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Lt Col James O. Hale
USAF Chief, Space Applications Division Headquarters Air Force Space Command Peterson AFB, CO

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Lt Col James O. Hale, USAF
Chief, Space Applications Division
Headquarters Air Force Space Command
Peterson AFB, CO

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Introduction

> "The quality and quantity of information comprehended per unit of time may now determine who wins or loses a sales order or a war."
>
> Tom Peters

We justifiably pride ourselves as a nation on our military capabilities, especially since our recent success in Desert Shield/Desert Storm. However, it is very possible that in the mid-90's the Federal Express truck driver will have better situation awareness and global connectivity than a fighter pilot.

As not only the Air Force, but the other military services look into the future, it is clear that we will all have to take the maximum advantage of both our newer technologies as well as existing capabilities to leverage costs and systems which can contribute to improved military performance on the battlefield.

This paper suggests some ways in which Air Force Space Command, working with other Air Force major commands, will increase the war fighter's comfort level with -- and ability to employ -- space systems. Space systems have been around for about thirty years, but their potential contributions to the "trigger puller" at the unit level are just beginning to be investigated and exploited by the operator. A reasonable comparison of how the Air Force air breathing flying community and the space flying community have done business in the past might be the left and right hemispheres of the brain, both "doing their own thing" with very little connecting tissue (*corpus colossum*) tying them together.

In order to convey the potential of space to support combat flight operations, it might be helpful to think of space systems as another "wingman" in the flight. A good supporting wingman provides mutual support, contributes to better situation awareness, and adds to the firepower potential of the flight. Space systems appear to have the ability to perform well as a "supporting wingman." Information output, force structure size and diversity, and predictability are real pluses for space system wingman support. In addition, connectivity can be enhanced

throughout all levels of command, from the flight lead to the Joint Force Commander.

The clear vision of Air Force senior leaders is to effectively integrate space capabilities into global reach, global power objectives. Air Force Space Command established an office in August, 1990, manned with a cross-section of highly experienced aircrews from all the major commands who are experts in the major weapons systems, along with engineers and space specialists. The Space Applications Division charter is to work closely with operational flying commands as well as with the various space communities to investigate, assess, and demonstrate the capabilities of space systems and their potential to support the operational missions of the Air Force. Since all Services have flying assets, the experiments conducted by the Air Force could be applied to other Services' flying programs as well.

Desert Shield/Desert Storm provided the first operationally relevant benchmark for space support to large-scale military operations over a sustained period. It never quite achieved "wingman" status for the operator, despite Herculean attempts by all who provided support to the war. Much of what was accomplished evolved over a period of some months before becoming operationally usable. Within the Air Force, a great deal of potential could not be converted to operational utility, since we lacked sufficient end user equipment, especially at the wing operational level, to exploit existing capabilities. Recent testimony from senior military leaders regarding Desert Shield/Desert Storm support and outcome, shows that much remains to be done to make good on the potential for support to the war fighter. The results of Desert Shield/Desert Storm provided an excellent stimulus to find ways of doing the job better, from both flight operations and space applications perspectives. A place to start would be to improve the awareness of both communities about each others' capabilities, limitations, and requirements.

The emphasis should be focused to provide tactical information including weather, communications, navigation, and inputs to improved situation awareness and targeting data at the unit level, preferably in the cockpit. By approaching the problem from a bottom-up perspective, it might be possible to adequately address not only the aircrew needs, but in the process satisfy the wing, air component, and possibly theater level requirements as well. The traditional top-down approach has done reasonably well at the highest levels of military command, but has not necessarily met the requirements of the trigger puller, especially regarding

issues of timeliness and accuracy of information at the tactical level of operations.

Even recent Senate Armed Services Committee (SASC) recommendations reinforce the idea that we should concentrate on the unit level -- that is, at brigade and wing operational levels -- and that space capabilities should therefore be investigated from the point of view that their capabilities, when properly exploited, comprise another tactically supportive wingman.

