. Eliminating or reducing the dependency on these downrange sites will further reduce configuration and checkout time.

Another initiative is a cooperative effort among all range customers to schedule smarter. Every launch operation also has somewhere between 5-10 supporting operations that also must be scheduled on the range. Every slip of a launch date causes a cascade effect throughout the entire schedule. Thus, the more accurate the schedule is earlier on, the more efficient it will be at the present which, in-turn, equates to faster turnarounds. One of the supporting operations scheduled for each launch is the F-1 day checks mentioned earlier. This check provides an end-to-end systems check with the opportunity to identify and correct any problems before the actual countdown begins. Since the vast majority of these systems checks are reaccomplished on launch day, there is a proposal to eliminate the F-1 day checks in favor of extending the launch-day checkouts where necessary. While saving the range an entire day per launch, this proposal will increase the reliance on instrumentation system operators and maintainers to isolate problems and take real-time corrective actions in avoidance of launch countdown scrubs.

On the booster side of the house, the responsible agencies will continue to review and scrutinize their booster processing flows for streamlining opportunities; however, the largest advance in this area will occur with the transition to the Evolved Expendable Launch Vehicle (EELV) currently in development. The EELV concept will utilize a single system with common boosters, engines, structures and spacecraft adapters to fulfill all our spacelift needs ... light, medium or heavy! Also employed in the concept are simplified launch pads with reduced on-pad processing, simplified and launch operations. This system will provide the flexibility to come as close as we possibly can to a "launch-on-demand" capability with current technology.

The net result of these efforts represents a quantum leap over today's range turnaround capabilities. To get more "lead on target," sometimes you just have to build a better "gun." That's essentially what's going on here at the 45th Space Wing.

INTEGRATING AIR AND SPACE

Maj Len Stec, HQ AFSPC/DORM, DSN 692-6851 and
Maj Larry Nikolaus, HQ AFSPC/XPXP, DSN 692-3202

CORONA (October 1996) decisions emphasized the importance of integration as necessary to accomplishing the longer term institutional goal of evolving the Air Force from an "air" force to a "space and air" force. Part of that evolution is tied to the important role the Air Force plays in supporting users of space-derived information, which will influence how the Air Force does business in the future. There are ongoing and planned efforts to develop strategy for integration; assess the policy, doctrinal, education and training, organizational and resource management implications for the Air Force as an institution; and develop a suggested integration time line. Largely as an outcome of the Gulf War, the contribution of information from space systems to support the warfighter has received much attention among decision-makers in the DOD and else where. Space systems owned and operated by military, intelligence, civil, commercial and international organizations and entities provided remote sensing, navigation, surveillance, warning and other kinds of information to a wide range of users, with the Air Force providing most of the national security community's contribution. The Air Force is the designated primary service with the responsibility for acquiring multi-user space systems as part of its functions of organizing, training, equipping and sustaining forces to support operational commanders. CORONA Fall (Oct '97) directed the Air Staff to lead the integration effort.

The Air Force currently has integrated equipment, manpower, organizations, training and doctrine into this effort. HQ AFSPC/DO is leading the near-term (0-5 year) integration effort for AFSPC and has drafted an Implementation Plan (I-Plan) to integrate air and space power. Following AFSPC/CC approval, the I-Plan will be forwarded to the Air Staff for final coordination among other MAJCOMs. The I-Plan will be the cornerstone document for the Air Staff as they lead the AF's integration effort. In addition, HQ AFSPC/XP, the MAJCOM lead for mid- and long-term planning (5-15 years), has developed a Strategic Master Plan, Long Range Plan and a Campaign Plan. Their long-range planning documents take the Air Force through the year 2015.

AFSPC will coordinate their internal efforts while working with external organizations (14 AF for operational inputs and the Space Warfare Center (SWC) for technical inputs) as they build the bridge between the MAJCOM and Air Staff. In addition, AFSPC is hosting the CAF Commanders' Conference at Peterson AFB, 11-14 May 98 with the theme of "Integrating Air and Space."

Space Operations figure prominently in our plans for the future. The integration of air and space will lay the foundation for the "space and air force" of the 21st century. However, a plan for this evolution needs to be developed and implemented. It must be cost effective, viable and set timelines for this all important evolution. The plan being written by Air Force Space Command for the Air Staff does just that and will set the stage for this integration that will propel us into the "space and air force" of the next century.

FIGHTING TOMORROW'S SPACE WARS TODAY

Capt Brian Landis, HQ SWC/AE, DSN 560-8238

The SWC participated in several exercises and wargames during the last year. Wargames differ from exercises in that the timeframe is usually futuristic and no actual systems are flown or tasked. The importance of space assets in conflict resolution is slowly being realized throughout the DoD. Now, game directors coordinate with the space community to ensure space assets are properly played and modeled for the wargames.

GLOBAL ENGAGEMENT '97 was the Air Force's big wargame last year; the SWC was heavily involved in planning and executing the game. We provided participants in every area of the game from players, modelers and assessors.

Many issues come to the surface during these games; often the same issue pops up in several games. The study of these issues allow us to start to analyze how best to fight future wars. The first issue is of time compression in a space war. Airplanes take hours to fly from base to theater, ground forces may take days to deploy enough forces, and naval forces take weeks to get into position; but a space war may be decided in a matter of minutes. The use of lasers and direct ascent anti-satellites (ASATs) can change the balance of forces in minutes, not days. This time compression affects our decision-making process the most; we will not have time to talk about the important decisions to be made, those decisions must be made into policy prior to conflict. A few of the questions facing the policy makers include: Who tasks intelligence assets, the theater commander or the intelligence community? Who authorizes the use of space control assets, USCINCSPACE or the National Command Authority? Are the Rules Of Engagement (ROE) rigid or flexible? Do the ROEs change after the shooting starts in space but no actions are seen on the Earth? These issues and many others are being played out in wargames.

Another interesting problem facing warfighters in the future is the commercial portion of the future space architecture. Most people agree that the commercial use of space will continue to grow; but how does that affect the way we will fight? Commercial communications companies are moving toward a "bandwidth-on-demand" concept. So, you only pay for the bandwidth you actually use. Or, as you need more bandwidth the satellite constellation apportions its payload to let you increase your portion. Commercial imagery will be available in sub-meter resolution in near real-time on the Internet to anyone with an electronic bank account. So, how do we keep our troop movements hidden? Once conflict starts, are commercial platforms viable targets? The issue becomes even more convoluted when both the US and our opponents are using different transponders on the same satellite.

Our future forces will rely on space assets in future conflicts, the issues previously mentioned are only a few that we must deal with as we move into the "space and air force" of the next century. The SWC continues to participate in wargames not only to educate the current capabilities space assets bring to the warfighters but to start to identify the large issues our leadership must consider today in order to achieve our military goals and minimize casualties for tomorrow.

COMMAND AND CONTROL OF SPACE FORCES USING THE SPACE TASKING ORDER

Lt Col John Larned, HQ SWC/DOS, DSN 560-9568

Command and control of military forces is critical to the daily operations of any military organization, be it in peacetime or war. History could very well be different if a given order to bring the cannons forward never reached the soldiers responsible for providing artillery support to a civil war field commander. Even worse would have been the field commander not knowing he had these assets available for his use prior to charging off across the battlefield.

During Operation DESERT STORM, nearly 110,000 coalition air sorties were flown over the 43-day war, an average of 2,555 sorties per day. Tasking these aircraft with mission objectives, weapons to use, and informing them of supporting assets was accomplished by using an Air Tasking Order (ATO). This tasking message was produced and disseminated daily to all flying units and enabled the command and control of the most decisive air campaign in history.

Space assets, both land-based and in-orbit over Southwest Asia, supported all aspects of military operations. Shortly after the conflict, an official Air Force survey concluded: *"DESERT STORM was America's first comprehensive space-supported war."* The Defense Department's April 1992 Title V Report to Congress on DESERT STORM stated: *"The war with Iraq was the first conflict in history to make comprehensive use of space systems support. All of the following helped the Coalition's air, ground and naval forces: the Defense Meteorological Satellite Program (DMSP) weather satellites; US LANDSAT multi-spectral imagery satellites; the GPS; Defense Support Program (DSP) early warning satellites; the Tactical Information Broadcast Service; with communications and intelligence satellites."*

As the United States Air Force moves to integrate space into current and future global military operations, enhancing our current capabilities to monitor the status, synchronize, direct, integrate and execute assigned forces becomes ever more important. To better task Air Force space forces daily and to provide their enhanced capabilities to commanders in warfighting theaters around the globe, the 14 AF Commander and Air Force Component Commander to USCINCSPACE, Major General Jerry Perryman, directed the creation of a Space Tasking Order (STO).

The STO is similar to the ATO. Just as the ATO synchronizes allied air assets to achieve mission objectives, the STO will integrate all component space forces to achieve mission objectives and maintain a worldwide space capability for military and authorized civil users.

In a parallel effort between the Operations Transition Branch (DOO) and the 14 AF chartered Guardian Tiger Team '97-2, the STO message format was developed. Using the United States Message Text Format (USMTF) guide, Air Force and contract personnel defined 14 AF units, systems, message formatting and common tasking definitions. Very much like an ATO, the STO follows the required fields of an ATO with built-in flexibility allowing for the uniqueness of space tasking. The STO is divided into specific mission areas including Warning, Space Control, Command and Control, Space Lift, Weather and Space Support Teams. Using the STO, all of these mission areas will now have a single document which tranforms COMAFSPACE's mission priorities and broad guidance into the specific guidance necessary for planners and units to complete detailed mission taskings.

Producing and disseminating the STO daily will be the mission of the 14 AF Space Operations Center (SOC) located at Vandenberg Air Force Base, California. Current plans call for the STO to be transmitted to users over the Global Command and Control System (GCCS). In the future, the STO may be integrated into the ATO at the theater level to provide an Air and Space Tasking Order for planners and mission execution. In addition, information from national agencies for possible integration into the STO is currently being researched in the attempt to bring detailed space support information to theater warfighters for better integration of space capabilities.

Space assets around the globe and on-station in the "high frontier" will be just as important in any future conflict as they were in DESERT STORM. Better command and control of space assets, better support to the warfighter and better coordination with other DoD organizations and agencies are the goals of 14 AF by establishing the SOC and the STO. Putting "Space in the Face" of any future adversaries just got better.

AIR FORCE TENCAP PROJECT SELECTION AN ANNUAL PROCESS

Maj Harry Leach, HQ SWC/CTO, DSN 560-9554

Each year, representatives from various MAJCOMs, Air Force agencies, laboratories and government contractors gather at the SWC to exchange information directly related to warfighter success. The MAJCOMs and agencies bring their mission needs to the table, while the laboratories and contractors showcase their emerging technologies and research projects. This meeting, known as POC Conference #1, kicks off the annual Air Force Tactical Exploitation of National Capabilities (AFTENCAP) project selection process.

Congress chartered TENCAP in 1977 to provide a venue for each Service to tactically exploit the capabilities of national space systems. While originally designed to support national decision-makers, these space systems provide exceptional capabilities that simply require innovative ideas to exploit those same capabilities for the tactical warfighter. This is where the annual process comes in.

At the conclusion of POC #1, the Talon Outlook branch of AFTENCAP consolidates the Air Force deficiencies and requirements into a Call for Concepts. This package invites organizations to submit concept papers for AFTENCAP funding. While the Call for Concepts package clearly delineates basic requirements for each proposal to meet, there are no limitations on which organizations or individuals may submit proposals. In fact, one of the strengths of the AFTENCAP program is the diversity of the participants each year. When all the submissions are in, the process moves to the next stage.

The Project Screening Working Group (PSWG) convenes each year to review the project proposals for compliance with Call for Concepts guidelines. Additionally, the PSWG brings together varied expertise to analyze the proposals in a "reality check." This year, as part of the FY99 process, the PSWG brought together representatives from two MAJCOMs, as well as representatives from the National Reconnaissance Office, Space Applications Program Office, Aerospace Corporation, Space Battlelab and the Space Warfare Center Operations, Intelligence and Plans Divisions. The group reviewed 58 proposals, eventually approving 23 to move to the next step in the process.

The next major milestone in the process is POC Conference #2. This conference hosts action officers from each MAJCOM and agency participating in the AFTENCAP process to receive briefings on proposals approved by the PSWG. Each briefer has a 15-minute period to present the proposal, followed by a 5-minute question and answer period. At the end of this process, the representative's vote on each proposal using three major grading criteria: military utility, execution risk and transition risk. Project cost is automatically factored into the final rating. When the voting is complete, the MAJCOMs sponsor those projects that have utility for their mission areas or those that may have wide applicability across the Air Force. In the FY99 process, for example, various MAJCOMs sponsored 9 of the 23 projects. This set the stage for the final step in the annual AFTENCAP process.