Wingman Potential

Today, space systems are information systems. The two general kinds of information of great worth to a war fighter are those which contribute to situation awareness and to achieving a targeting solution for weapons delivery.

1. **Situation Awareness.** There are many different definitions of this concept, and here's another one which will help frame the following discussions about making space real to the operator. (As can be seen, by substituting different words, the definition could also be applied to the business world as well). Situation awareness is knowledge of the mission (product), environment (business climate), threat (competitors), and target (customer) along with knowledge about changes in the above factors in time to make a difference, and to use that knowledge to retain the strategic/tactical advantages of the plan.

2. **Targeting Quality Information.** Information of sufficiently fine granularity to successfully plan and execute the strategy. Includes accurate pre-conflict deliberate planning with prioritized information exchange requirements suitable for immediate implementation upon execution; pre-mission planning information just prior to mission execution; penetration/enroute information; and, finally, detailed information about the target and surrounding area.

One of the most important capabilities of a wingman is to be in the briefed position, when and where required. Kepler dictates the availability of space systems, and therefore they can be used to rendezvous with a large air package, just like other aircraft coming from widely separated bases do. By planning Time Over Target (TOT) and other timing factors to take advantage of space system availability, the strike force commander can improve his overall ability to successfully carry out his plan of attack. However, this requires that the planners responsible for generating the Air

Tasking Order (ATO) be aware of the availability times of various space systems.

Communications connectivity is another very important wingman requirement, and is the key to successfully integrating space systems into the cockpit. This allows the "wingman" to impart knowledge of the tactical situation, provide warning of threats not generated by the leader's on-board sensors, and pass information from other support units which will contribute to successful mission accomplishment. There is a valid concern that task saturation can occur with too much information coming into the cockpit. By bringing in the operators early on, and experimenting in realistic tactical situations with the types and amounts of information per unit time we prevent the "fire hose" effect. By allowing receiver filtering of information, the pilot can plan his mission, set filters before takeoff, and then get what he wants, when he wants it during his mission profile. The man-machine interface factors for helping determine the acceptability of information have been progressing very well ever since the F-15 re-introduced the single-seat fighter concept to the Air Force. The real challenge is to integrate space-derived information in an easily digestible way which complements information from on-board sensors and other familiar information sources.

Space and the New Weapon Systems

A natural affinity exists between air power and space power. The kinds of information and update rates, coupled with predictability, global coverage, and communications connectivity make space systems very attractive to the operator as he looks for improvements in his employment capabilities. These capabilities exist today, and must be examined for their value added and operational utility at all levels of command. Draft Air Force Program Guidance for this year states the following:

> "As the department of Defense focuses on what each service does best, the unique characteristics of airpower -- speed, stealth, range/reach, flexibility, precision, and lethality -- will be at a premium."
>
> "...Investment priorities will focus on capabilities or platforms representing core combat capabilities of our aerospace force into the next century. We should increase efforts to evaluate our investment programs, implement lower cost acquisition strategies, and

ensure greater program stability to maximize combat capability."

The new weapons and weapon delivery systems under development today are becoming larger and larger consumers of higher and higher quality information delivered in less and less time. Statements of Need (SONs) and other formal documentation already on the books for numerous systems just being fielded, clearly show a need for support from off-board systems. In order to make good on the promise of ideas like adverse weather, autonomous, stand-off precision weapons, excellent connectivity between the sensor and the shooter needs to exist. The connectivity must be available during pre-mission planning, enroute to the target, and at the weapon delivery point.

In the past, technology constraints, security policy, and timeline requirements for top-level (National Command Authorities and theater commanders) assessments and planning dictated an "operational tempo" that was not driven by rapidly evolving tactical changes on the battlefield. Requirements for some space system tasking, collection, and information dissemination were sized to support strategic, deliberate technical analysis. Support timelines were measured in days, and performed well for the activities that were supported at a time when the principal emphasis was on the ability to respond effectively at the strategic level of conflict.

The Changing Environment

The current world economic and military environment is extremely dynamic. It remains to be seen whether the Russian Republics will stay the course with their experiments in greater freedom, with the accompanying wrenching changes in their culture, society, economy, and military. While strategic capabilities must be retained at a reasonable level *vis a vis* nuclear capabilities, we need to address the potential contribution of space systems to theater tactical, and low-intensity conflict as well.

U.S. forces are becoming smaller, lighter, and more expeditionary, based in CONUS and rapidly deploying worldwide to respond to crisis situations. Due to the increasing sophistication of possible adversaries, these lighter forces must be able to bring firepower to bear in a decisive, efficient way. Lift assets must provide smaller, more capable support packages which can be easily set up, transported, and used in adverse weather environments.

The SASC recently addressed this concern with this observation:

> "A variety of ongoing DOD programs provide terminals to tactical forces to receive, process, and display critical...data. The committee is concerned, however, that these systems are not being deployed widely enough or are too large to deploy easily in contingencies...."

End user terminals which require huge lift budgets for mobility will not compete favorably with beans and bullets when we try to deploy rapidly to a contingency. Additionally, these large processing units require large numbers of support personnel. Besides eating lift, these personnel increase the signature of deployed forces, and provide additional targets of opportunity for hostile action. A better situation would be to develop systems which can fit into the mobility kits of the war fighting units, leave labor intensive functions in CONUS, and use global connectivity devices to pass information to a smaller, lighter, less vulnerable deployed force.

A good example of how Air Force Space Command and Air Force Systems Command were able to solve the problem of large size quickly during Desert Shield/Desert Storm involves the Mark IV van which receives and processes the downlink from the Defense Meteorological Satellite Program (DMSP). Through a program called "High Gear," Systems Command was able to retain the capabilities of the Mark IV van but shrink them from a C-130 load into a suite of equipment that, even with its packing cases, fits nicely in the back of a HUMMV. We need to do more along these lines with all end user terminals which receive/process space-derived information.

The trend in military operations worldwide is toward a technically more capable threat able to mask its intentions better, resulting in highly compressed decision, and response times, both in the cockpit and at command levels.

Recalling the Air Force Draft Program Guidance, we need to examine all available capabilities to improve our ability to operate at high closure rates and over large geographic areas that characterize air operations. Our C4I systems have to match the speed and area coverage potential of the air domain; that is, speeds from 200 - 800 knots and combat radius of about 1000 nautical miles (nm).

Our current airbreathing Service-organic sensors (E-3A, J-STARS, Rivet Joint, etc.) are limited to about 300nm line-of-sight. On the night of 16 Jan 91, the distance travelled by F-117s, F-15s, and other aircraft from the Saudi political border to Baghdad was approximately 600nm. The question is: who was watching the store and providing support to the aircrews for the last 300nm to the target?

How to Get There from Here

We need to expand the ability of space systems from the traditional C4I/mission planning functions into the mission execution functions. Space systems can indeed provide global situation awareness for the war fighters when they have penetrated beyond organic service sensors. To achieve a higher degree of operational utility involves reducing timelines for sensor tasking, collection and information dissemination.

Ongoing efforts to streamline and speed up information collection, analysis and dissemination will emphasize use of expert system processing for those functions which need them. It leads both the space and operational communities to a detailed discussion and examination of the utility of space systems with on-board processing capabilities and direct downlinks as well as centralized processing. In addition, war fighters need to evaluate additional alternatives such as satellite direct downlink to theater processors like those developed by the Army Space Program Office for support to the Corps Commander.

Where timelines can be reduced by eliminating intermediate handlers and middlemen, we can improve information flow to the trigger puller all the way up the chain to the theater commander. The objective is to improve all space systems' ability to process and provide the most timely data to all levels of command. That way operators can access information required to execute the ATO, the air component commander can access information to build the ATO, and the theater commander can access information to enhance the theater operational level of planning. This must be done in a way that still allows information access to other users as well. Detailed analysis, data base development and the other laborious tasks which form the baseline by which we can effectively employ military force must be equally well served in the future.