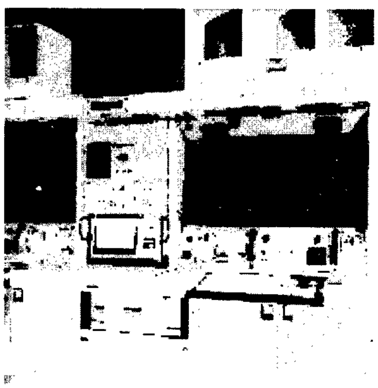
The process concludes with an executive review by the O-6 Review Group. The MAJCOM colonels review the results of the process and may change the ranking of projects to better reflect Air Force needs. Once the projects are in their final order, the group allocates the available funding for the next fiscal year to determine which projects will proceed. Those projects approved, but not funded, are carried on the AF TENCAP books as unfunded requirements for the remainder of the year, and may compete for additional funds.

MAJCOM deficiencies and requirements drive the AFTENCAP process. At each step, the MAJCOMs provide direction on which proposals should advance and which should not. Furthermore, the MAJCOM O-6 representatives make the final funding decisions. The process exists to exploit national capabilities for the warfighter and the MAJCOMs are in the driver's seat. Each MAJCOM has both an action officer and O-6 AFTENCAP representative. They are the conduits for Air Force personnel to inject ideas into the AFTENCAP process.

"MR. PRESIDENT, THE CODES ARE CHANGED"

Capt Jim Jennings, 576 FLTS/TEM, DSN 275-6355

The latest computer software update to the Rapid Execution and Combat Targeting (REACT) Higher Authority Communications/Rapid Message Processor Element (HAC/RMPE) is complete. The intensive and meticulous 24-hour a day analysis of the software code by members of the 576 FLTS started on 23 Feb 98 and came to a close 80 hours later on 26 Feb 98. This was the second scheduled update and subsequent test of the HAC/RMPE software this fiscal year.



HAC/RMPE software is fielded at 50 Launch Control Centers (LCCs) located across the United States. HAC/RMPE offers combat crew members on nuclear alert duty unparalleled Emergency Action Message (EAM) processing, war execution matrix determination and targeting capability. REACT is a major modification to the existing Minuteman III LCCs and HAC/RMPE is a vital component of the REACT Weapon System Control Console (WSCC). The REACT modification gives the President, as advised by the Joint Chiefs of Staff, greater flexibility to execute the nation's ICBM force.

Team members from the 576 FLTS were Capt Don Mowles Jr., Test Director; Capt Erik Hoihjelle, Test Manager; Capt Jim Jennings, Assistant Test Manager; Capt Sandy Gregory, Capt Gerry Harpole and Capt Walt Jimenez, Test Conductors; Capt Lance Adkins, Capt Mike Cancellier and Capt Mark McDonald, Console Operators; and MSgt Ralph Gantt and MSgt Becky Barna, Maintenance Expediters. Personnel from 20 AF and AFMC's Ogden Air Logistics Center observed the test.

The next scheduled software update is set for early Sep '98 and will incorporate changes to the nation's nuclear war plan, the Single Integrated Operational Plan (SIOP), and other improvements deemed necessary by Air Force Space Command.

The 576 FLTS continues to press ahead preparing for the busy spring launch schedule and is proud of our heritage and the contributions we make to the SWC team.

RAPID EXECUTION AND COMBAT TARGETING SYSTEM PROVIDES STATE OF THE ART COMMAND AND CONTROL

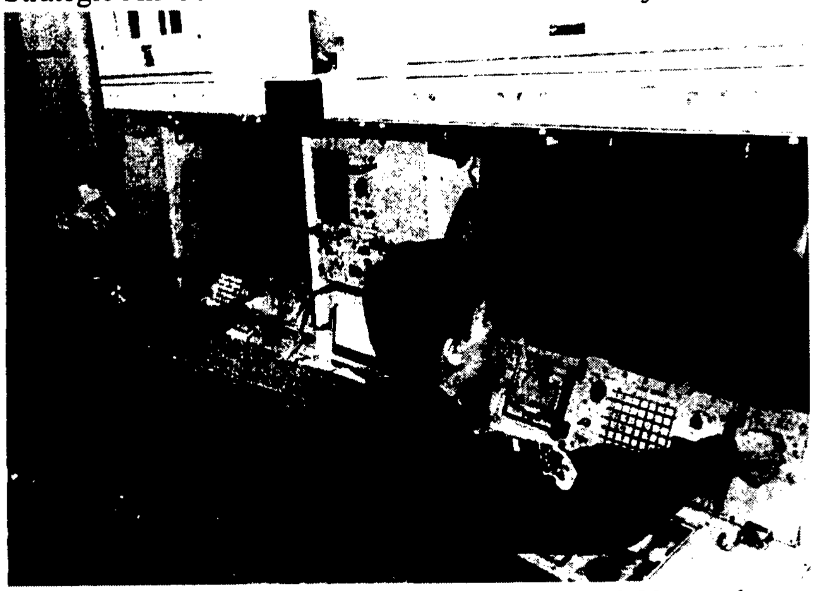
Col Rosser J. Baldwin, Special Asst to 20 AF/CC, DSN 481-5310

Picture yourself 60 to 90 feet underground in a cramped LCC for Minuteman Intercontinental Ballistic Missiles (ICBMs). The LCC is shaped much like a Tylenol gelcap, and the floor is suspended from the ceiling by shock isolators that look much like the shock absorbers on your car. A two-officer missile combat crew composed of a commander and a deputy stand alert within the LCC (or capsule) around the clock.

The commander's console is located up front, about 10-12 feet from the deputy's console on the right side of the capsule. The consoles look like large metal desks, the kind you see at government auctions, with a lot of small lights and switches. Numerous 6-feet high equipment racks line the walls and the front of the capsule. A 1960s-era computer monitors and controls up to 50 missiles located miles away at the end of the buried cable lines. When the crew receives instructions to retarget a missile, they manually enter longitude, latitude and other vital information via a large keyboard into the computer for processing, then later transmit it to the affected missile. These retargeting actions take more than 30 minutes for a crew to complete.

Message traffic from higher headquarters is received over multiple communications systems and printed out on three separate racks that line one wall of the LCC. When traffic is received, one of the crew members must get up from his or her console to retrieve all of the message copies for the crew to use. During wartime, this would significantly complicate and slow down the crew's response because a crew member has to move all over the LCC just to retrieve one message.

It might surprise you to learn that the above depicts the state of ICBM command and control in the early '90s, rather than the '60s or '70s. However, Air Force Space Command (AFSPC) was already in the process of bringing to fruition several upgrades to Minuteman command and control (C2) that were initiated by Strategic Air Command in the late '80s with the objective of fielding a state of the art C2 system. AFSPC began fielding this system under the Rapid Execution and Combat Targeting (REACT) program in 1994.



As a result, today's Minuteman LCCs look significantly different from those of the early '90s. The primary difference lies in the new REACT console. The old commander and deputy consoles were combined into one streamlined workstation on the right side of the LCC. Now, the commander and deputy sit side by side with nearly everything they need to conduct day-to-day operations (including Emergency War Order procedures) at their finger tips. Each crew member receives data over two computer screens. The weapon system screen displays the status of the LCC and 50 squadron missiles, whereas the Higher-Authority (HA) screen displays incoming message traffic and the operational status of different communications systems. The crew members use a separate keyboard and track ball to input data. The REACT software uses Window's-type screen displays that allow quick and reliable tracking of weapon system status and input of data. Senior missile instructor, Capt Tracy Patton, indicates that REACT provides the crew much better situation awareness than the old command data buffer (CDB) system did. "We can view the status of all 50 squadron missiles at the same time as we display detailed status for our 10 primary sorties and the LCC. This provides much greater awareness of what's going on in the entire squadron than CDB provided."

REACT integrates all communication systems into the console, so the crew members never have to leave their positions to check messages received via different systems. The messages are automatically routed to the HA monitor for crew member response. Retransmissions of messages are suppressed to preclude interrupting crew member actions. An interactive decode feature greatly facilitates crew member processing of messages. The resulting rapid message processing capability greatly enhances the crew's ability to respond to time-sensitive retargeting and execution messages, then perform required commands to affected missiles. The REACT system does all this while ensuring positive control of nuclear weapons by requiring both crew members to individually take a number of actions prior to missile launch. Missile instructor commander, Capt Mike Assid, described it this way. "The old CDB system required us to run all over the LCC to react to and process EWO messages. REACT integrates virtually all our critical tasks into a single console. That allows us to perform all our actions to go to war without ever having to get out of our chairs." Assid further praised REACT as a system that's quite "intuitive" to operate for officers brought up in the computer age.

REACT also provides an enhanced capability to rapidly retarget Minuteman ICBMs. This new command and control system provides the ability to transfer targeting data and preparatory launch instructions received from higher headquarters, directly into the LCC computer for quick transfer to the affected missiles. This capability significantly increases the responsiveness of the Minuteman alert force by reducing the time involved in retargeting missiles. Moreover, it greatly enhances the capability of missile crews to address emerging threats posed by former adversaries or rogue states per NCA direction. As Patton describes it, rapid retargeting is one of the "biggest advantages" of REACT. "Retargeting used to be one of the most cumbersome and time-consuming tasks in the CDB system. It typically took a crew more than 30 minutes to manually insert each and every targeting parameter into the affected missile. With the REACT system, we can reduce the time required to retarget an ICBM in response to NCA direction by nearly 75 percent."

AFSPC completed the REACT upgrade of Minuteman LCCs at F. E. Warren AFB, Wyoming, Malmstrom AFB, Montana and Minot AFB, North Dakota in 1996 at a cost of $650 million. The REACT system has proven vastly more effective and efficient than the system it replaced, but like all things, it can be improved. We plan to do so through a number of initiatives in the near future.

First, we want to upgrade the computer system's random access memory from 4 to 16 megabytes. This memory upgrade will enable REACT to accommodate other planned improvements while also reserving memory to support future advances. Second, we will automate the Target and Timing Document which is used by crew members to ensure the proper targeting of ICBMs with the required launch timing in the event of war. Third, based on crew member inputs, the launch facility display on the weapon system screen will be improved through prioritization of status, better use of colors and separation of security status from operational missile status. Fourth, we will upgrade the REACT system's software to support the Guidance Replacement Program (GRP) which is designed to modernize the electronics within the Minuteman guidance system. This software change will significantly decrease the time required to run certain tests and calibrations to ICBMs.

As a result of the REACT upgrade and follow-on enhancements, the Minuteman weapon system will continue to provide an essential leg of the strategic nuclear triad well into the next millennium. By operating this advanced command and control system, AFSPC missile crews underwrite deterrence with a highly ready, reliable and responsive nuclear retaliatory force. Moreover, by maintaining their around-the-clock vigil, these Air Force professionals help ensure continued peace and prosperity for our great nation in an unpredictable world.

SPACE-BASED INFRARED SYSTEM (SBIRS)

Maj Ron Thompson, HQ AFSPC/DORM, DSN 692-5483

SBIRS is the next generation space-based non-imaging infrared system, designed to replace the DSP. SBIRS is designed to support four missions: Missile Warning, Missile Defense, Technical Intelligence and Battlespace Characterization. The system consists of satellites in Geosynchronous Orbit (GEO), sensors on satellites in Highly Elliptical Orbits (HEO), satellites in Low Earth Orbit (LEO) and the associated ground elements. SBIRS is to be acquired in three increments:

Increment 1: Consolidation of the ground elements for the current system (DSP and ALERT) in FY99.
Increment 2: Addition of the GEO/HEO space assets and the associated ground upgrade starting in FY02
Increment 3: Addition of the LEO space assets and the associated ground upgrades starting in FY04.

SBIRS Increment 1 is proceeding on schedule, with software delivery of Spiral 7.2 expected in Mar '98. This software includes strategic and theater mission processing, as well as telemetry, tracking and commanding. Initial Operational Capability of the consolidation phase (Increment 1) is scheduled for late 3rd quarter '99.

The project is currently on schedule and is expected to follow the incremental time lines.

SPACE-BASED WARNING FOR THE 21ST CENTURY ENABLING FULL SPECTRUM DOMINANCE

Maj Scott Hendersen, HQ USSPACECOM/J5R, DSN 692-3134

Accurate SBIRS impact point improves passive defesnse

In the quest for full-dimensional protection, a cornerstone of Joint Vision 2010, theater commanders must leverage their space capabilities in order to maximize the force they bring to the fight. With the goal of exploiting the advantages of space, US Space Command's vision is built upon key operational concepts. Two of those concepts, which directly impact the theater commander, are GLOBAL ENGAGEMENT and Full Force Integration. In support of these operational concepts, Space Command is developing a new surveillance system called SBIRS. In the future, SBIRS will give the warfighter a significant tool to augment surface and air surveillance systems. In particular, SBIRS is the first step toward a truly global engagement capacity and is directed at helping troops on the ground.

The proliferation of missiles and weapons of mass destruction drives the US toward a more robust defensive capability. The vantage of space adds a global view, which is unconstrained by geography and politics. By significantly improving our space-based sensor network, SBIRS will directly contribute to a top priority mission of nearly all regional commanders; missile defense (which includes passive defense, active defense and attack operations). Doctrine for Joint Theater Missile Defense defines passive defense as "measures taken to posture the force to reduce vulnerability and minimize the effects of a theater missile attack.[1]" SBIRS will drastically improve the impact point prediction provided to the commander on the ground. This ensures only the forces in danger are required to implement protective measures, significantly reducing the negative impact on operations tempo that typically results when a missile impact is thought to be imminent.

Improved launch point prediction can aid in attack operations

Active defense consists of "operations to protect against a theater missile attack by destroying airborne launch platforms and/or destroying missiles in flight." SBIRS will provide a very accurate estimate of the missile's position and velocity to weapon systems in theater designed to shoot down incoming missiles. The result is that a single AEGIS destroyer or ground-based anti-ballistic missile system can defend a much larger area than it could using only its inherent radar.

Finally, SBIRS will aid in attack operations; "those operations taken to destroy, disrupt or neutralize theater missile launch platforms .... before, during and after launch." Building on lead developed by the ALERT program, SBIRS will provide a more accurate predicted launch point, which will minimize the area that must be searched by airborne sensors in theater such as JSTARS. A small search basket enables a JSTARS to pinpoint its search pattern, which increases the probability of detecting mobile launchers on the move. Once the launcher is detected by JSTARS, the theater commander has a number of options at his disposal to kill it.

In the battle for full spectrum dominance, space systems such as SBIRS will play an increasing role in the regional commanders battle plans. It is essential that the commander prosecuting the next campaign be prepared to exploit the space medium to give US forces the edge they need to fight and win.

The SBIRS program, the first phase consisting of four geosynchronous satellites and two highly elliptical sensors, is on track to be deployed starting in 2002. With a final operational capability in 2005, SBIRS will begin to make full spectrum dominance a reality for future regional commanders.

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[1]*Joint Pub 3-01.5 "Doctrine for Joint Theater Missile Defense," 23 Feb 1996*

NOTIONAL SPACE OPERATIONS VEHICLES (SOVs)

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To maintain our status as the preeminent military space power, the Air Force has formed strong partnerships to produce our next generation space force. In 1996, the SOV Integrated Concept Team, consisting of key Air Force and NASA members, began working together to establish operational concepts, determine system requirements and identify key technologies for a multi-mission reusable space vehicle to provide the nation affordable and responsive space operations. Additionally, in 1997, the Air Force stood up a Technology Program Office to manage SOV system technology development. Two $4M contracts were awarded to develop a concept definition and initial ground test articles.

The Air Force will team up with NASA on its Future-X vehicle program to test operability technologies essential for the SOV's military utility. The projected technology schedule will support Future-X demonstration flights as early as 2003. This vital partnership will continue to tackle challenges in key technologies, such as a more efficient propulsion system, to ensure future generation SOVs continue to significantly reduce space operation costs.

Space has evolved into such a critical enabling element for our military force that "Joint Vision 2010" identifies space as the fourth medium of warfare. Current space systems, however, have significant deficiencies in the critical ability to control space, meeting launch-on-demand, and operational responsiveness requirements. The rapid response, quick turnaround and high maneuverability of the SOV system will answer these shortfalls by providing greater space asset protection and enabling US forces to achieve and maintain space superiority. It's unpredictable lauñch times and azimuths, coupled with tremendous speed, will ensure commanders retain the advantage of surprise while operating well above current and projected threats. Time-critical tactical spacelift support for regional CINCs will be accomplished in hours or days instead of weeks or months. The SOV will bring unique capabilities to the warfighter early in the conflict. Onboard intelligence, surveillance and reconnaissance suites could pass critical information directly to the warfighter. This "first to the fight" capability assures the theater commander maintains a distinct advantage while his other forces are being deployed or generated to alert.

This revolutionary system, designed for high sortie rate operations and assured affordable access to space, will provide global and orbital payload delivery within hours of notification and within minutes of launch. Combined with existing air, ground and naval forces, the SOV system will be a true force multiplier and strengthen national defense strategy through omnipresence into areas unattainable by other forces. With the SOV's ability to rapidly establish virtual presence, and with capabilities that span several operational areas while employing inherent speed, range, flexibility and precision, the "Joint Vision 2010" goal of Full Spectrum Dominance will become significantly more achievable.

SATELLITE MANEUVERING USING ELECTRIC PROPULSION

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I. Introduction

Electric propulsion enables more satellite maneuvers than chemical propulsion because of its higher specific impulse (exhaust velocity). Chemical propulsion's specific impulse is in the range of 100s of seconds, whereas electric propulsion's is on the order of a 1,000 seconds or more. Thus, for a given maneuver (impulse) electric propulsion uses less propellant than chemical propulsion, roughly by the ratio of the chemical propulsion's specific impulse to the electric propulsion's specific impulse.

Satellite maneuvering exploits this advantage as illustrated by three cases: 1) maneuvering a satellite in geosynchronous earth orbit (GEO) to survey ground targets; 2) altering a satellite's arrival time over a ground target and 3) maneuvering a satellite for close-up surveillance of GEO satellites.

II. Maneuvering In GEO to Survey Ground Targets

The earth is motionless as viewed from a satellite in GEO. When a satellite is to be maneuvered, its altitude is changed and the earth rotates under the satellite. When the satellite is near the target, the satellite is returned to GEO where it remains stationary over the target. The greater the altitude change, the greater the speed relative to the Earth. Electric propulsion, because of its higher specific impulse, uses less propellant than chemical propulsion for an altitude change commensurate with a given maneuver speed. Thus, for a fixed onboard propellant mass, electric propulsion performs more maneuvers than chemical propulsion. Conversely, if both propulsion systems use the same amount of propellant for a given maneuver, the electrically propelled satellite maneuvers faster because its altitude change is greater. Examples are shown below.

We compare three types of electric propulsion, differing in how they produce thrust, to chemical propulsion for maneuvering a variety of satellites 180 degrees (halfway around the world). They are 1) Pulsed Plasma Thruster (PPT); 2) Stationary Plasma Thruster (SPT) and 3) Ion, ion engine. The table values are how many times more maneuvers and how much faster electric propulsion are than chemical propulsion for a given maneuver. For example, a "x5" in the "# Maneuvers" column means five times more maneuvers, and in the "Speed" column means five times faster than chemical propulsion.

The table shows electric propulsion can do up to twelve times as many maneuvers for the same onboard propellant mass, and is up to twelve times faster for the same propellant mass per maneuver than chemical propulsion.

Satellite (mass, power)

Electric Thruster	114kg,50W # Maneuvers (1)	Speed (2)	455kg, 500W # Maneuvers (1)	Speed (2)	227kg, 2000W # Maneuvers	Speed (2)
PPT	X5	X5				
SPT			X5	X5		
Ion					X12	X12

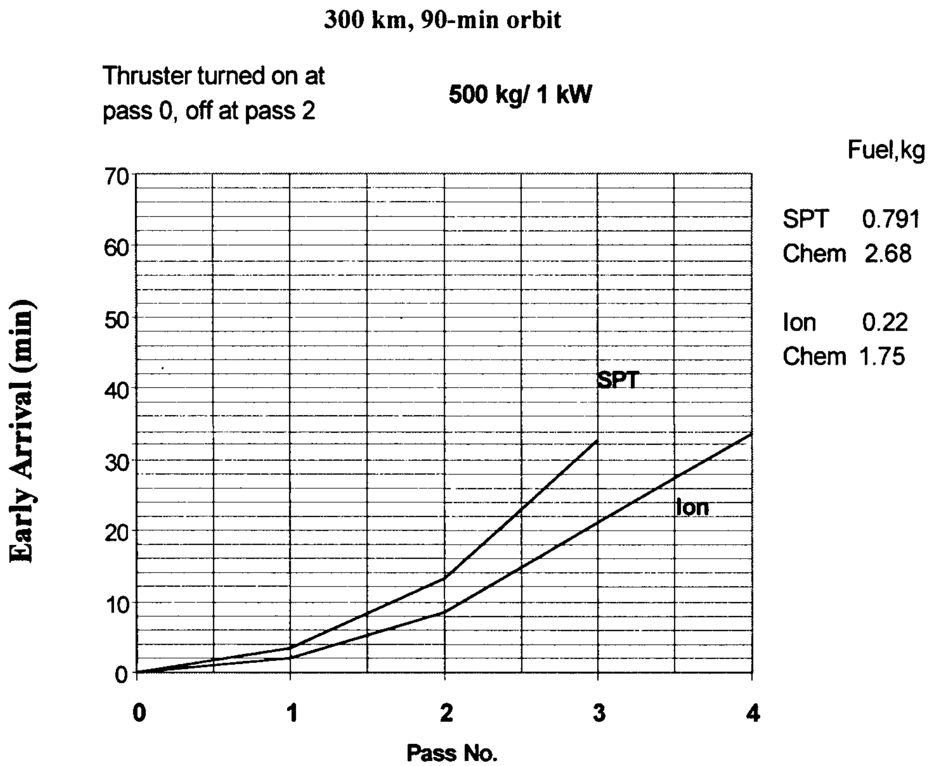
(1) Electric propulsion and chemical propulsion have the same onboard propellant mass
(2) Electric propulsion and chemical propulsion use same propellant mass per maneuver

III. Changing Arrival Time Over the Ground Target

A surveillance satellite in LEO that arrives earlier than expected over a target has the element of surprise. It can inspect the target before the target is "hidden." In this example the surveillance satellite is in a 300-km orbit with a 90-minute period, i.e., one orbital revolution in 90 minutes.

The thruster is turned on a pass number zero over the target, and the satellite's orbit is lowered. The earth rotates under the orbit until thirty-two orbits later the satellite again passes over the target (pass 1). It arrives earlier than it would have originally because it's in a shorter period orbit. The thruster is turned off at the next target fly over (32 orbits later, on pass 2). The satellite continues to arrive earlier on each pass until it arrives 90 minutes early. It's now in phase with what would have been its fly over time if in the original orbit. The cycle repeats.

The plot below shows arrival time vs pass number and compares electric propulsion propellant consumption with chemical propulsion (Chem.) for the same arrival times. The satellite's mass is 500 kg and it has 1 kW of power.



This plot shows the SPT consumes 30% and the ion engine consumes 13% of the fuel mass chemical propulsion would consume in altering fly over time. Thus, for the same amount of onboard propellant mass, the SPT can do three times and the ion engine seven times as many of these maneuvers as chemical propulsion.

IV. Maneuvering For Surveillance of Satellites in GEO

Two cases are considered:

1) The observation satellite is in an orbit just below GEO. It passes under every satellite in GEO once every thirty days because of the difference between its orbital period and that of GEO. If a close-up view of a satellite is needed, the observation satellite is raised at the right time to GEO, so that (for purposes of this analysis) it intersects (is arbitrarily close to) the target satellite. After reconnaissance, the satellite is returned to its original cruising orbit where it continues circumnavigating objects in GEO every 30 days until commanded again to surveil a satellite.

2) The observation satellite is in GEO. When a close-up view of a satellite is needed, the observation satellite is commanded to "intersect" the target satellite. This is the GEO maneuver described in Section II. After reconnaissance the observation satellite can remain where it is, maneuver back to its original position, or maneuver to a new position in GEO, until commanded again.

The following example assumes a surveillance satellite with mass 227-kg, and 500W of electrical power. CP is chemical propulsion.

Case 1: The observation satellite is in cruising orbit just under GEO. The table shows that the SPT can do six times more observation than chemical propulsion for the same onboard propellant mass.

	Cruise alt. To GEO		GEO to Cruise alt.		Total Propellant
Thruster	Time (days)	Propellant (kg)	Time (days)	Propellant (kg)	kg
SPT	4.47	0.891	4.47	0.891	1.78
CP	0	6.01	0	6.01	12

Case 2: The observation satellite is stationed in GEO. The table below shows that the SPT can do three times more observations than chemical propulsion for the same onboard propellant mass.