We must examine ways in which our existing space capabilities can be leveraged to provide cost savings in avionics development and design

for new aircraft and weapons systems (off-board complements to on-board sensors). At approximately $2000 per pound, any savings realized on avionics, when multiplied by large procurement numbers, can add up to significant cost savings.

Experiment with new ideas and capabilities. Few, if any, in either the space community as a whole or in the operational war fighting community can state conclusively what the bounds of the possible are with respect to operational utility and value added of space in the cockpit. We can establish the envelope by investing very small resources in user-oriented demonstrations and experiments which put space capabilities in the hands of the operator, allow him to exercise and train with them, assess these capabilities with simulation and analytical tools, and ensure that both the space and the operator communities become more aware of each other.

With the objective of making space real for the operator, HQ AFSPACECOM established the Space Applications Division in August, 1990. Manned by experts from all the major Air Force commands and their weapons systems as well as with engineers and space personnel, the office is chartered to work with both the aircrews and with the space communities. Since the office's beginning coincided with Desert Shield/Desert Storm, interest in how space systems performed in the war has been integral to the office's efforts. Part of the office's charter is to be the Air Force executive agent for a Congressionally mandated program known as Tactical Exploitation of National Capabilities (TENCAP).

TENCAP is an activity that all Services pursue with varying levels of success and funding. Both war fighters and Congress noted the impressive leveraging capabilities of TENCAP where the military was able to generate additional value added from the nation's investment in high-cost space systems. By developing simple, low-cost user terminals, improving communications connectivity, and educating operational users on the capabilities inherent in the systems, the TENCAP organizations were able to contribute some of the most valuable information systems in the Gulf.

While the capabilities by our nation's space systems are impressive, they are not unique from a support standpoint. They fit well-established concepts developed over the history or air warfare. Doctrinally and procedurally, these capabilities should fit into existing roles and missions of the Air Force as articulated in AFM 1-1, MCM 3-1, and in theater Operations Plans (OPlans).

In particular, operational planning has not addressed the capabilities of space to support the commander or his subordinates. There is a specific space support annex (Annex N) identified for providing required information on space capabilities in support of the plan. Generally, the Annex N is very skimpy on detail, or non-existent. Recently, the Air Component Command of US Forces Korea was the first Air Force organization to develop a detailed space support annex to OPlan 5027. By developing the plan, the command was able to improve its knowledge about space systems as well as identify operational shortfalls. Those shortfalls can be used to initiate formal requirements to improve various combat functions by adding space-derived capabilities to in-theater capabilities. Additionally, this gives the theater a good baseline from which to exercise space systems in support of the OPlan, thereby giving the operators greater insight into the support available from overhead.

Of equal importance to the planning process is the need to get hardware and prototype systems into the hands of the operator. There are several ongoing projects designed to explore and investigate integrating off-board sensor information into the cockpit, to examine more efficient ways to provide warning data on tactical ballistic missile launches, to bring space capabilities into the new Theater Battle Management initiative chaired by Air Combat Command. Also, a simulation facility is being developed to assess the value added of space systems to theater level war fighting, and education efforts are ongoing throughout the USAF.

Space Applications Division Projects

The first priority of the office is to get space hardware and capabilities in the hands of the operators, preferably in the cockpit. To that end, we have begun a project known as Talon Sword which takes advantage of the ongoing interest in Real Time Information to the Cockpit (RTIC) by the tactical air forces. Talon Sword builds on the "Fastball" F-16 work done by Air Warfare Center in trying to fuse various information inputs and then pass them into the cockpit and display them in a timely fashion to the pilot. This study will focus on tactically useful information which will be assessed principally in terms of its utility in improving situation awareness. The Navy will participate with an EA-6B equipped with a Tactical Receive Equipment (TRE) suite aboard. However, an adjunct to the demonstration will be to explore the ability to provide targeting quality information to a stand-off, precision weapon.

One of the most important aspects of all demonstrations is to adequately provide communications connectivity to all participants. The office will provide suitcase-sized UHF satellite communications hardware along with small SHF transceivers to support exercises in the Far East, within CONUS, and in Europe. Successful use of SATCOM will free commanders from having to depend exclusively on heavy, static landline-specific communications architectures, and will allow a much higher level of mobility, flexibility, and throughput.

Once the hardware is in the hands of the operators, exercising and training with it is vital. The Space Applications Division works with other service TENCAP organizations and air components to integrate space capabilities efficiently into large-scale theater efforts as well as daily training. In Korea, exercise Cope Jade will provide an opportunity for the air component commander to exercise its newly developed space support plans. The upcoming JCS Special Project 93 will also examine the utility of space systems from a unified command theater standpoint. The Army is lead on Questor Grail, part of a continuing series of tests to improve the timeliness and accuracy of tactical ballistic missile warning data to air defense units.

The adage that "you fight like you've trained, so train like you'll fight" was proven once again in Desert Shield/Desert Storm. Any operator who has been in combat knows that unless he/she has trained with a capability and is proficient in using it, a promised capability which only appears when the first bullet goes by the windscreen will not be used effectively. It will probably be dispensed along with the chaff and flares. That is why the emphasis on training and exercising with our nation's space systems needs to be conducted all the way down to brigade and wing operational levels. The good news is that many valuable capabilities can become available with changes to procedures, philosophies, and policies.

Air Force Space Command is actively participating in the Theater Battle Management initiative by integrating space-based capabilities into the emerging C4I architectures being developed to support the war fighter at all levels of command. The efficiencies achievable by using the global connectivity offered by SATCOM will contribute greatly to the stated objectives in the Air Force Program Guidance.

One of the areas that needs rigorous examination is the explicit modeling of space systems support to theater level warfare. While there

are numerous tools at all levels of fidelity and aggregation to examine theater war, and a similar number of excellent space analytical tools, a need exists to tie the two together with specifically developed Measures of Effectiveness (MOEs) to assess the value added of space to war fighting from an analytical standpoint. The office has begun a modest effort to attempt that feat. We will not conduct comparative evaluations of the various space systems; that is not our charter. But we can provide an operationally relevant viewpoint about how space systems might contribute.

The Challenge: Focus the Vision

The paradigm shifts that have occurred in world affairs also greatly affect the military. The emerging third world countries with access to highly sophisticated military hardware, coupled with our current budget constraints, rapidly advancing technologies, and the continuous search for greater efficiencies dictate that all of this country's capabilities be examined carefully for their potential contribution to support military operations. The issue is not whether we should have a military, but rather how well we can focus military power in a timely, effective fashion when, where and at the level of force necessary to successfully carry out national policy. However, in order to make good on the promise space systems hold, both operational war fighters and the space community as a whole must re-think the way we have done business for the last thirty years. New national strategies directed at regional contingencies being fought with a CONUS-based, small, lethal expeditionary force structure will demand highly responsive space system support.

We must avoid becoming mesmerized by technology for technology's sake. Operational requirements need to drive how we spend our next dollar within the space community. In an austere budget environment, clear strategy-to-task-to-force structure methodologies must direct our ideas and R&D efforts. The space communities need to be attentive to the emerging C4I initiatives like the Navy's Copernicus and the Air Force's Theater Battle Management, and build new capabilities that are interoperable with military systems.

To summarize, there is a fantastic opportunity for the U.S. military to greatly improve its capability to operate effectively in a dynamic, rapidly changing threat environment at all levels of conflict by better use of space systems to support military operations. The key, for the Air Force, is to put these capabilities in the hands of both the aircrews and the

commanders. As we gain in sophistication, we can anticipate cost savings in new avionics packages, greater accuracy and timeliness of information exchange, and, to return to Mr. Peters' quote, a resulting "X" in the win column by bringing space systems into the flight as another wingman.

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