Thruster	Maneuver	Transit Time	Propellant Mass
	(deg)	(days)	(kg)
SPT	180	12.4	2.48
CP	180	12.4	8.39
SPT	90	8.81	1.76
CP	90	8.81	5.81
SPT	30	5.1	1.02
CP	30	5.1	3.32

In addition to the advantages, electric propulsion's inherently low thrust (a small fraction of a pound) enables precise maneuvers around the target satellite.

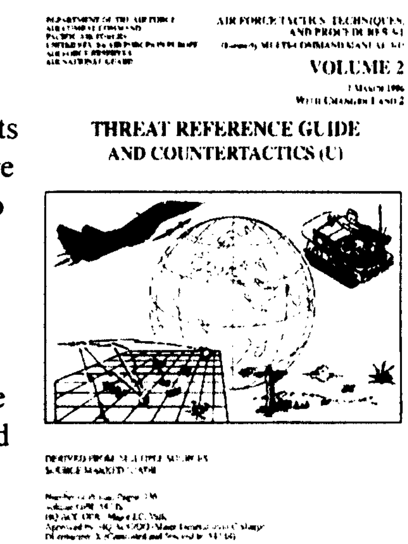
V. Summary

We have shown that electric propulsion, because of its higher specific impulse, offers more efficient orbital maneuvers than chemical propulsion. This provides enhanced capabilities, such as more or faster maneuvers or both, for surveying ground and space targets from space.

AIR FORCE TACTICS, TECHNIQUES AND PROCEDURES (AFTTP) 3-1, VOLUME 2, THREAT REFERENCE GUIDE AND COUNTERTACTICS, SPACE

Capt Thomas E. Meyer, HQ SWC/DOW, DSN 560-9593

AFTTP 3-1, Volume 2 is designed to provide users with threat information to effectively plan and execute combat missions and return home safely. The threat to our space systems and products plays a major role in combat operations planning. From 13-27 Feb 98, a dedicated group of space operations officers and intelligence analysts identified what the threats are and sat down to write the first-ever space chapter for Volume 2. Our focus was the same as the rest of the volume: identify only current operational threats that can affect the warfighter today; maintaining that focus was not easy. There are distinct differences between air and space threats, which must be taken into account. For instance, how do consortium communications satellite platforms like international telecommunications satellite (INTELSAT) and international maritime satellite (INMARSAT) pose a threat to US forces? Or, does widely available imagery from imaging systems like satellite pour l'observation de la terre (SPOT) and land satellite (LANDSAT) provide a ready-made intelligence program for countries without their own dedicated space assets? What are valid countertactics against these systems? The team made a good first stab at answering these questions; future updates will refine the space threats and



countertactics. Other parts of the space chapter are more clearly related to ground-based operations. These include the plethora of uplink and downlink jammers; dedicated ground and air-launched antisatellite weapons; and directed energy weapons.

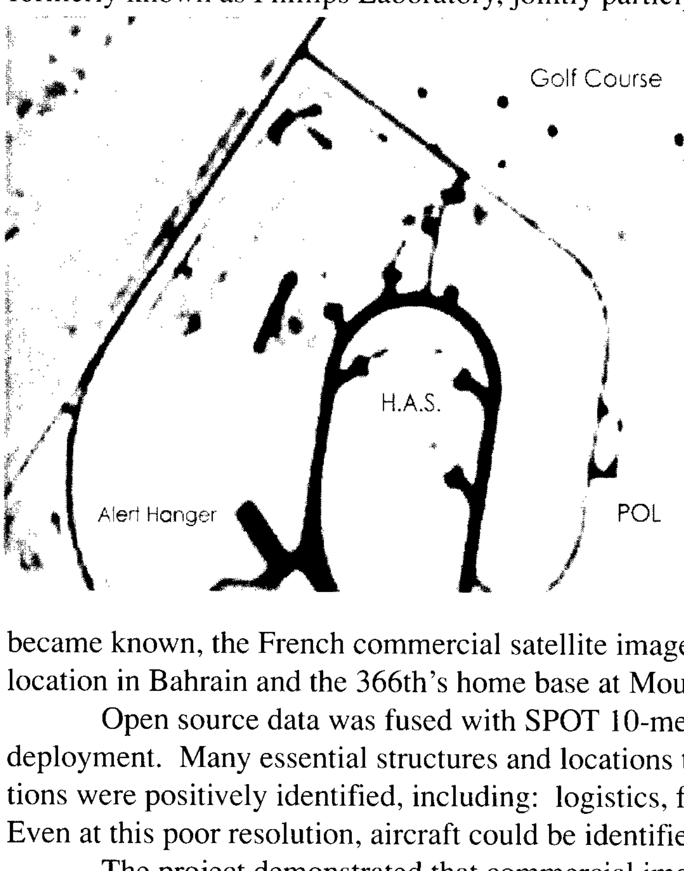
Like other volumes in the AFTTP 3-1 series, Volume 2 will be released on CD-ROM. This provides an opportunity to include links between related sections within a chapter or to other chapters. Videos, animation and sound will provide information in a format that can be more easily understood and used by operators and planners. The space chapter contains many video and sound clips that act as a means of educating Space Command's air-breathing counterparts in orbital dynamics and the effect on space-borne threats. Also, given the amount of space available on a CD-ROM, additional information in the form of Weapon School papers, intelligence documents or other references can be included and linked to the main text body. Finally, computer programs that are useful in threat analysis may be included. Future updates of Chapter 14 may include orbit visualization tools like Space and Missile Analysis Tool (SMAT).

The updated Volume 2 will be available in July 1998. Take a good hard look at the space chapter and provide your comments on the comment/critique sheet provided. This volume is updated every 8 months, so comments you provide now will be included ASAP. Along with AFTTP 3-1, Volume 28, Tactical Employment, Space, this chapter in Volume 2 will continue to bridge the gap between today's air and space forces.

OPERATION SEEK GUNFIGHTER

MSgt John Weeber, HQ SWC/IN, DSN 560-9260

Operation SEEK GUNFIGHTER was conducted as an initiative of the newly formed Aggressor Space Applications Project (ASAP) located at the SWC. The SWC and the Air Force Research Laboratory (AFRL), formerly known as Phillips Laboratory, jointly participated in the operation.



ASAP was initiated to raise awareness of the emerging commercial space reconnaissance threat. It does so by emulating the capabilities of potential adversaries by using commercial satellite imagery and open-source information to obtain operational intelligence about our forces and facilities. The ASAP Team includes a "Red Cell" that tasks commercial satellite systems to image Air Force exercises and deployments. The Red Cell uses publicly available information to tip-off collection as well as augments the imagery analysis.

SEEK GUNFIGHTER focused on the deployment of the 366th Air Expeditionary Wing to Bahrain in September 1997. ASAP Red Cell members learned of the deployment several weeks in advance using open sources (primarily the Internet). As more details became known, the French commercial satellite imagery system, SPOT, was tasked to image the deployed location in Bahrain and the 366th's home base at Mountain Home AFB, Idaho.

Open source data was fused with SPOT 10-meter imagery (shown left) to gain valuable insight on the deployment. Many essential structures and locations that an adversary could use to target US forces and operations were positively identified, including: logistics, fuel storage, hangers, tent cities and security perimeters. Even at this poor resolution, aircraft could be identified.

The project demonstrated that commercial imagery and open sources could provide a valuable intelligence picture of an Air Expeditionary Force (AEF) deployment. The ASAP team is presently working on a

Korean Capabilities Scenario, an Iranian Study and gearing up for the next AEF deployment, dubbed GUNFIGHTER II.

COMMAND AND CONTROL MOBILE CAPABILITY (C2MC) A NEW WAY TO SCUD HUNT

Maj Don Allen, HQ SWC/CT, DSN 560-9051
Capt Derek Wong, HQ SWC/CT, DSN 560-9924

The photo right is not a prop from "Stripes 2", it's the developmental van used by the SWC for C2MC. C2MC is an FY97/98 Air Force Tactical Exploitation of National Capabilities (AF TENCAP) project developed by the SWC's Talon Command branch to assist command and control centers in the detection, nomination and prosecution of time-critical targets (TCT's) through improvements in existing software, while also providing an improved situational awareness display.

THE C2MC VAN AT ROVING SANDS '97

C2MC is capable of bringing in and fusing multiple intelligence data, such as Signal Intelligence (SIGINT) and Measurement and Signature Intelligence (MASINT), as well as tactical data from aircraft like the U-2 and the E-8 JSTARS (Joint Surveillance and Target Attack Radar System). This data allows C2MC to locate and nominate TCTs, such as theater missile transporter-erector-launchers (TEL's) and mobile command posts. Attack aircraft or Army Tactical Missiles (ATACM's) can then be tasked to attack these targets. C2MC ties directly into the Air Operations Center (AOC) or Control and Reporting Center (CRC) Contingency Theater Automated Planning System (CTAPS) local area network (LAN). This gives C2MC the capability to search the Air Tasking Order (ATO) for the right mix of available aircraft and weapons to strike TCT's.

C2MC receives warning messages about incoming theater ballistic missiles (TBM's) from the 11th Space Warning Squadron Alert Launch Early Reporting to Theater (ALERT) facility and several other sources. C2MC can then warn US and coalition forces of the inbound missile and cue friendly Patriot defense batteries to help engage these missiles. This helps increase the chances that the incoming missile will be destroyed well before it can impact among friendly forces. C2MC does all three pillars of Theater Missile Defense (TMD) (Active Defense, Passive Defense, Attack Operations) and also provides a situational awareness tool called the Common Battlespace Display (CBD). The CBD gives commanders a fused air; ground and sea picture of friendly and known or suspected enemy units. The CBD is similar to the Global Command and Control System (GCCS) Common Operational Picture (COP) but the CBD is not a replacement for the COP.

Maj Allen, Senator Wayne Allard (R-CO), Lt Col P reissinger and Capt Wong pose in front of the C2MC van parked at the Capitol Building in Washington DC

C2MC was tested at several exercises in 1997. The first exercise C2MC supported was ROVING SANDS (RS) '97, where the C2MC and the CRC staff were delegated the task of handling the entire target prosecution for the exercise. At WARRIOR FLAG '97 the system's theater battle management tools were used to enhance the exercise's TMD cell. C2MC showed its flexibility by switching its role from the All Service Combat Identification and Evaluation Team (ASCIET) '97 exercise to one of showing the complete air and ground picture for the newly designated Regional Air Defense Coordinator (RADC) position, providing the effective air defense of a large land and sea defended area. Following ASCIET, the C2MC van made stops at ACC, the Air Force Association Convention in Washington DC, the Pentagon, Capitol Hill and Hanscom AFB to show its enhanced space-aided TMD capabilities to various DOD and congressional visitors.

In 1998, C2MC is hoping to participate in Expeditionary Force Experiment (EFX) '98, ULCHI FOCUS LENS '98 and an integration test with the Command and Control Test Integration Center (C2TIC) at Hurlburt Field FL.

TRACKING NORTHERN EDGE (NE) '98 FROM SPACE

Maj Dave Micheletti, HQ SWC/DOX, DSN 560-9351

During NE '98, 14-19 Feb 98, airlifters and mission support personnel surfed technology's latest wave using COMBAT TRACK for the first time in Alaska. Invited to NE '98 as part of the exercise's In-Transit Visibility (ITV) focus, COMBAT TRACK is a "snap-on" command and control system allowing theater air mobility commanders to track and communicate with aircraft and locate cargo and passengers. For NE '98, COMBAT TRACK was installed on a C-130 from the 517 Airlift Squadron (517 AS), Elmendorf AFB AK, and a C-141 from the 62 Airlift Wing (62 AW), McChord AFB WA. The ground unit was placed in the Alaskan Command headquarters to act as the Command and Relay Station (CRS).

COMBAT TRACK uses an ultra-high frequency military satellite communication channel and Global Positioning System (GPS) broadcasts to give airlift crews and logisticians on the ground instant information on aircraft location, load plans and cargo, as well as secure two-way E-mail.

Navigators can also use the laptop computer to plot a route on the computer's screen and accurately follow their progress. With the click of a button, air mobility directors and airdrop/airbridge mission schedulers on the ground can also get aircraft cargo information and maintenance status. If additional information is required, ground operators can send and receive secure E-mail directly from the aircraft. For instance, if you're tracking a C-130 loaded with Army personnel en route to the drop zone, you can receive information about who jumped and who didn't jump via E-mail from the COMBAT TRACK operator on the aircraft. Commanders on the ground would also know immediately if an aircraft diverted due to adverse weather or other conditions in the drop zone.

The near-real-time information was all good news for navigators at the 517 AS. The C-130 unit flew three Northern Edge sorties equipped with COMBAT TRACK. Maj Terry Huff, a navigator on one mission, said "COMBAT TRACK provided me with immediate situational awareness, as well as the location and cargo on other aircraft in the 'package'." "The E-mail capability from aircraft to aircraft is real nice," Huff said. "You can E-mail your exact maintenance status. People can also accurately monitor your location, intention and what you're carrying." A quick look at the computer screen also gives your aircraft's location on a full-color map, he added. "If you're part of a big aircraft package, it lets you see where the other guys are you have to hook up with."

Since Aug '95, COMBAT TRACK has flown onboard C-141, C-17, C-130 and KC-135 aircraft in support of airlift missions from the US to bases in Europe, the Near East, Haiti and the Pacific region. COMBAT TRACK was used during the Pacific Airlift Rally in Jun '97, the Air and Space Firepower Demonstration in

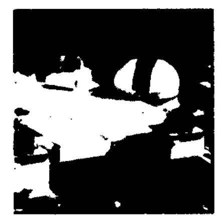
Oct '97 and directly supported two Air Expeditionary Force (AEF) deployments to the Middle East.

Development of an improved COMBAT TRACK unit, called TRACK II, continues with initial delivery of three units expected early Mar '98. The US Coast Guard Fourteenth District will begin a 6-month operational evaluation using COMBAT TRACK beginning in Mar '98. Demonstration of TRACK II capabilities is planned for Expeditionary Force Experiment (EFX) '98 and Air and Space Firepower Demonstration in Sep '98. The SWC and NASA Shuttle Ferry Flight Coordinators are working closely to install COMBAT TRACK onboard a Pathfinder aircraft to support a shuttle ferry flight mission in Aug '98. COMBAT TRACK is "on-call" to support future AEF deployments.

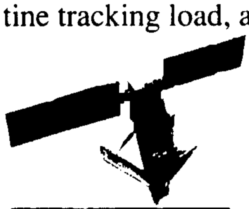
AIR FORCE SPACE BATTLELAB, THE WAY AHEAD

Capt James Trimble, HQ SWC/SB, DSN 560-9381

The Space Battlelab (SB) is still in its first year of operation and is making rapid progress evaluating innovative space operations and logistics concepts. Led by Colonel Robert Bivins, the SB team has reviewed over 200 ideas and is working five initiatives for FY98. One of the initiatives the SB is executing is called "Space Surveillance Network (SSN) Optical Augmentation" or "SOA." The SB is working with the Air Force Research Labs and the Massachusetts Institute of Technology/Lincoln Labs to use a commercial astronomical telescope to augment the Ground-Based Electro-Optical Deep-Space Surveillance System (GEODSS) by providing data on deep-space objects. The specific goal is to demonstrate automated collection and reporting of metric data on deep-space objects for use by USSPACECOM in the maintenance of the satellite catalog.



The deployment of a low cost, low maintenance system could off-load a significant portion of the routine tracking load, allowing GEODSS to focus on other missions.



Another SB concept making outstanding progress is Commercial Applications for Combat Effectiveness (CACE). This idea proposes the use of commercial satellite communication systems to augment DoD communication needs. The SB is working with the Motorola/Iridium Corporation, Federal Agencies and the Unified and Combined Commands to demonstrate the use of a commercial satellite communication system during ULCHI FOCUS LENS '98.

Augmentation of DoD worldwide communications with commercial systems could become a critical part of the future military communications systems. There is a projected need of increased DoD communications capabilities in the next decade and commercial satellite systems could help fill the need for reliable worldwide secure communications.

The SB is working hard to bring innovative and revolutionary operational and logistics concepts to the warfighter. We are always looking for new ideas to explore. If you have ideas or questions on our ongoing concepts please submit them to the AF Space Battlelab.

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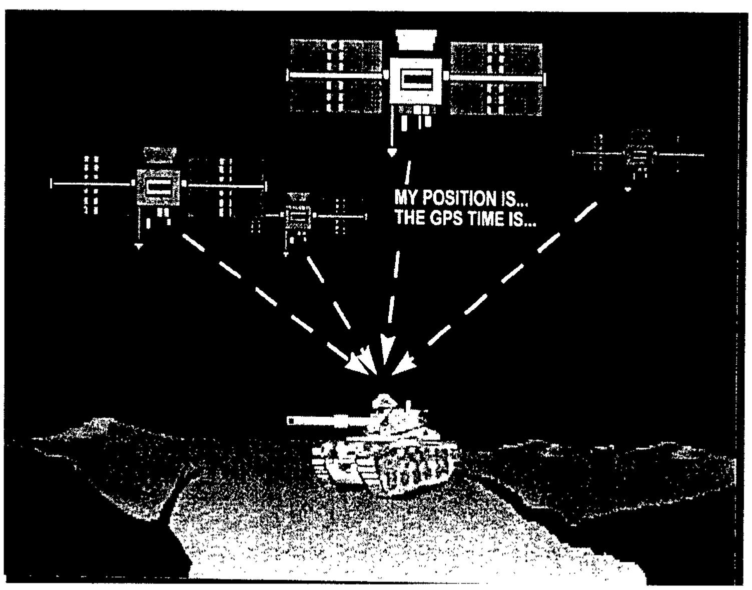
SPACE 101: NAVIGATING THROUGH CHANGING SPACE

Capt David Malinowski, HQ SWC/DOT, DSN 560-9653

The concept of the Global Positioning System (GPS) was alluded to in an old Star Trek episode in which Capt Kirk ordered navigation buoys to be dispatched around a planet the crew wanted to explore. Today, navigation from space is a reality. The US has a complete GPS constellation of 24 satellites on orbit, transmitting their precise position and the precise time to the world. Users located anywhere in the world can now triangulate off these satellites and determine their position to within approximately 100m (16m for authorized users), in any weather, 24-hours a day. It is probable that shortly after the turn of this century, all GPS users (military and civilian alike) will have access to 3- meter, 3-D accuracy. More so than any other space system, GPS seems to be fulfilling the early promise of "space exploration for the benefit of all mankind."

How does GPS provide you, the user, with your position? Each satellite continuously broadcasts its position and the correct time. Your receiver/user set decodes this information and uses it to calculate the transmission delay between you and each satellite. From that delay, the receiver can calculate how far away it must be from each satellite. This is triangulation. Since there are four unknowns associated with your position (latitude, longitude, altitude and time), your user set must have four satellites in view to solve for your position. If you already know one of these unknowns, such as your altitude, you only need three satellites for a positional fix.



The GPS constellation with its 24 satellites employs a 12-hour orbit corresponding to a medium high altitude. This altitude is preferable over a low earth orbit because it minimizes the total number of satellites required for a user on the ground to be able to see at least four at any one time.

The satellites know where they are very accurately but not exactly. Moreover, their onboard atomic clocks (providing the timing) are extremely accurate but not perfect. Therefore, the solution a user set computes will have some error. There is also some error introduced because of the propagation medium. The signal does not travel in a straight line from the satellite to the receiver. The signal refracts or bends, as it travels from the vacuum of space through the Earth's atmosphere. For the best position fix, the user needs to be able to determine the height of the ionosphere very precisely, because it is the ionosphere that is responsible for most of this phenomenon.

In addition to these inherent uncertainties, the positional fix of the user set also depends on the geometry of the ranged satellites. If you triangulate off three satellites that are close together you will not get a very accurate positional fix. With GPS, the best solution will generally result when the user set selects three satellites low on the horizon and far apart (maximizing the area between them) and one satellite directly overhead. Most user sets currently use algorithms that select the best combination of satellites in view.

By controlling the uncertainties, GPS has been able to achieve an average accuracy of just over 6 meters for authorized users (from a 1996 study). That is a significant improvement over the 16-meters accuracy promised to authorized users. Unfortunately, this 6-meter accuracy was only available to those users authorized a crypto-keyed receiver. Only 5% of the GPS user sets produced are crypto-capable. Those who did not have the crypto-keyed receivers had to settle for the 100-meter, 3-D accuracy that results from errors intentionally intro introduced into the GPS signal by the military.

But soon, civilians around the world will have access to an unaltered GPS signal. Our President issued a policy stating that by 2006 the military will stop the intentional degradation to GPS. As a matter of fact, in the year 2000 and every year thereafter, the DoD and the Department of Transportation (DOT) will meet on equal terms and decide whether the degradation, called Selective Availability (SA), is still required. If the two cannot agree, the President will decide.

This is a challenge for the military. While the US can effectively deny its adversaries the use of GPS through intentional degradation, the impact to the non-military users is too high. Because this method has been deemed inappropriate, the military is now actively exploring alternate means of denying an enemy the use of GPS while protecting our own ability to use it. Ideally, we want to find a way which will not affect the entire world but can be focused in a given theater. The challenge is to keep the playing field sloped in our favor.

CURRENT EARTH DEFENSE EFFORTS

Capt Bruce Bookout, 21 OSS/OSOY, DSN 834-7820

We are at war! The enemy has been attacking and committing genocide for at least the last 570 million years. This enemy is responsible for the extinction of countless species over the fossil record of life on the planet Earth. As the current dominant species populating the Earth, we now are aware of the threat from asteroids and comets. The Air Force is examining the acceptance of a new mission of Earth Defense; the detection & defense against rogue asteroids and comets impacting the Earth. I will survey the current effort on this mission: detection--the finding, tracking and characterization of the enemy.

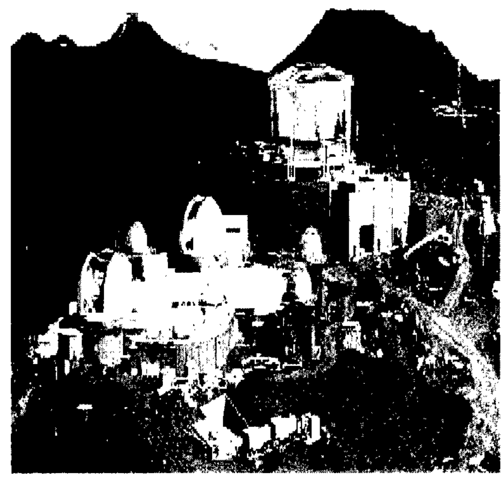
Any defense effort begins with understanding the threat. Near Earth Objects (NEOs) are defined as any naturally-occurring solid matter orbiting the Sun whose orbit intersects that of the Earth or might do so in the future. This includes objects of all sizes: from sand grains to 10-km wide planet busters. Comets and asteroids are two major sources of debris left over from the formation of the solar system[1]. There is strong evidence, showing that the impact of an asteroid, 10 to 20 km across, in the now Yucatan Peninsula, brought the age of dinosaurs to an end[2]. Such large impacts apparently occur at intervals of tens of millions of years. In 1908, a stony meteor apparently 50 meters across exploded in the air above Tunguska, Siberia. This explosion devastated the area with the equivalent of 40 megatons of TNT, or the equivalent of 2,000 times the force of the atomic bomb exploded over Hiroshima in 1945[3]. Evidence from Defense Support Program satellites indicates similar explosions occurred in Feb 1994 and April 1988 in the Western Pacific[4]. The probability of a large (+1 Km) hit is relatively low[5], however it may not be as low as we have traditionally believed[6]. Other examples comprise an enormous list, but these few serve to shed enough light on the enemy. Understanding the threat is a natural step in defending against an enemy.

When a nation is at war, the military is the defense expert. There are two fundamental issues to military strategists; first to detect the enemy and then to defend against enemy attack. The first fundamental issue is detection and consists of three parts; find, track and classify. The detection effort has already started. There are two significant worldwide efforts underway: Spaceguard and Near Earth Asteroid Tracking (NEAT).

[1] Biazael, Richard, Ed., Asteroids II, Tucson AZ, The University of Arizona Press, 1988
[2] Science, Alverez, Dr. Lewis, "Extraterrestrial Cause for Cretaceous-Tertiary Extinction ," Vol 208, Num 4448, 6 June 1980, p1095
[3] Longo, Giuseppe, (7 Jan '98), University of Bologna International Workshop Tunguska '96, [On-line]. Available: http://bohp03.bo.infn.it/tunguska96/ [17 Jan '98]
[4] Sky & Telescope, "Satellites Detect Record Meteor", June 1994
[5] Biazael, Richard, Ed., Asteroids II, Tucson AZ, The University of Arizona Press, 1988
[6] Bell, Maj Larry D., Planetary Asteroid Defense Study (PADS), Air University, Air University Press, 1995

Spaceguard is a civilian association aimed at the protection of the Earth environment against the bombardment of NEOs. The Spaceguard Foundation was officially founded on 26 March 1996, in Rome, Italy. It consists of a network of individually accredited worldwide observatories that provide viewing time toward the pursuit of NEOs. These telescopes belong to various universities and private corporations that lend themselves at no cost to the NEO effort. The foundation[7] is an entity oriented within the most general framework of scientific research. Spaceguard promotes and coordinates activities for the discovery, pursuit and orbital calculation of NEOs at an international level. They also promote study activities for characterization of the minor bodies of the solar system, with particular attention to NEOs. Finally they promote and coordinate a ground networks (the Spaceguard System) for the discovery observations and for astrometric and physical follow-up.

NEAT is an autonomous space sensor located at Det 3, 18th Space Surveillance Squadron (18 SPSS), Ground-based Electro-Optical Deep Space Surveillance (GEODSS) site atop Mt Haleakala, Maui, Hawaii. Det 3 is a dedicated and shared-use space surveillance unit on the island of Maui, approximately 90 air miles east of Hickam Air Force Base. The site is atop the 10,023-foot summit of Mt Haleakala, a dormant volcano. The isolated, high mountain top provides an excellent location for electro-optical operations.



Det 3, 18 SPSS, Mt Haleakala, Maui, Hawaii

The primary mission of the detachment is to detect, track and identify all tasked space objects within its area of coverage using the GEODSS system and the Maui Space Surveillance System (MSSS). Both GEODSS and MSSS provide metric positional data and Space Object Identification (SOI) data to the Space Control Center at Cheyenne Mountain Air Force Station, Colorado, and the Combined Intelligence Center at Peterson AFB, Colorado, respectively. Det 3 produces three types of SOI: visual imagery, photometric and radiometric signatures. In addition, the MSSS conducts Research and Development (R&D) through a tenant Air Force Materiel Command unit, Air Force Research Laboratory.

The GEODSS system performs its mission using three optical telescopes, low-light level electro-optical cameras, radiometers and support computers. The three telescopes include two main telescopes with 40-inch primary mirrors and one auxiliary telescope with a 15-inch primary mirror. The GEODSS is part of a three site, worldwide network. The other GEODSS sites are located in Socorro, NM and Diego Garcia, British Indian Ocean Territories. GEODSS limited to nautical sunset to sunrise, due to their sensitive cameras.

The NEAT is a cooperative effort between the National Aeronautics and Space Administration, Jet Propulsion Laboratory (JPL) and the Air Force Space Command (AFSPC). The NEAT was built and is being managed by the JPL for NASA's Office of Space Science, Washington DC. It is designed to complete a comprehensive search of the sky for NEOs.[8] Discoveries of these faint and remote objects, and some surprisingly close by, are increasing due to the introduction of a technologically advanced, fully autonomous Charged Coupled Device (CCD) sensor. The NEAT camera employs a very large, very sensitive 4,096-by-4,096-pixel CCD[9]. The Air Force operates NEAT through a civilian contractor that also operates the GEODSS system. The NEAT began observing in December 1995 and observed for 12 nights each month centered near new moon through December 1996. In January 1997, NEAT operations were reduced to 6 nights each month starting 6

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[7] Carpino, Mario, (29 Oct 1997) The Spaceguard Foundation Home Page, [On-line]. Available: http:/www.mi.astro.it/SGF[21 Feb 1998]

[8] Pravdo, Dr. Steve, (21 Feb 98) Near-Earth Asteroid Tracking General Information Home Page, [On-line]. Available: http://huey.jpl.nasa.gov/~spravdo/neatintr.htm, [23 Feb 98]

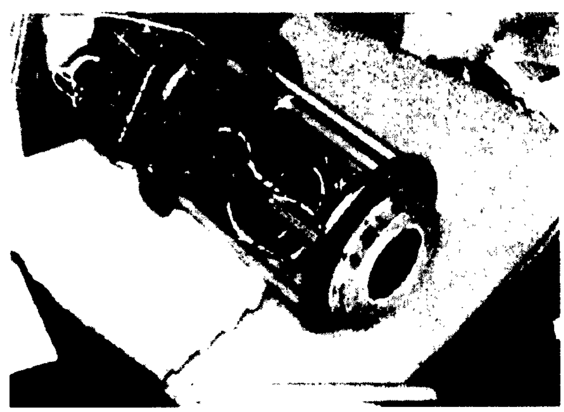
[9] Pravdo, Dr Steve, (21 Feb 98) NASA NEAT Press Release, [On-line]. Available. http://huey.jpl.nasa.gov/~spravdo/nasa197.html,[23 Feb 98]

nights prior to the new moon. The observation time was reduced to minimize the impact to GEODSS primary. The NEO discoveries are reported to the Minor Planet Center (MPC)[10] whose Internet web site contains new objects that require confirmation by observers. Using this powerful, fully automated system, astronomers are discovering many more objects than was possible in the past. The January observing run produced more than 700 asteroid sightings, including high-inclination inner-belt asteroids and a number of potential Mars-crossers. Total detections since NEAT began operations in late 1995 have climbed to more than 9,000 objects, of which 4,515 are new objects and more than 800 of those have received new designations. The 27 new NEO asteroids and one NEO comet represents 25% of the total potentially hazardous NEO cataloging in just 2 years worth of work and minimum observing time. Since their initial sightings, the NEAT NEOs have become the focus of worldwide observations by astronomers in Japan, China, Australia, Italy and the Czech Republic.[11]

There is a clear need for a more comprehensive space surveillance network than presently available. Recommendations from many studies point out that Air Force Space Command's (AFSPC's) existing space surveillance network, as well as ground radar and space-based infra-red sensors, can accomplish the search mission significantly cheaper than a system proposed by Safeguard, a NASA study requested by Congress.[12] The next step will be to develop tools for follow-up tracking to further define the path of a NEO, both astrometrically and photometrically.

NEAT/GEODSS Telescope Tower

Currently, we treat natural space debris as unstoppable, leading us to only passive defenses. This scenario has the military acting as a response to natural disasters. Historically, military involvement in natural disasters has evolved to its current emphasis on "Military Activities Short of War."[13] This is the basis for military concern over NEOs. Once accepted as a military mission, there will need to be a Defense Department paradigm shift concerning the military's perceived role in disaster response. A NEO disaster is not like any other experienced and should not be treated as such. The worse case scenario is a >15-km wide asteroid striking the Earth, resulting in a nuclear winter worse than an all-out nuclear war. The best plan is to treat the cause and not the effect. The identification of natural space debris as a real threat must continue to improve the threat model and communicate that threat to those able to take action. Action refers to offensive strike ability, not necessarily to destroy, but deflect. The kinetic energy of a mountain-sized object traveling typically at 20 miles per second is so enormous that it is difficult to comprehend. At the lowest level, the military should recognize the primary role they will have in responding to a NEO induced natural disaster, understanding that no other federal organization or agency has the necessary organizational base and resources to do so.[14]



NEAT CCD Sensor

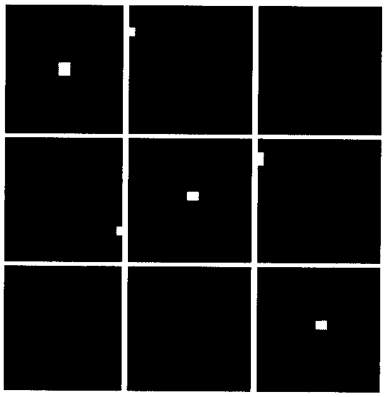
[10] Williams, Gareth (No Date) IAU: Minor Planet Center. [On-line]. Available: http://cfa-www.harvard.edu/cfa/ps/mpc.html

[11] Air Force Doctrine Document 1, http://www.hqafdc.maxwell.af.mil//doctrine/pdf/afdd1%2D1.pdf

[12] Bell, Maj Larry D., Planetary Asteroid Defense Study (PADS), Air University, Air University Press, 1995

[13] Air Force Doctrine Document 1, http://www.hqafdc.maxwell.af.mil//doctrine/pdf/afdd1%2D1.pdf

[14] Bell, Maj Larry D., Planetary Asteriod Defense Study (PADS), Air University, Air University Press, 1995



Neat CCD Detection Image

The Air Force acceptance of a new mission of Earth Defense is a natural extension of the military's mission to defend. Early warning is the ultimate key to success in this war. Current surveillance efforts by both Spaceguard and NEAT represent a small beginning. We must consider ground and space-based assets and the integration of current technologies into systems capable of protecting the Earth from most NEO impacts. Humans are the only Earth species, so far, who can prevent their extinction by asteroid or cometary attack.

AFSPC currently has no assigned mission either warning of natural object threats or mitigating them. However, they have identified in mission area plans, which are blueprints for the command, the potential for a future national mission to detect and warn of potentially threating natural objects.

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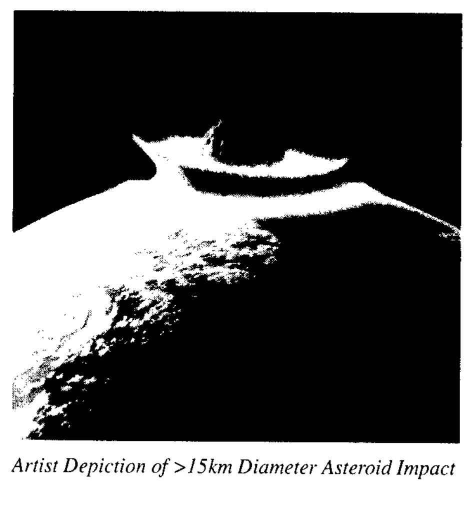

Artist Depiction of >15km Diameter Asteroid Impact

LAUNCH OF THE SPACE ELECTRONIC WARFARE TEAM (SEWT)

Capt Dwight E. Andersen, HQ SWC/DOWY, DSN 560-9189

As the integration of space into warfighting operations advances, the US becomes increasingly reliant on services provided to, from and through space. In order to gain and maintain space superiority, the US must ensure access to these space systems and protect them from vulnerabilities and susceptibilities that threaten our operations. Because many of these space systems operate in the electromagnetic spectrum, and in particular, the radio frequency (RF) spectrum, protection from adversarial exploitation in space electronic warfare is paramount in ensuring current and future US space superiority. The threats continue to escalate.

In order to meet this threat, on 10 April 1998, Major General Moorhead, SWC/CC, established the Space Warfare Center's Space Electronic Warfare Team (SEWT). The SEWT is chartered to explore defensive and future offensive space control options through space electronic warfare.

The SEWT vision: *"Providing our warfighter the best space electronic warfare protection and negation capabilities possible."*

The SEWT mission: *"To optimize the United States' ability to gain and maintain space superiority through initiating, developing and executing realistic space electronic warfare tests, exercises and operations."*

To accomplish this mission and attain its vision, the SEWT will work with the Big Crow Program Office (BCPO) and other EW assets in tests, exercises and operations. The BCPO, an Army office, established in 1971, operates out of Kirtland AFB and provides projected electromagnetic environments for electromagnetic vulnerability assessments. It operates airborne and ground-based platforms for electromagnetic experiments, tests, trials and training. Their mobile test beds include: NKC-135E, EC-135C, CH-47D, Gulfstream G-II, 10 vans and trucks and a SkyShip 600 blimp, just to mention a few. The capabilities of these platforms include frequencies of 5 MHz – 26.5 GHz from multidirectional antennas, including 15 on their two USAF-owned 135 aircraft. Power of 4 Megawatts, and more, is attainable. All of their equipment is commercial off-the-shelf (COTS) and platform independent. One of their objectives is to give operators an appreciation of vulnerabilities and how they can receive the data they need through alternate routes, if prime routes go down. For years they have provided EW environments for vulnerability assessments and exercises in the traditional roles of air and ground EW and Big Crow stands ready to transition their expertise to the space EW realm.

The plan of attack for the new SEWT will be a phased approach. The first phase is to conduct live RF vulnerability tests on select satellite uplinks and downlinks to obtain verified data, data that is critical yet lacking today. The results will be applied to tactics, techniques and procedures (TTP) and countermeasure technologies for US space protection. The second phase will integrate the SEWT in exercises as an element of a space "Red Aggressor" force. This phase will also yield TTP for space protection and will increase the battlespace awareness for warfighting operations. Out of these two previous phases, the SEWT will gain concepts and technologies that could also be applied to future negation space control options, the third phase.

The SEWT is organized under the Weapons and Tactics Branch (HQ SWC/DOW) of the SWC. Capt Dwight E. Andersen, HQ SWC/DOWY, DSN 560-9189, is the Team Chief and SSgt Ken Trousdale, HQ SWC/DOWY, DSN 560-9647, is the Project Leader. They welcome any inputs or suggestions you have. Only working together can we transition to the 21st Century's Space and Air Force. The new SWC's Space Electronic Warfare Team stands ready.

WELCOME TO THE USAF WEAPONS SCHOOL SPACE DIVISION CORNER

Lt Col Gregg "Mr. Bill" Billman, WSS/CC, DSN 682-2065

When the folks at the SWC came up with the idea to host a "USAF Weapons School Space Division [USAFWS WSS] Corner" as part of their quarterly publication, we here at Nellis thought it was yet another great way to continue to integrate the space and air operations communities. We appreciate the opportunity to provide you with what we hope are thought-provoking articles, as well as information you may find useful as you carry out your vital missions. For additional hard-hitting, operations-related, CAF-wide articles, check out the *USAF Weapons Review*, the authoritative Weapons School quarterly weapons and tactics publication (call DSN 682-8629 to get on the distribution list).

As Maj Gen Moorhead wrote in the inaugural USAFWS Space Division Corner in the Winter 1997/1998 *Space Tactics Bulletin*, "The success of air and space power rests in our advanced technology, effective doctrine and *world-class training*." Our division's efforts are integral to his last point--world-class training. We take space operators, highly qualified instructors in their respective systems, and turn them into expert space tactics instructors--PhDs in all facets of space operations and intimately familiar with all flying CAF operations. Our graduates are highly prized as NAF/JTF-level space experts, and will continue to contribute to the normalization and operationalization of space operations as they matriculate back into AFSPACECOM. They are spearheading space integration into the fight.

How do these folks get here? Twice a year (generally March and August) a board is convened at AFPC to select from among the many highly qualified applicants who want to attend this tough, but rewarding, 5° -month course. The records which meet the board have made multiple "cuts," the first of which is at the squadron level, with the squadron commander nominating qualified instructor-applicants. The culmination of the local "cut" process occurs as the wing commander (or equivalent) ranks the wing's choices and sends them to MAJCOM where they are reviewed to ensure eligibility (time in service, instructor time, etc.). Nominated officers' records are then reviewed and scored at the AFPC board by the respective USAFWS division commander and representatives from all MAJCOMs, as well as the appropriate AFPC functional manager. Obviously, not everyone gets chosen. The secret is not to give up! As long as you remain eligible, continue to apply--desire is a "good thing" (its what gets folks through this rigorous course)!

Our next class ('98B) has already been selected and will report in early July, graduating in December. The board process was tough--approximately 40 very highly qualified applicants for 8 primary and 2 alternate slots. We get the best of the best. Look for news of the next board this summer and start getting those packages together!

One of our plans for this "Corner" is to include synopses of our last class' papers. If any of them spark your interest, you can access the entire paper on our website (wwwmil.nellis.af.mil/usafws).

We will also periodically publish information on our assigned personnel, as well as graduates. You can keep abreast of who's where, and use the information to contact individuals who may have expertise you need--or you may just want to catch up with old buds.

We look forward to sharing information with you as each *Space Tactics Bulletin* is published. We also look forward to seeing you out in the field and working with you to integrate space into the fight.

Check 6, 12, GEO and LEO!

USAF WEAPONS SCHOOL SPACE DIVISION INSTRUCTOR CADRE

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THE HUNT FOR RED MISSILES
DETECTING, TRACKING AND DESTROYING
THEATER BALLISTIC MISSILES BEFORE LAUNCH

Capt Richard Cross, Space Class 97-B, USAF Weapons School

INTRODUCTION

If you asked veteran DESERT STORM air campaign planners to list problems they had during the war, undoubtedly, they would include the United States' and coalition's inability to eliminate the Iraqi Theater Ballistic Missile (TBM) threat. (8:3) The ideal solution to this problem is to detect and destroy the TBM and its associated equipment before launch. One instrument for pre-launch detection is the Unattended Measurement and Signature Intelligence (MASINT) Sensor or UMS. This type ground sensor can detect TBM vehicle traffic and report the detection to airborne or spaceborne platforms, notifying decision-makers and "trigger pullers" of a launcher's location. (6:1-2) This paper describes the need for the UMS and the process, then compares potential collection systems to get the information to decision-makers and shooters.

THE THREAT

The TBM threat has existed since Nazi Germany developed and launched the V-2 rocket against England and Allied Forces in liberated NW Europe during World War II. Though not considered an accurate weapon by any stretch of the imagination, it proved effective as a "weapon of terror." Iraq employed this same terror tactic with the SCUD missile during DESERT STORM. As a result, cohesion between the US and the coalition partners was threatened, since the lack of an effective countermeasure to the SCUD threat could have deterred some allies from standing up to this aggression. Furthermore, the job of combat planners and operators became more difficult with the added planning consideration of SCUD Combat Air Patrols (CAPs) on top of the already demanding air operations schedule. Worst of all, 28 American lives were lost as a result of one SCUD attack. (3:75) Though air superiority was rapidly and undeniably achieved, as far as the TBM threat was concerned, the US was forced into an undesirable defensive posture.

OUR RESPONSE

US response to this threat can be described based on the three pillars of Theater Missile Defense (TMD) termed passive defense, active defense and attack operations. (9:70)

Initially, passive defense measures were employed, alerting troops and civilians in enough time for them to don gas masks and seek shelter. This is the "duck and cover" response to a potentially deadly situation. It is also the least desirable response, since no active measures are taken to defeat the threat.

Active defense measures achieved some success through the interception of incoming SCUDs by the Patriot Anti-tactical Ballistic Missile. This proved effective in terms of counter-psychological operations (PSYOPS), giving US troops and allies some assurance that a defense did exist with some degree of demonstrated success at intercepting the SCUDs. However, even our active defense measures can be rendered ineffective as they were in DESERT STORM. Some SCUD missiles broke into several pieces in their terminal phase of flight, sending the Patriot missiles after something other than the warhead or requiring missile salvos against one SCUD. It would also be futile to destroy missiles equipped with nuclear, biological or chemical (NBC) weapons in their end phase, as these weapons would still rain down over friendly territory. (3:75)

Passive and active defense measures are limited simply because they are defensive. The preferable method of countering the TBM threat is attack operations, assuming an offensive posture, destroying the TBM and associated equipment before the missile can launch. General George S. Patton, Jr. understood the importance of taking the offensive when he said, "In war, the only sure defense is offense. Above all else, remember that we as the attackers have the initiative ... We must retain this tremendous advantage by always attacking: rapidly, ruthlessly, viciously and without rest." (7:1) Based on operational procedures in place during DESERT

STORM, however, this proved to be a difficult task.

SCUD Launchers, either vehicle mounted Transporter-Erector-Launchers (TELs) or a trailer mounted Mobile-Erector-Launcher (MEL) and their associated battalions rapidly evaded detection due to use of the desert landscape, camouflage and concealment techniques and a practiced ability to quickly fire and hide. SCUD CAP strike aircraft also had difficulty locating the TELs because they were responding to launches, rather than being directed to known SCUD TEL locations prior to launch. They were too late to locate the TELs mainly because of delays in launch detection and reporting by our space and ground early warning systems. (2:31)

INCREASING THREAT

The number of countries possessing TBMs has tripled in the last 20 years, many of which are third-world countries like our DESERT STORM adversary. Whether by proliferation of missile technology or their own indigenous production, more and more countries will add TBMs to their military arsenal and theater missile technology will continue to improve in range and accuracy. To add insult to injury, more countries are developing and stockpiling NBC weapons, which can be mated to a TBM. This alone changes the profile of TBMs from terror weapons to Weapons of Mass Destruction (WMD). With NBC-tipped TBMs, accuracy becomes less of a factor of lethality as winds can carry these agents over great distances. Additionally, our active Patriot missile defense becomes futile for the late game kill, because the effects of these WMDs will not be nullified when intercepted over friendly territory.

It is imperative, therefore, this threat be countered in its earliest stages, i.e., before launch. The demonstrated ability to execute an early stage or pre-launch kill can serve as an effective deterrent to WMD use when the adversary considers the threat of WMD destruction on their own soil. It will deter the use of conventional TBMs, as well. But, should deterrence fail, our attack operations should be capable of destroying the TELs and missiles prior to launch.

TECHNOLOGY

The solution to this problem employs the developmental Unattended MASINT Sensor (UMS). The UMS is a self-contained leave-behind sensor, processor and communications link package that can, in near-real-time, autonomously report target detection, target identification and location via built in Global Positioning System receivers.

UMS EMPLOYMENT

The UMS Steel Rattler can be placed by Special Operations Forces, while the Steel Eagle is being developed for airdrop, from aircraft, Unmanned Aerial Vehicles (UAVs) or helicopters, in areas pre-identified by the Generic Area Limitation Environment (GALE) system. The GALE system is "a system of general purpose mapping and modeling to derive area limitation, based on intelligence, imagery and terrain." In other words, it can derive where a SCUD TEL and its associated equipment can and cannot operate, simplifying where to look for them. (6:6)

As a vehicle or convoy passes over or near the UMS, a data burst will be transmitted by the sensor to a collection platform after matching the vehicle's acoustic signature or frequency, that the UMS has been "tuned" to detect. As the name implies, UMS functions based on the intelligence discipline of MASINT. The measurement aspect of MASINT refers to measuring the parameters of an object. The signature aspect refers to distinct characteristics that identify an object, such as frequencies of acoustic waves emanating from a target, like that of a SCUD TEL. (1:2)

The UMS concept is not new. Its roots can be traced back to the Vietnam War, where Air Delivered Seismic Intruder Devices were dropped over the Ho Chi Minh Trail to remotely detect Communist movement of men and supplies. (5:26-27) Additionally, Acoubuoy sensors were designed for deployment from aircraft by parachute, which would hang in trees, detecting vehicle movement below. (5:166) The US Navy developed an anti-submarine warfare sensor which can detect and track submarines operating in the open ocean. (10:4) The same philosophy can be applied to detecting TEL activity.

UMS will detect the TEL and transmit the data burst to a collection platform which will report the TEL's location in near-real-time to the Air Operations Center (AOC) or an airborne command and control (C2) platform. The AOC or C2 platform will track the SCUD TEL based on subsequent UMS data bursts and direct strike aircraft to its current location. (6:2) Both airborne and spaceborne platforms have the capability or can be modified to receive and report the UMS data bursts. Herein lies the issue and remaining focus of this paper. Which platforms are the most timely, accurate and capable for collecting and reporting UMS data bursts ... airborne or spaceborne? The following paragraphs examine the processes, requirements, capabilities and limitations of both mediums and concludes with a recommendation.

AIRBORNE PLATFORMS

Current planning is for communications satellite (COMSAT) systems to collect and relay UMS data bursts to users. (6:8) However, aircraft platforms such as Rivet Joint and the Joint Surveillance and Target Attack Radar System (Joint STARS) can be modified to take on this detection and reporting role.

Rivet Joint is an RC-135 aircraft designed to loiter near battlefields, providing data on enemy air defense systems to shooters. JSTARS is an E-8 aircraft with an array of capabilities, including ground surveillance, targeting, attack and battle management, bomb damage assessment, Suppression of Enemy Air Defenses (SEAD) and yes, TMD, with emphasis on detecting mobile launchers. (11:174)

The high-altitude, reconnaissance U-2 aircraft performed SCUD hunting in DESERT STORM, by sensing vehicle movement and alerting strike aircraft to the location. (11:172). Equipping the U-2 with UMS receive capability can further enhance the aircraft's mission.

By retrofitting these aircraft with any number of "monitoring UMS receive boxes" under development, these aircraft and others can detect initial and subsequent UMS signal bursts, assisting the operator aboard the aircraft in tracking and reporting the SCUD TEL in real-time to the Air Operations Center (AOC) or a CAP aircraft via voice communications and data links. Decision-makers can redirect strike aircraft to the target or exploit the data to reveal launch, hide and resupply locations.

AIRCRAFT CAPABILITIES

A significant characteristic of aircraft is the positive control exercised over them in a theater of operations. The Joint Force Air Component Commander (JFACC) has operational control (OPCON) over aircraft assigned and attached operating within theater, to include their availability and use. The JFACC exercises tactical control (TACON) over other aircraft made available for tasking. (4:9) To enhance coverage, the number of aircraft in theater can be increased consistent with available aircraft and existing operations tempo.

Positive control of aircraft and personnel in theater further lends itself to an instant situational awareness capability. If the combat situation changes or equipment outages occur, locally owned or controlled assets can be aware of, and compensate for, the changes in real time.

The abilities of Rivet Joint and JSTARS as combat information collectors were proven in DESERT STORM. It is their job and the aircrews do it very well. The necessary communications nodes and links are operational, both air-to-air and air-to-ground. Similar procedures can be easily developed to include this UMS role.

AIRCRAFT LIMITATIONS

The number one limitation imposed on aircraft is vulnerability to attack by surface and air threats. Even when air superiority has been achieved and maintained, the potential remains for these threats to endanger the personnel aboard these high-value airborne assets (HVAAs).

TMD is a continuous operation, driving an intense operations tempo. SCUDs can be launched at anytime and if the adversary is smart, they'll launch when and if our defenses are down. Therefore, if a single aircraft type were selected for this mission, it would have to be airborne 24-hours a day, everyday of the war. The requirement to conduct continuous operations is campaign and situation dependent. For example, Rivet Joint performed continuous operations during DESERT STORM but not during DESERT SHIELD.

These aircraft can only provide limited coverage and might not be line-of-sight with areas from which SCUDs could be launched. The range of a SCUD far exceeds the detection range of the aircraft. Coverage is dependent on line-of-sight capability from sensor to aircraft and aircraft to users of the information. The aircraft can literally be pushed out of coverage by air-to-air or surface-to-air threats. When dealing with a desert environment, this is not much of a problem unless the aircraft is over-the-horizon or blocked by a mountain. However, when considering the limitations imposed by terrain in a theater like Bosnia or Korea, line-of-sight coverage will certainly be degraded.

There are also physical limitations on the airframe. All military aircraft are subjected to a significant amount of stress, more so during intense conflicts due to shorter turnaround times, driving the potential for mechanical failure. Aircraft will also undergo scheduled phase maintenance, temporarily grounding the aircraft in the interest of preventative maintenance and safety. Whether for unanticipated or routine maintenance, the requirement for backup aircraft and personnel exists. Lack of a backup will result in gaps in coverage. Adding this detection and reporting role on an aircrew may be at the expense of other already existing roles in the heat of battle or it might take a back seat to information deemed of higher priority by the operator. If the aircraft simply functioned as a data link to relay information to an operator on the ground, as with a satellite, then it would only be limited by coverage availability and equipment failure.

SPACEBORNE PLATFORMS

The COMSATs can receive and transmit UHF UMS data bursts to decision-makers and warfighters in the air and on the ground. The ground receive equipment suites are being specifically designed to collect relayed UMS data bursts. Upon receipt, ground operators can provide near real-time and assured notification to the maximum number of users through existing voice communications and data links. Decision-makers in an AOC will coordinate a strike by aircraft or missiles, such as the Army Tactical Cruise Missile System (ATACMS) or exploit the data to reveal hide and resupply locations.

SPACE CAPABILITIES

If we can find a method that not only enhances mission success but also keeps the good guys out of harm's way, we should lean in favor of that method. The satellite, as an unmanned relay vehicle, does just that. UMS collection HVAAs can remain at a safe distance and aircrews will be endangered only for the kill, rather than the hunt.

The key capability space systems bring to theater operations is a constant presence over areas of interest. The majority of COMSATs are in a geosynchronous orbit, 19,600 nautical miles above the earth. This orbit allows a satellite to continuously "stare" at the same area of the Earth. A geosynchronous orbiting COMSAT can direct downlink a UMS data burst in near real-time at the speed of light to receive stations in the same AOR. By employing just four COMSATs, worldwide overlapping coverage can be achieved with the exception of above 70 degrees North and below 70 degrees South latitudes.

Polar coverage is not a strong concern because of the limited threat of TBM use in these high latitudes. In the event TBMs become a threat in the extreme northern latitudes, gaps in satellite coverage can be compensated for by communications relay packages on other polar-orbiting spacecraft in highly elliptical orbits, providing a long dwell time over the northern latitudes.

Spacecraft are also highly reliable by design. They are engineered to survive the physical stress encountered during launch and exist in the harsh environment of space for years. Onboard support systems that power and protect the satellite payloads are redundant, which further enhances the satellite's lifespan.

Satellite systems thrive on automation, remotely performing their job in space, with very little manpower support on the ground. In the high operations tempo environment of an AOC, this automation will be key. AOC personnel will be free to concentrate on other matters since ground systems can be configured to alarm operators of TEL detection, rather than requiring they continually monitor the system.

SPACE LIMITATIONS

Though unmanned and remote, satellites are still dependent on ground support. Ground stations track the satellites, monitor states of health and conduct remote maintenance. These ground stations can be positioned in friendly areas, still within field of view of the satellite, to minimize risk. However, the threat of air, land or sea attacks remain.

Just as aircraft break, so do spacecraft. This can degrade a satellite's operations capability (OPSCAP), which can be a single point of failure if not backed up by overlapping satellite coverage. Without this coverage, a single satellite is more dependent on on-board support system redundancy and spacecraft design. If a satellite dies prematurely, the replacement time line is lengthy due to a crowded launch schedule, which lacks room for such contingencies.

ANALYSIS

Both platforms can receive and rebroadcast UMS data bursts in near real-time. But, one advantage aircraft will always have over satellites is the positive control a JFACC can exercise over "in-theater" assets. Being able to "put his fingers in the chest of the operator" gives the boss a degree of comfort that satellites cannot, because he does not have OPCON/TACON over space assets belonging to US Space Command or civilian agencies. Aircraft tasking will fall within OPCON/TACON of the JFACC.

The instant situational awareness afforded by positive control of aircraft and personnel in theater further increases flexibility. If the combat situation changes, or equipment outages occur, locally owned or controlled assets can be aware of and compensate for, the changes in real time. Awareness of changes in satellite system coverage or state of health are not as timely.

However, the number one limitation imposed on aircraft is vulnerability to attack by surface and air threats. Even when air superiority has been achieved and maintained, the potential remains for these threats to endanger our HVAAs. On the other hand, satellites are unmanned and generally out of reach of surface and air threats, orbiting 19,000 nautical miles above the Earth's equator. With the exception of Russian anti-satellite weapons, our satellite systems are generally not threatened. Data links between satellite and ground receivers can be jammed but the same is true for aircraft.

Spacecraft provide constant worldwide coverage. The higher the altitude, the more line-of-sight restrictions are reduced. Aircraft are altitude-limited, which reduces their line-of-sight when influenced by mountainous terrain. Furthermore, manpower requirements are less with spacecraft due to their unmanned, automated monitoring and reporting capabilities, allowing decision makers to focus on more pertinent operations, like execution of the Air Tasking Order.

PROPOSAL

Again, the preferable method of countering TBMs is <u>attack</u> <u>operations</u>. If UMS is used as the system to detect TELs for pre-launch attack, the question remains: Which platform is the most timely, accurate and capable for collecting and reporting UMS data bursts ... airborne or spaceborne?

Based on the spacecraft advantages recaptured above, I endorse the plan for UHF COMSATs functioning as the vehicles for receiving and retransmitting UMS data bursts. I further support this recommendation by the fact that COMSATs are already capable of this relay function. Therefore, this system will not be operationally delayed by requirements to modify aircraft or redesign and launch new satellites.

Furthermore, I recommend the AOC be the primary command and control center, reporting initial detection, tracking and reporting of activity and directing attack by strike aircraft, either directly or through airborne command and control assets. The TMD cell within the AOC should be responsible for this function, in addition to its active defense role of alerting warfighters of TBM launches.

CONCLUSION

UMS enhances the capabilities of decision makers and warfighters ... informing command and control who, in turn, direct shooters to the kill in the most timely, accurate and capable manner. In addition to their constant presence and lower manpower requirements, the most important contribution of space in this role is elimination of an unnecessary risk to our HVAAs and the men and women who operate them. The best relay platform for the UMS program is the COMSAT.

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HQ SWC/DOT COURSE SCHEDULE FOR FY '98

SAAC	**START**	**FINISH**	**LOCATION**	**CLEARANCE**
98004	28 Apr 98	15 May 98	Falcon AFB	TS/SCI
98005	9 Jun 98	26 Jun 98	BETAC	TS/SCI
98006	4 Aug 98	21 Aug 98	Schriever AFB	TS/SCI

SASOC	**START**	**FINISH**	**LOCATION**	**CLEARANCE**
98011	20 Apr 98	21 Apr 98	PACAF	TS/SCI
98012	2 Jun 98	3 Jun 98	DC	TS/SCI
98014	16 Jul 98	17 Jul 98	Schriever AFB	TS/SCI
98031-P3	28 Jul 98	29 Jul 98	Hanscom AFB	TS/SCI
98013	17 Aug 98	18 Aug 98	USAFE	TS/SCI
98015	22 Sept 98	23 Sep 98	Schriever AFB	TS/SCI

ASAC	**START**	**FINISH**	**LOCATION**	**CLEARANCE**
98019	23 Apr 98	24 Apr 98	PACAF/Hawaii	Secret-TS/SCI
98019 cont.	27 Apr 98	30 Apr 98	PACAF/Korea	Secret-TS/SCI
98019 cont.	4 May 98	8 May 98	PACAF/Guam	Secret-TS/SCI
98029	26 May 98	27 May 98	SAAS/Maxwell	Secret-TS/SCI
98020	16 Jun 98	18 Jun 98	8 AF/Barksdale	Secret-TS/SCI
98019 cont.	23 Jun 98	25 Jun 98	PACAF/Alaska	Secret-TS/SCI
98022	14 Jul 98	15 Jul 98	Schriever AFB	Secret-TS/SCI
98021	19 Aug 98	28 Aug 98	USAFE/Ramstein & Italy	Secret-TS/SCI
98023	15 Sep 98	17 Sep 98	14 AF/Vandenberg	**Canceled**

SWISC	**START**	**FINISH**	**LOCATION**	**CLEARANCE**
98026	2 Jun 98	15 Jun 98	Schriever AFB	TS/SCI

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SPACE APPLICATION PROJECT OFFICE (SAPO)	Col O'Shea	SAPO (osheamf@swc.schriever.af.mil)	8811
SPACE APPLICATIONS ADVANCED COURSE (SAAC)	Capt Malinowski	DOTT (malinodm@swc.schriever.af.mil)	9653
SPACE APPLICATIONS AND INTEGRATION FACILITY (SPAIF) JOINT DEMONSTRATION CENTER (JDC)	Capt Carneal	DOSG (carneaw@swc.schriever.af.mil)	9893
SPACE APPLICATIONS SENIOR OFFICER COURSE (SASOC)	Capt Smith	DOTS (smithwm@swc.schriever.af.mil)	9658
SPACE-BASED SENSING: NATIONAL EAGLE & BETA TEST OF COMMON SPECTRAL MASINT EXPLOITATION CAPABILITY (COSMEC)	Ms. Johnson	AETA (johnsondk@swc.schriever.af.mil)	9196
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SPACE SURVEILLANCE OPERATIONS ENHANCEMENTS AND SPECIAL PROJECTS	Dr. Liu	AES (liujjf@swc.schriever.af.mil)	9044
SPACE TACTICS BULLETIN	Mrs. Wolfe	DOW (wolfebj@swc.schriever.af.mil)	9586
SPACE TASKING ORDER (STO)	Lt Col Larned	DOS (larnedjk@swc.schriever.af.mil)	9568
SPACE TRAINING FACILITY (STF) OL-H Nellis	Lt Col Trest	trestw@swc.schriever.af.mil	682-6630
SPACE WEAPONS INSTRUCTOR SPIN-UP COURSE (SWISC)	Capt Scully	DOTT(scullydf@swc.schriver.af.mil)	9598
SPADOC SIMULATION AND TEST SYSTEM (SSTS)	Dr. Liu	AES (liujjf@swc.schriever.af.mil)	9044
SPANG	Capt Boyson	CTS (boysonte@swc.schriever.af.mil)	9313
SPECIAL PROJECTS	Lt Col Traxler	DOZ (traxlerj@swc.schriever.af.mil)	9045
SPECIAL OPERATIONS FORCES-TACTICAL DATA PROCESSOR (SOF-TDP) (SEE TALON KNIGHT)	Maj Murphy	CTK (murphykm@swc.schriever.af.mil)	8767
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SSNAM	Dr. Liu	AES (liujjf@swc.schriever.af.mil)	9044
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TALON WARRIOR	Lt Col Larned	DOS (larnedjk@swc.schriever.af.mil)	9568
TENCAP	Lt Col Preissinger	CT(preissed@swc.schriever.af.mil)	9738
TENCAP TRANSISTON	Capt Boyston	CTS(boystonte@swc.schriever.af.mil)	9313
THUNDER UPGRADE	Ms. Adams	AEWF(adamsaj@swc.schriever.af.mil)	9082
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WEATHER RELATED ISSUES	Capt Koch	DOSG (kohnanns@swc.schriever.af.mil)	9272
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